中国天文学会 2024 年学术年会

论文摘要文集

大会报告摘要

极大光谱巡天望远镜 ESST

崔向群　中国科学院南京天文光学技术研究所

LAMOST 已经鼓励和激发了国际上多个开展大规模光纤光谱巡天的计划。近些年来，围绕天体物理的前沿科学问题，欧美相继开始计划研制 12 米口径的大视场光谱巡天望远镜，开展超大规模光纤光谱巡天。带有鲜明中国特色的 12 米-16 米全反射大视场极大光谱巡天望远镜 EST（Extremely larger spectroscopic survey Telescope）方案具有同时观测 5 万个天体的超大规模光谱巡天的能力，可以开展星系面源的光谱巡天、还具有大口径精测的能力和开展中红外天文观测的能力。EST 的提出和实施，将使得中国可以再次占据光纤光谱巡天这一领域的高地。

爱因斯坦探针卫星及其初步探测结果

袁为民　中国科学院国家天文台

时域天体物理学已经进入了多波段和多信使观测的黄金时代。 X 射线的宇宙是动态的，有丰富的高能暂现和耀发源，其中一些本质上仍然是神秘的，而更多的等待发现。 2024 年初成功发射升空的爱因斯坦探针（EP），是一个空间 X 射线天文天文台。EP 在国际上首次实现了微孔 X 射线聚焦成像这一创新技术的大规模空间在轨运用，探测灵敏度和空间分辨率比国际上该领域设备提高 1-2 个数量级，蕴含着巨大的发现空间。 EP 旨在对目前知之甚少的软 X 射线波段进行高灵敏度的监测，有望系统性发现的银河系内和河外的 X 射线暂现源，并监视已知源的时变。 EP 是由中国科学院主导、欧空局(ESA)、德国马普地外物理所(MPE)和法国航天局共同参与的空间卫星项目。本报告将介绍 EP 卫星、以及在轨测试运行情况和初步科学探测结果，并基于目前结果讨论 EP 的科学前景。

探索高红移星系富含重元素的星系周气体

蔡峥　清华大学

宇宙学模拟显示，星系通过暗物质晕内纤维网状的气体内流驱动恒星形成。这种气体流通过宇宙网，与星系际介质相连。但是观测上，还没有足够的直接证据来证实此图像。特别在早期宇宙，观测对星系内流、外流细节刻画严重不足。最近，我们建立了尺度超过 100kpc 的数十个红移 2 到 4 的大星云样本。利用积分视场光谱仪 Keck、ALMA、JWST、和 JVLA, 我们通过三维成像的方法，直接探测大质量暗物质晕中延展超过 100 kpc 的冷、温气体。利用这个样本，我们初步获得了高红移星系周介质的重元素分布、动力学。结合吸收线，我们更进一步发现，高红移星系的星系周气体可能富含重元素，这些被重元素增丰的星系周气体，能够以反馈内流的形式，驱动气体更迅速地冷却从而转化为恒星，这些观测一定程度上，加强了人们对高红移星系形成与演化的认识。

Early observations of stars and substellar objects with Euclid

Eduardo Martín

Euclid is a mission of the European Space Agency that was launched from Cape Cañaveral
in july 2023. It is a wide angle 1.2-meter space telescope that is taking deep high-resolution images and spectra of the sky. The two Euclid instruments are a visual imager (VIS) and a near-infrared spectrometer and photometer (NISP). We present here early scientific results of Euclid observations of stars and substellar objects obtained during the science verification phase. An updated overview of the scientific prospects of the mission in the context of stellar and substellar objects will also be presented.

“夸父一号”ASO-S 卫星观测总结和首批成果

苏杨　　中国科学院紫金山天文台

“夸父一号”卫星（先进天基太阳天文台，ASO-S）于 2022 年 10 月 9 日发射，实现了我国太阳综合性探测卫星零的突破和多项国内外首次。经过近一年的在轨测试，卫星在 2023 年 9 月底正式交付。卫星搭载三个科学载荷 FMG、LST 和 HXI，分别观测太阳磁场、日冕物质抛射和耀斑，研究磁场和两类太阳爆发的起源和相互间的本质关联，科学目标简称为“一磁两暴”。两年在轨观测期间，“夸父一号”捕捉到了数以千计的太阳爆发，包括 30 多个 X 级大爆发，并同国内外设备联合构成“天地一体”观测网。国内外学者利用 ASO-S 数据已发表近百篇论文，在白光耀斑、硬 X 射线立体成像、耀斑超高温等离子体、日冕莱曼阿尔法波、耀斑准周期振荡起源机制、Lyα 耀斑属性等方面取得了重要进展。

矮星系积分视场单元巡天

施勇　　南京大学天文与空间科学学院

星系光学巡天，特别是以 SDSS 系列巡天包括单光纤和积分视场单元观测等为代表，在星系恒星质量演化、星际介质再生、气体吸积、以及中心超大质量黑洞的增长等方面取得了重要进展。全面理解分层式等级结构形成理论，需要对小质量星系开展细致研究。我们通过 VLT/MUSE 和 ANU/WiFes 的观测开展矮星系积分视场单元巡天项目，基于高空间分辨率和高信噪比的数据理解矮星系中的暗物质分布、中等质量黑洞以及星际介质等，本报告将介绍该项目取得的前期结果。

空间引力波探测和低频引力波天文学

韩文标 中国科学院上海天文台

LIGO 对引力波事件的探测已经进入“新常态”，引力波天文学时代已经到来。在空间构建更长臂长的引力波探测器，可以对毫赫兹波段的低频引力波进行探测，其目标主要是超大质量黑洞，宇宙早期原初引力波等。报告将对空间引力波探测器进行概要的介绍，然后将对低频引力波观测所关心的科学问题进行详细的讨论。主要集中于讨论利用低频引力波研究超大质量黑洞附近的生态、宇宙学标准汽笛、黑洞的物理性质、引力理论检验等。

日冕磁场观测

田晖　　北京大学

磁场是日冕加热和爆发的能量之源，但日冕磁场迄今仍难以测量，这已成为制约太阳物理研究的最大因素这一。近年来，我们主要从两个方面对日冕磁场测量方法进行了系列探索。（1）我们基于近红外成像光谱观测，发展了二维“冕震”方法，由此测得世界首幅全局性的日冕磁图，并于近期首次在国际上初步实现了日冕磁场的日常测量，揭示了日冕磁场在近 1 年时间内的演化规律。（2）基于磁流体力学数值模型，我们首次通过正演验证了用磁诱导跃迁方法测量日冕磁场的可行性，并进一步发展和改进了该方法，还将该方法推广到其他恒星的星冕磁场测量中。

快速射电暴的起源、辐射和应用

戴子高 中国科学技术大学

快速射电暴（FRB）是持续时标为毫秒量级的、辐射频率为千兆赫兹的射电爆发现象，也是高能时域天文学的最前沿研究方向之一。从 2007 年发现以来，天文学家一直不懈地努力理解这类神秘现象，近几年取得了重要进展，包括已经观

测到 800 多个 FRB 源，其中约 60 个为重复暴源。本报告将介绍 FRB 的研究现状，特别是讨论 FRB 的起源模型、辐射机制和宇宙学应用。

从超新星搜寻到星系迷宫，China-VO 全民科学平台让社会参与天文发现和创新

李珊珊

全民科学（Citizen Science）项目通过公众参与来收集数据和解决实际问题，有效提升了公众对科学的理解和兴趣。这类项目允许普通公众直接参与到科学研究活动中，是大数据互联网时代最具特色的数据驱动的天文科学教育项目。自 2015 年起，中国虚拟天文台（China-VO）与星明天文台合作，首次推出了公众超新星搜寻项目，让用户可以简单看图的方式在线搜寻超新星。此后，在国家天文科学数据中心（NADC）的技术和资源支持下，China-VO 团队与不同领域天文学家合作，陆续推出包括“火流星上报系统”、“星系迷宫”和“星系马戏团”在内的六个不同类别和科研方向的全民科学项目，并搭建了国内最具影响力和规模最大的全民科学项目平台。本报告将介绍 China-VO 全民科学平台的项目的策划与创新，并展示多年来项目开展过程中的发现与成果。

南极天文光学望远镜研制与观测

李正阳 中国科学院南京天文光学技术研究所

中国南极昆仑站位于南极内陆冰盖最高点的 Dome A，距离海岸线约 1260 公里，海拔 4083 米，极夜期间的极寒、干燥、几乎可以忽略的风速等这些稳定的大气条件为天文观测提供了连续三个月的绝佳窗口期。自 2008 年开始，我国在南极昆仑站先后成功研制运行包括中国之星小望远镜 CSTAR、南极巡天望远镜 AST3、近红外望远镜等在内的多台套天文光学仪器，取得了利用珍稀台址资源开展前沿天文学研究的先机。本次报告将介绍在南极极端环境研制天文光学望远镜的过程以及部分观测成果。

探测动态宇宙：从法拉第到格罗斯曼

李茹　清华大学

墨子巡天望远镜（WFST）进展和早期科学成果

孔旭　　中国科学技术大学

本报告首先介绍中国科学技术大学-紫金山天文台联合研制的墨子巡天望远镜的建设进展。墨子巡天望远镜于 2023 年 9 月 17 日建成并开展巡天观测，报告将介绍利用墨子巡天望远镜先导巡天科学观测数据，在时域天文领域取得的一些早期成果。

人工智能新技术在天文中的应用

罗阿理 中国科学院国家天文台

本报告回顾人工智能（AI）技术的发展，介绍了从判别式 AI 向生成式 AI 的技术跨越。介绍不同时代的 AI 技术在天文学中的重要应用场景。在大模型主导 AI 发展的潮流下，transformer 为代表的工业界大模型以 scaling law 为指导思想不断扩大模型参数，而在天文学中怎样应用是值得探讨的。另一种不同的学派是所谓的世界模型学派，通过遮掩时空大部分数据强迫模型学习和发展对场景的学习，天文学研究也需要进行相应的尝试。当前的物理内嵌神经网络（PINN）主要应用是将边界条件作为损失函数进行约束，在天文中也有相应的应用。报告最后将讨论大样本多波段的天文大数据背景下，多模态大模型的分析方法是否适用于各种不同的场景。

1、射电天文分会场报告摘要

分子云的结构分层研究

杨戟　　中国科学院紫金山天文台

星际分子云普遍呈现不规则级联结构，但对这些结构的认识却很局限。基于银河画卷巡天的高质量样本，我们分析了一批分子云图像的流量-量度关系。结果显示，分子云的 12CO 流量-量度关系可以足够精确地用指数分布来描述。分析的一个重要发现是，部分样本的云流量-亮度关系呈现分段的指数分布，也就是辐射的分层。对比高密度分子气体的 13CO 辐射的分布像图后发现，12CO 流量-量度分布上的折断点所对应的边界与 13CO 辐射区域的外边缘相重合。在少量分子云的流量-亮度关系中还进一步发现了 2 个以上的断点。这些断点与分数维的联合分析结果高度一致，进一步支持了断点是分子云内部分层的结构分层。这些特性表明分子云演化过程中经历过显著的动态调整。本报告将介绍这些全新的发现，讨论可能的含义。

FAST meets MeerKAT: a panoramic view from clouds to stars

王科　　北京大学

The life cycle of the ISM is of fundamental importance to the Galactic ecosystem. We are carrying out a project that combines FAST and MeerKAT to study the formation of clouds and stars, in selected fields guided by our previous studies on the largest filaments in the Milky Way. In this project, we combine MeerKAT narrow band HI imaging at 0.35 km/s spectral resolution, currently offered as a shared risk, with FAST on-the-fly HI maps, together with deep wide field 21cm continuum images at a resolution of ~6 arcsec, obtained simultaneously with HI. The unique combination of wide field, high spectral and spatial resolution images of the two cutting-edge telescopes allow us to study the transition from atomic to molecular clouds, and the formation and death of stars. In this talk, I present our analysis of a pilot field, which contains several giant filaments, infrared dark clouds, HII regions, young stars, and supernova remnants. Of particular interest is that we identify HI narrow self-absorption features (HINSA) prevalent in distant star-forming clouds for the first time, and find cloud formation timescales comparable to star formation timescales, suggesting a rapid star formation scenario. Our project pushes the capabilities of both MeerKAT and FAST to the current limit, and that enabled us to conduct sciences otherwise infeasible.

分子云的几何结构

闫庆增 中国科学院紫金山天文台

内银道面分子云的 N-PDF 研究

唐雨平 上海师范大学

作为一种连接分子云大尺度湍流结构与小尺度恒星形成区的统计测度，分子云的柱密度-概率密度分布函数(N-PDF)对理解跨越多个空间尺度数量级的恒星形成过程有重要意义。目前，对分子云 N-PDF 的研究局限于邻近分子云以及银河系中的低密度区域。然而，银河系中分子气体高度集中的内银道面，由于严重的视线方向污染，极少成为研究分子气体柱密度分布的目标区域。在这项工作中，我将分离分子云视线方向污染的贝叶斯分析方法，并以对银心分子云的连续谱观测为例，初步论证该方法的可行性。对银心区域的数据分析表明，银心分子云的 N-PDF 呈现极其平坦的高密度幂律分布，与近邻分子云的 N-PDF 形态形成鲜明对比。

Cosmic Sculptors: Unraveling Core Formation in Molecular Clouds Using Numerical Simulations

Pak Shing Li 中国科学院上海天文台

Molecular clouds (MCs) serve as star forming nurseries, birthing stars through intricate processes. Recent observational studies have unveiled a fascinating truth: filamentary structures pervade MCs across a wide range of scales. These elongated threads of interstellar material, spanning from a few parsecs to tens of parsecs in length, play a pivotal role in star formation (e.g., Bergin & Tafalla 2007, Andre et al. 2014, Hacar et al. 2023).

Recent observations reveal rich filamentary substructures at parsec and even sub-parsec scales threading inside MCs. Dense cloud cores are found located along or at the intersections of these filamentary substructures (e.g., Tafalla and Hacar 2015). In this study, I use advanced large-scale high-resolution numerical simulations to explore the formation of dense cores in magnetized and supersonic turbulent MCs. Our investigation sheds light on (1) the stability of filamentary substructures and their physical conditions when cores are forming, (2) the consequences of the highly non-uniform gas accretion of dense cores as the result of the connection with filamentary substructure during their formation, (3) the frequent merging of cores due to their proximity along the filament substructures, and (4) the restructuring of

magnetic field around dense cores during their formation and evolution. I shall use a few examples in the simulation to discuss the dynamical evolution of some key physical properties, including mass, size, specific angular momentum, kinetic and magnetic energies of the dense cores. I shall also discuss the delicate balance between angular momentum due to gas accretion and the braking effect of the magnetic field of cores in their growing processes. The simulation outcomes offer valuable insights into some of the recent observations, such as highly non-uniform separation of dense cores forming along filaments (e.g. Miettinen 2012, Smith et al. 2023), the behavior of core-streamer systems (e.g. Ren et al. 2021, Olguin et al. 2023), and a variety of magnetic field structures around dense cores (e.g. Sanhueza et al. 2021, Pattle et al. 2021).

Tracing the magnetic field in filaments

顾琦烙 中国科学院上海天文台

The magnetic field is dynamically important in the star formation process, but the details are still under debate, especially the role it plays in the formation and evolution of filaments. Here, we present our new studies of the magnetic fields in some typical filaments based on the polarization observations from James Clerk Maxwell Telescopes to discuss the interplay between the magnetic field and the star-forming process.

Filamentary mass accretion towards the high-mass protobinary system G11.92−0.61 MM2

张遂楠 中国科学院上海天文台

We present deep, sub-arcsecond (~2000 au) resolution ALMA 0.82-mm observations of the former high-mass prestellar core candidate G11.92–0.61 MM2, recently shown to be an ~500 au-separation protobinary. Our observations show that G11.92–0.61 MM2, located in the G11.92–0.61 protocluster, lies on a filamentary structure traced by 0.82-mm continuum and N2H+(4-3) emission. The N2H+(4-3) spectra are multi-peaked, indicative of multiple velocity components along the line of sight. To analyse the gas kinematics, we performed pixel-by-pixel Gaussian decomposition of the N2H+ spectra using SCOUSEPY and hierarchical
clustering of the extracted velocity components using ACORNS. Seventy velocity- and position-coherent clusters (called 'trees') are identified in the N2H+-emitting gas, with the eight largest trees accounting for >60 per cent of the fitted velocity

components. The primary tree, with ∼20 per cent of the fitted velocity components, displays a roughly north–south velocity gradient along the filamentary structure traced by the 0.82-mm continuum. Analysing an ∼0.17 pc-long substructure, we interpret its velocity gradient of ∼10.5 km s−1 pc−1 as tracing filamentary accretion towards MM2 and estimate a mass inflow rate of ∼ 1.8 × 10−4 to 1.2×10−3 M yr−1. Based on the recent detection of a bipolar molecular outflow associated with MM2, accretion on to the protobinary is ongoing, likely fed by the larger scale filamentary accretion flows. If 50 percent of the filamentary inflow reaches the protostars, each member of the protobinary would attain a mass of 8 M within ∼ 1.6 ×105 yr, comparable to the combined time-scale of the 70-μm- and mid-infrared-weak phases derived for ATLASGAL-TOP100 massive clumps using chemical clocks.

Gravitational Shaping of Magnetic Fields and their Interplay with Gas Streamers in G335.579-0.292

焦文裕 中国科学院上海天文台

Prospects for Observing High-redshift Radio-loud Quasars in the SKA Era: Paving the Way for 21-cm Forest Observations

牛琦　东北大学

The 21-cm forest is a sensitive probe for the early heating process and small-scale structures during the epoch of reionization (EoR), to be realized with the upcoming Square Kilometre Array (SKA). Its detection relies on the availability of radio-bright background sources, among which the radio-loud quasars are very promising, but their abundance during the EoR is still poorly constrained due to limited observations. In this work, we use a physics-driven model to forecast future radio-loud quasar observations. We fit the parameters of the model using observational data of high-redshift quasars. Assuming Eddington accretion, the model yields an average lifetime of tq ~ 10^5.3 yr for quasars at z ~ 6, consistent with recent results obtained from quasar proximity zone observation. We show that if the radio-loud fraction of quasars evolves with redshift, it will significantly reduce the abundance of observable radio-loud quasars in the SKA era, making 21-cm forest studies challenging. With a constant radio-loud fraction, our model suggests that a one-year sky survey conducted

with SKA-LOW has the capability to detect approximately 20 radio-loud quasars at z ~ 9, with sufficient sensitivity to resolve individual 21-cm forest lines.

利用 HINSA 追踪氢分子的形成

邢宇辰 国家天文台

氢分子的形成是恒星形成的关键步骤，但寻找这些正在经历氢分子形成的早期结构具有挑战性。中性氢的窄线自吸收(HINSA)产生自氢原子与冷的氢分子之间的碰撞，可以用来示踪分子云核中残存的氢原子。在本研究中，我们展示基于 FAST 望远镜 CRAFTS 项目数据进行的普朗克冷核的 HINSA 搜寻。模拟表明在氢分子形成过程中，由于中心密度更高、反应速率更快，可能出现一个云中心的氢分子丰度更高的阶段。我们使用 HI, 13CO 和尘埃数据搜寻这些正在经历氢分子形成的早期结构，增进对氢分子的形成的了解。

ALMA Observations of Massive Clouds in the Central Molecular Zone: External-Pressure-Confined Dense Cores and Salpeter-like Core Mass Functions

张朕荧 中国科学院上海天文台

ATOMS stacked hot cores]{ATOMS: ALMA Three-millimeter Observations of Massive Star-forming regions - A sample of weak hot core candidates through line stacking

李紫杨 中国科学院上海天文台

ALMA-ATOMS 项目对甲醇的大样本调查研究

邹家航 中国科学院上海天文台

Characterising large-scale overdense galaxy structures at z = 2.2 with deep uGMRT observations

彭昊　　中国科学院紫金山天文台

Theories, simulations, and recent observations show that the galaxy overdensities at high-redshift are extended structures containing numerous star-forming galaxies (SFGs). The scale of these overdense structures reaches to tens to hundreds of comoving Mpc (cMpc). The intersections of these overdense structures are expected to host the “protoclusters”, which evolve into galaxy clusters later. Radio continuum observations can play a key role in our understanding of these overdense structures at high-redshift, because the thermal free-free emission traces photoionisation-based star formation and the radio synchrotron radiation is tightly correlated with far-infrared emission in the SFGs. In addition, the radio continuum emission at %\nu\lt% 30GHz is impervious to the dust attenuation. We had finished a deep uGMRT band-4 (550-850MHz) continuum survey for an overdense region at z = 2.2, which has been identified by combing the strong intergalactic medium Ly-alpha absorption systems and Ly-alpha emitters (LAEs) within 100cMpc. There is also a quasar overdensity at a similar redshift in the centre of this field, which makes this field a unique target for studying the growth of protoclusters and their associated large-scale structures. We present the imaging data of the uGMRT band-4 observations and show some preliminary results.

快速射电暴与脉冲星 glitch 的标度不变性研究

高崇宇 中国科学院紫金山天文台

The recent discoveries of a remarkable glitch/antiglitch accompanied by fast radio burst (FRB)-like bursts from the Galactic magnetar SGR J1935+2154 have revealed the physical connection between the two. In this work, we study the statistical properties of radio bursts from the hyperactive repeating source FRB 20201124A and of glitches from the pulsar PSR B1737–30. For FRB 20201124A, we confirm that the probability density functions of fluctuations of energy, peak flux, duration, and waiting time well follow the Tsallis q-Gaussian distribution. The derived q values from q-Gaussian distribution keep approximately steady for different temporal interval scales, which indicates that there is a common scale-invariant structure in

repeating FRBs. Similar scale-invariant properties can be found in PSR B1737–30's glitches, implying an underlying association between the origins of repeating FRBs and pulsar glitches. These statistical features can be well understood within the same physical framework of self-organized criticality systems.

FAST 球状星团脉冲星巡天（FAST Globular Cluster Pulsar Survey）

刘通　国家天文台

壳核相变点处的压强对中子星 M-R 关系的限制

刘学智 华中师范大学

The timing and polarization of PSR J0002+6216

魏宇　中国科学院新疆天文台

The origin of the initial spin and velocity of pulsars remains largely enigmatic. Fortunately, the detection of two-dimensional (2D) spin-velocity alignment in young pulsars has provided valuable insights into the origins of their rapid rotation and high velocity. By studying the spin-velocity relationship of the young pulsar PSR J0002+6216, we can impose stringent constraints on the mechanisms behind neutron star kicks. Our analysis, based on FAST observations, revealed variations in the interstellar rotation measure (RM) and allowed us to measure the direction of 3D spin axis. Combining Fermi and FAST data, we determined the pulsar's proper motion through timing, which is consistent with VLBI results. Additionally, we detected two glitches in the pulsar for the first time. Ultimately, we found that the 2D spin-velocity angle of PSR J0002+6216 is 23 degrees.

Glitches and glitching clusters in rotational pulsars

朱沛鑫 华中科技大学

作为能够直接揭示中子星内部物态的动力学现象，脉冲星 glitch 的研究对于理解极端高密度条件下的物质性质具有重要意义。

然而，为不同脉冲星观测到的各种现象提供统一的理论解释，仍然是一项艰巨的挑战。

通过研究 glitch 大小的分布和累积过程，我们发现了脉冲星 glitch 的长期聚类现象。

改变以往单独的看待每一个 glitch 的前提，我们提出在更长时间尺度上看待 glitch 活跃度与角动量的关系。

这种观点使我们能够从统一的立场来看待各种脉冲星中不同的 glitch 表现，将观测数据的某些周期性与随机性联系起来。

在不依赖特定物理模型的情况下，我们利用离散系数来确定 glitch 团的最佳分组和团周期。

我们对 30 颗脉冲星的分析揭示了 glitch 团周期与特征年龄之间明显的线性关系。

并且，glitch 团的大小与等待时间的累积分布函数（CDF）表现出相似的分布模式，可以通过高斯过程拟合。这些结果为 glitch 现象提供了新的理解。

基于 VLBI 的空间天线合成技术研究

刘畅　　中国科学院上海天文台

未来我国计划建设地月骨干链路，实现全月通信遥感以及区域导航，为后续深空探测任务提供技术支撑。在其基础上，计划将多颗卫星的抛物面天线合成大口径射电望远镜，并与地球大口径望远镜合作开展超长基线 VLBI 观测。本文对该 VLBI 网络的指标体系进行研究，明确在地月空间超长基线上实现 VLBI 测量的指标约束。为探究多颗卫星抛物面天线合成大口径 VLBI 天线的可行性，本文首先基于国内外相关研究总结出的经验关系进行建模，然后提出空间 VLBI 天线合成算法，最后利用鹊桥二号实测轨道结合多组模拟轨道进行算法验证。实验结果表明，该算法可以较好地预估不同轨道构型下针对不同类型目标源的空间天线阵的合成效果。

QTT—vivaldi 相控阵馈源数字波束合成

仵鹏　　中国科学院新疆天文台

面向国内自主 UT1 快速测量服务的自动化数据处理研究

刘龙辉 中国科学院上海天文台

地球定向参数(EOP)是实现天球参考架与地球参考架相互转换的参数，其中的 UT1 参数反应了地球自转速率的变化。UT1 预测值的准确性随着时间的推移而下降，为满足国内 VGOS 快速测量 UT1 的需求，观测数据的自动化处理是必须的。本报告针对国内 VGOS 系统，实现了 1 小时观测数据相关处理的自动化，并和人工处理结果做对比进一步验证了自动化处理流程的可行性

自适应 RFI 抑制研究

吴涵 中国科学院新疆天文台

Performance of the Segment Anything Model in Various RFI/Events Detection in Radio Astronomy

杨琰斌 中国科学院上海天文台

The emerging era of big data in radio astronomy demands more efficient and higher-quality processing of observational data. While deep learning methods have been applied to tasks such as automatic radio frequency interference (RFI) detection, these methods often face limitations, including dependence on training data and poor generalization, which are also common issues in other deep learning applications within astronomy. In this study, we investigate the use of the open-source image recognition and segmentation model, Segment Anything Model (SAM), and its optimized version, HQ-SAM, due to their impressive generalization capabilities. We evaluate these models across various tasks, including RFI detection, solar radio burst (SRB) identification, and pulsar/fast radio burst (FRB) analysis. For RFI detection, HQ-SAM (SAM) shows performance that is comparable to or even superior to the SumThreshold method, especially with large-area broadband RFI data. In the search for SRBs, HQ-SAM demonstrates strong recognition abilities for Type II and Type III bursts. Additionally, our tests on the signal-to-noise ratio (SNR) limits for detecting weak signals in dispersed dynamic spectra of pulsars (or FRBs) highlight HQ-SAM's notable capability to identify faint signals. Overall, with its impressive generalization capability, SAM (HQ-SAM) can be a promising candidate for further optimization and application in RFI and event detection tasks in radio astronomy.

基于云架构的分布式相关处理机研究

谢科屹 中国科学院上海天文台

随着甚长基线干涉测量（VLBI）观测需求的提高，更多基线与更高带宽的观测数目日益增多，观测产生的数据量急剧增长，成为现 VLBI 数据处理的一大挑战。为此提出了一种基于分布式云计算架构的 VLBI 相关处理机设计方案，并使用 Spark 框架搭建了原型机。通过 CPU+GPU 异构运算，计算速度超越了先前的云计算架构 VLBI 相关处理机。采用 MapReduce 模式设计，易于在云计算集群上部署，可提供对大规模 VLBI 数据高可扩展性与高可靠性的相关处理计算，以应对未来更大规模的 VLBI 观测数据处理需求。

Radio continuum surveys in the SKA era: source classification and radio spectral properties

安芳霞 紫金山天文台

The high-sensitivity, wide-field extragalactic radio continuum surveys conducted by facilities such as MeerKAT, ASKAP, and the future Square Kilometre Array (SKA) are revolutionizing our ability to explore cosmic evolution. To fully exploit this data, fast and automated methods, including machine learning, are becoming crucial. In this presentation, I will outline our machine-learning approach to classifying star-forming galaxies (SFGs) and active galactic nuclei (AGN) in radio continuum surveys. I will then introduce two of our recent projects based on data from MeerKAT+VLA+GMRT in the COSMOS field and LOFAR+GMRT+VLA in the ELAIS-N1 field, with a focus on the radio spectral properties of SFGs. I will discuss the physical mechanisms that shape the radio spectra of SFGs, highlighting key correlations between radio spectra and the physical properties of these galaxies. Furthermore, I will demonstrate the significant impact of using different radio spectral indices (from both low- and high-frequency ranges) in k-corrections, particularly in studies of the far-infrared-radio correlation of SFGs, which are key to broader investigations of cosmic evolution through radio continuum emission.

Simulating High-Redshift Radio Continuum and HI 21-cm Line Emission for SKA Observations

Masoumeh Ghasemi-Nodehi 中国科学院新疆天文台

Galactic gas contains atomic hydrogen (HI), a key component in numerous astrophysical phenomena. Investigating HI in and around galaxies provides valuable insights into the processes of gas accretion and feedback in classical galaxy evolution models, as well as the physical conditions that quench massive star formation over cosmic time. Sensitive measurements from the Square Kilometre Array (SKA) offer an unprecedented opportunity to explore HI in high-redshift galaxies. We model high-redshift HI maps of galaxies with star formation rates (SFR) and HI emission properties similar to those of nearby galaxies, such as M51. Our simulations assess the potential of planned surveys to map HI at high redshifts using SKA configurations and sensitivities. Additionally, we model the evolution of radio continuum (RC) emission on kiloparsec scales for both thermal and non-thermal sources within the redshift range $0.15 < z < 3$. This study aims to investigate: (a) the structures of thermal and non-thermal emission on kiloparsec scales; (b) the evolution of the synchrotron spectrum and thermal component at mid-radio frequencies; and (c) the detection of RC-emitting structures in the SKA1-MID reference survey.

FAST 中性氢宇宙学巡天

李毅超 东北大学

The Faraday rotation measure of the M87 jet at 3.5mm with the Atacama Large Millimeter/submillimeter Array

彭思佳 中国科学院上海天文台

Faraday rotation is an important probe of the magnetic fields and magnetized plasma around active galactic nuclei (AGN) jets. We present a Faraday rotation measure image of the M87 jet between 85.2 GHz and 101.3 GHz with a resolution of ~2" with the Atacama Large Millimeter/submillimeter Array (ALMA). We found that the rotation measure (RM) of the M87 core is $(4.5\pm0.4)\times104$ rad m−2 with a low linear polarization fraction of (0.88 ± 0.08)%. The spatial RM gradient in the M87 jet spans a wide range from $\sim-2\times104$ rad m−2 to $\sim3\times104$ rad m−2 with a typical uncertainty of 0.3×104 rad m−2. A comparison with previous RM measurements of the core suggests that the Faraday rotation of the core may originate very close to the super massive black hole (SMBH). Both an internal origin and an external screen with a rapidly varying emitting source could be possible. As for the jet, the RM gradient

indicates a helical configuration of the magnetic field that persists up to kpc scale. Combined with the kpc-scale RM measurements at lower frequencies, we found that RM is frequency-dependent in the jet. One possible scenario to explain this dependence is that the kpc-scale jet has a trumpet-like shape and the jet coil unwinds near its end.

近邻低光度活动星系核喷流的高分辨率 VLBI 观测研究

闫玺　　中国科学院新疆天文台

低光度活动星系核（LLAGN）是一类研究超大质量黑洞、热吸积流和喷流的独特天体。对它们进行充分的研究有助于全面理解 AGN 喷流的物理过程，这是因为过去的研究明显侧重于明亮的、遥远的耀变体。在本次报告中，我们将展示关于低光度活动星系核 NGC 4261 和 M104 的最新高分辨率 VLBI 研究结果，包括喷流的运动、准直、基本物理属性和毫米波射电辐射的可能起源。此外，我们还将简单介绍关于 NGC 3998 一些初步研究结果。

Swift-BAT 活动星系核的射电性质

常宁　　中国科学院新疆天文台

活跃星系核(AGN)在星系演化中扮演着至关重要的角色，其射电辐射为吸积和反馈机制提供了独特的见解。我们利用 SKA 先导巡天的数据，深入研究由 Swift-BAT 探测到的 AGN 的射电辐射性质。我们通过交叉认证 Swift-BAT 的 AGN 全天样本与 SKA 先导巡天（VLASS、RACS）的射电数据，我们将分析 X 射线光度、射电光度以及其他 AGNx 性质之间的相关性，这对于理解黑洞吸积和喷流形成之间的内在联系至关重要。尽管结果尚未完全得出，预期本研究将将提供：对硬 X 射线选择的 AGN 中射电辐射的理解，并深化对 AGN 吸积状态与喷流产生关系的认识。

FAST FRB Key Science Project

朱炜玮 中国科学院国家天文台

I will introduce some of the recent observational progress made by the FAST FRB Key Science Project, including unveiling how magnetars emit FRBs and recent solid evidence that supports some FRBs coming from the inner magnetosphere of magnetars.

快速射电暴的研究进展和展望

冯毅　之江实验室

快速射电暴（fast radio burst; FRB）是指遥远宇宙中突然出现的短暂而猛烈的无线电波爆发。快速射电暴发展为当今天文最大的热点前沿领域之一，迄今没有关于其起源的公认解释。本次报告将介绍快速射电暴偏振方面的最新进展。

快速射电暴周围的磁爆发现象

李晔　中国科学院紫金山天文台

南山射电望远镜宽带观测脉冲星

袁建平 中国科学院新疆天文台

Search and Study of Pulsars in Globular Clusters with FAST and MeerKAT

张蕾　中国科学院国家天文台

Pulsar search is an important foundation for studying compact objects, testing gravity test, and potentially elucidating the origins of FRBs. Globular clusters (GCs), among the oldest celestial bodies in the universe, are dense stellar clusters with abundant compact objects including high-value millisecond pulsars and exotic pulsar binary systems. In the last few years, the total known population of GC pulsars has increased dramatically, jumping from about 150 in 2018, to more than 300 today. Such a surge in new discoveries and the consequent "renaissance" of the field have been possible mainly thanks to two major radio facilities: the FAST radio telescope in the northern hemisphere and the MeerKAT radio telescope in the southern hemisphere. In this talk, I will present some major breakthroughs obtained with FAST and MeerKAT regarding GC pulsars, discuss the challenges that GC observations pose. Utilizing state-of-the-art pulsar searching techniques, we have successfully discovered a

number of new pulsars in different GCs, phase connected over three decades of timing data, revealed evidence of GC affected by its interaction with the Galaxy.

Single-pulse study of CRAFTS pulsars discovered at FAST

Rukiye Rejep　　中国科学院国家天文台

面向 SKA 的数字波束合成研究进展

顾俊骅 中国科学院国家天文台

作者以 SKA 低频孔径阵列为背景，基于位于新疆乌拉斯台的 21CMA 天线阵，开展了数字波束合成观测技术的研究。本报告将介绍此工作的最新进展。

BINGO 射电望远镜——到地球对面建站

张佳骏 中国科学院上海天文台

BINGO 射电望远镜是一台建设于巴西帕拉伊巴州的 40 米口径巡天射电望远镜。主要科学目标是 21 厘米强度映射巡天和快速射电暴监测。作为中巴合作的重点项目之一，该射电望远镜预计在 2024 年底建成。本报告将介绍 BINGO 射电望远镜的建设进展情况，并探讨未来基于 BINGO 射电望远镜进一步加强中巴科技合作的前景。

子午工程行星际闪烁望远镜

王威　　中国科学院国家空间科学中心

子午工程，全称“空间环境地基综合监测网”，是我国分两期建设的国家重大科技基础设施。子午工程二期于 2019 年开工建设，在一期工程的基础上，新增 16 个台站，形成沿东经 100°、120°、北纬 40°、30°“井”字型布局的 31 个台站、近 300 台（套）监测设备组成的空间环境监测网络，首次从地面实现对日地空间环境全圈层、多要素综合的立体式探测。行星际闪烁望远镜是子午

工程二期中的重要设备，可实现对行星际进行射电探测。望远镜由设在内蒙古的三个站点组成，主站包括 3 排 140 米*40 米的抛物柱面天线，两辅站各有一个 30 米天线。报告将着重介绍这望远镜的观测原理，设备构成、当前的研制进展和观测结构

天马望远镜的运维和科研

刘庆会 中国科学院上海天文台

天马望远镜已经运转 12 年。在月球和深空探测 VLBI 测定轨，谱线、脉冲星和 VLBI 射电天文观测研究中取得了一系列重要成果。本报告将介绍天马望远镜的运行状况，最近几年取得的重要科研成果，特别是今年完成的嫦娥六号 VLBI 测定轨情况予以重点介绍。

LCT 亚毫米望远镜天线辐射方向图分析

汪峥 东南大学

加州理工学院亚毫米波天文台望远镜(CSO)将从夏威夷的莫纳克亚山搬迁至智利的查南托高原，在那里重新组装并更名为莱顿-查南托望远镜(LCT)。恢复运行后，其科学目标是需要在高频率(857GHz)下达到高指向精度(1 角秒)。要实现这一技术指标，除了需要高精度指向模型和指向控制系统，也需要望远镜天线辐射方向图(特别是其主波束)具有很好的特性。在 LCT 亚毫米望远镜重新安装以及恢复观测的过程中，天线主反射面拼接镜面的安装误差以及新台址露天环境和高海拔下的重力及风载都会影响天线主反射面的面型精度，从而影响其辐射方向图的关键特性，包括主波束方向、主波束增益、半功率波束宽(HPBW)、旁瓣电平。本研究针对主反射面的镜面拼接误差、以及重力和风载作用下的主反射面变形，分别提出了不同的方法来快速计算 LCT 天线的辐射方向图，这一计算方法综合了光程差计算方法、光程差拟合方法、以及分段孔径场积分法。通过所提出的方法，可以针对 LCT 亚毫米望远镜天线几种典型的镜面拼接误差形式，以及不同天顶角下重力和风载的影响，分析其辐射方向图及其主要性能指标，并将有助于通过主动控制来优化主反射面面形、实现更高的指向精度。

基于地理共存概念下的射电天文台址无线电环境数据分析与保护区规划

董亮 中国科学院云南天文台

大型射电望远镜天线热变形调控及系统

连培园 西安电子科技大学

增大射电望远镜的天线口径和工作频段是提升射电望远镜性能的有效途径。目前国际上已经建成的大型射电望远镜相当多，例如美国 100×110 米射电望远镜、德国 100 米射电望远镜以及意大利 64 米射电望远镜等，国内也先后有堕胎大型射电望远镜投入使用，例如上海 65 米射电望远镜，天津 70 米射电望远镜以及在建的新疆 110 米、云南 120 米等超大口径射电望远镜等。射电望远镜通常工作于高原山区或者荒漠戈壁，工作环境恶劣（热载荷、风荷等），导致天线的电性能严重下降。日照热载荷作为射电望远镜天线重要载荷之一，因材料热胀冷缩固有特性，其与重力及风荷的影响机制不同，难以通过结构刚度设计减小其对电性能的影响，对于高精度射电望远镜而言，热变形引起的天线形面误差可占到 30%-40%左右。日照热载荷已成为大型高精度射电望远镜不可忽视的制约因素，研究温度场-位移场-电磁场多学科交叉耦合问题，控制热变形对天线性能的影响是目前亟待解决的科学难题。

目前工程中为了降低太阳辐射对射电望远镜电性能的影响，部分高精度射电望远镜天线系统配置了温控措施，例如加装天线罩或者隔热板等或者采用低热膨胀系数的碳纤维材料来建造天线，然而上述措施的制造成本及其高昂，对于超大型射电望远镜而言是不现实的。既然热变形难以避免，研究热变形补偿机制则成为潜在抵御热环境影响的重要手段，若能够实时得到反射面的热变形，则可通过调整机构实现热变形的实时补偿。为此，本文从温度场获取、电性能评估、热变形调控以及系统研制等方面进行介绍。

首先，为了获取反射面天线的热变形就需要先获取天线的温度场。基于天线节点热敏度分析和工程经验，在天线辐射梁关键节点布置温度传感器且周向呈现对称分布，同时在天线座架关键节点布置温度传感器或采用倾斜仪研究座架热变形对天线指向的影响；当获取部分测量温度数据后可采用合适的插值算法实时重构天线整体温度场，例如距离反比插值、Kriging 插值、Barnes 客观分析插值等，将获取的温度场作为热载荷施加在有限元模型上获得天线热变形。

其次，为了快速评估天线热变形对电性能的影响就需要建立机电热耦合模型。将面电流积分公式中指数误差项进行分段线性展开，在保证精度和计算速度的前提下进行系列近似处理，将积分形式转变为线性矩阵形式建立热变形与电性能之间矩阵函数关系；基于插值算法获得温度传感器所在节点与天线所有节点之间的温度场插值矩阵，基于有限元模型建立天线所有节点温度场与天线热变形之间的热影响矩阵，进而获取温度传感器测量数据与天线热变形之间的矩阵函数关系；基于上述两个矩阵函数关系即可分析测量温度、热变形、电性能之间的耦合影响。

然后，利用主动主反射面技术对天线热变形进行调控。从面板刚度方程出发在主动面区域中的反射面每一环面板中均选取一块面板，建立单块面板变形与面板四角支撑调整量之间的函数关系，通过旋转变换得到同一环其他面板相应的函数关系，再将所有面板的函数关系组集成整个主动面区域的形面调整矩阵；基于该形面调整矩阵推导主动主反射面促动器最优调整量计算模型，由于目标函数均方根

误差可以表示为调整量二次型函数，故基于二次型最优方法推导得到调整量显式表达模型，实现了主反射面促动器调整量的快速高精度计算。
同时，在主动主反射面调控过程中副面和伺服系统要实时配合实现协同调控。将主面的调整过程分为多次进行，每次调整过程都进行副面与主面的实时匹配，同时计算天线系统整体指向偏移量，利用伺服系统实时调整天线的指向状态，保证天线调整过程中保持较优的电性能；多系统协同调控考虑了主反射面调整过程中的天线变形，在主反射面调整过程中通过调整副面位姿来实现主副面匹配，并通过调整伺服系统来补偿天线的指向偏转，在实现多系统协同调控的过程中，主反射面、副反射面和伺服系统的调整是同时进行的。
最后，基于上述理论研制了大型射电望远镜天线的机电热耦合分析与协同调控软件系统，实现了温度场插值、热变形计算、电性能评估与调整量计算等功能；同时针对喀什 35 米反射面天线对热变形严重影响天线指向精度问题，开发了一套热变形下天线指向补偿软硬件系统，实现了温度场采集与重构、电性能计算评估、伺服系统调整量计算以及相应数据存储与显示等功能，实时将方位和俯仰调整量送往天线控制单元实现天线指向的实时修正。
上述大型射电望远镜天线热变形调控理论与软硬件系统，解决了热环境下大型射电望远镜天线温度场-位移场-电磁场之间非线性多场耦合和服役过程中电磁性能实时补偿难题，为提升现有服役大型射电望远镜天线的性能提供了理论支撑，相关系统可直接应用于工程中，相关理论对我国大口径高精度反射面天线的研制也具有重要的参考价值。

基于压缩感知的射电干涉成像方法

杨晓城 浙江理工大学

综合孔径射电望远镜在射电天文领域具有重要的应用价值。然而，综合孔径射电望远镜成像反演过程是病态的反问题。虽然以稀疏平均重加权分析(Sparsity Averaging Reweighted Analysis, SARA)算法为代表的压缩感知技术已经成功应用于综合孔径射电望远镜成像中，但是目前的射电干涉成像方法依然存在较大的重构误差。为了提高射电干涉成像的精度，提出了两种新的算法：

1）提出了一种基于小波紧框架的射电干涉成像方法。该方法将射电信号稀疏地表示为方向性的张量积复小波紧框架，其可以有效地表征图像的背景和纹理信息。为了提高计算效率，采用投影快速迭代软阈值算法求解 L1 范数最小化问题，并利用双变量收缩规则自适应地更新正则化参数。通过数值实验验证了该方法的有效性和性能。

2）传统的 SARA 算法通过求解 L1 范数最小化问题来近似代替 L0 范数最小化问题，其存在一定的偏差。针对上述偏差问题，提出了一种 Lq（0<q<1）近端梯度算法以提高成像反演的精度。该方法利用近端梯度算法高效地求解 Lq 范数最小化问题，并采用重启和延迟启动策略减少振荡，加快收敛速度。数值实验结果和定量分析验证了该方法的有效性。

国家授时中心 VLBI 系统及进展

姚当　　中国科学院国家授时中心

中国科学院国家授时中心正在运行一个 3×13 米的大地测量系统 VLBI 系统，包括位于吉林、新疆、海南的 3 个站点和位于西安的一个数据中心。该网络的基线长度在 3000-4000 公里之间。每个站都配备了低温制冷宽带接收机、氢钟和 GNSS 接收机。VLBI 网于 2017 年建设完成，2018 年开始开展 UT1 测量工作。本文将介绍测地 VLBI 观测网，并展示近期在大地测量方面的工作，包括 UT1 测量，软硬件升级以及 EOP 综合和预报。

长周期脉冲星自转减慢规律与高速中子星

彭秋和 南京大学

2、太阳、行星分会场报告摘要-太阳部分

太阳抵近探测

林隽中国科学院云南天文台

感应爆发事件的多波段观测研究

张擎旻中国科学院紫金山天文台

我们对 2024 年 2 月 9 日活动区 13575 的爆发事件进行了后续研究。热通道的爆发产生了一个 X3.4 级耀斑、一个全晕状日冕物质抛射（CME）和一个极紫外波。极紫外波与宁静日珥发生作用后，驱动日珥大幅度横向振荡。横向振荡结束不久，该日珥逐渐失去平衡进而爆发出去。GOES-16/SUVI 和 ASO-S/LST/SCI_UV 两个仪器完整观测到它的上升过程，从低日冕到 2.2 Rs(太阳半径)。日珥的速度从 12.3 线性增加到 68.5 公里每秒。日珥感应爆发产生了一个具有三分量结构的 CME，CME 的亮核就是日珥本身，而且在 SOHO/LASCO 视场中可继续追踪到 3.3 Rs。CME 的亮前沿也经历了加速运动，从 120 到 277 公里每秒。这是第一次报道在 Lyman-alpha 波段完整追踪一个爆发日珥从 1.1 到 2.2 Rs。

活动区 12673 爆发事件所引起的宇宙线事件的对比研究

于晓霞 中国科学院高能物理研究所

Two major solar eruptions on AR 12673 produced a Forbush decrease (FD) event on 2017 September 8 and ground-level enhancement (GLE) on 2017 September 10. The occurrence of two contrasting cosmic-ray events within 2 days that are associated with two similar X-class solarflares (X9.3 and X8.2) and share the same active region on the Sun provides us a rare opportunity to understand the dominant factors in determining the properties of transient cosmic-ray events. Using a suite of modern-day instruments continuously tracking solar eruptions from the Sun to the Earth with ground-based cosmic-ray detectors, we reveal the complete cause–effect chain of activities for these two events. We conclude that the different consequences on the ground arise from two effects of the eruptions near the Sun: (1) the geometric effectof CMEs and (2) the intensity effect of CME-driven shocks. The first eruption, which originated at the heliographic longitude of W34°on 2017 September 6, had its CME ejecta and CME-driven shock intercept the Earth, leading tothe FD event. The second eruption, which occurred on September 10 at W88°, only had its far flank

reach the Earth. The peak shock speed of 3344 km/s of the second eruption, much faster than the 2175 km/s of the first eruption, is the dominant factor producing the GLE event, even though the first eruption is better connected magnetically to the Earth and has a similar flare. The results indicate that the production of GLE particles can be dominated by fast-enough CME-driven shocks.

太阳色球的较差自转

万苗　　云南民族大学

带电粒子在磁重联出流区中的加速

李燕　　中国科学院云南天文台

太阳耀斑及日冕物质抛射爆发过程中，带电粒子可以被加速到很高的能量并产生硬 X 甚至伽玛射线，对空间环境及宜居环境产生重要影响。尽管我们知道磁重联在粒子加速过程中起到了很重要的作用，但具体的加速细节仍不是很清楚。本研究采用磁流体力学和试验粒子方法进行数值计算，研究了粒子在湍动磁重联出流区的加速。此报告将主要介绍我们所取得的一些主要结果。

太阳磁周期的演化规律

邓林华云南民族大学

日冕自转的初步研究

向南彬 中国科学院云南天文台

太阳日冕自转的研究对太阳发电机理论和日冕加热的认识都具有非常重要的意义。但是，日冕对于紫外波段是光学薄的，没有像光球层的太阳黑子这种长时间存在的示踪物用于对日冕自转的精确研究。同时，到目前为止，仍然没有日冕磁场的准确测量。因此，对于日冕自转的研究存在诸多困难，仍然是一个开放性的课题。

本报告主要是介绍利用太阳光谱辐照度以及全日面的射电流量对于日冕自转的相关研究结果。一方面，是介绍日冕自转比底层光球自转更快的原因及其日冕自转变化的驱动源；另一方面是介绍日冕自转随高度变化（径向较差自转）的规律，

以及径向较差自转的物理起源。

太阳磁绳/日珥爆发、行星际激波传播及相关粒子加速过程的数值模拟

赵小舟 中国科学院云南天文台

太阳耀斑、爆发日珥和日冕物质抛射等剧烈太阳活动对地球及其周边空间天气产生显著影响，直接关系到人类的宜居环境。本报告将深入探讨三个核心主题：（1）太阳磁绳爆发与日珥形成的磁流体动力学(MHD)模拟：基于标准太阳爆发模型，我们采用 2.5 维 MHD 模拟，在较为真实的重力分层太阳大气环境下，研究了两种磁绳爆发及日珥形成机制。我们发展了日珥形成的抬升模型，并提出磁岛输运导致日珥形成的新机制。前者刻画了光球汇聚运动驱动磁绳和日珥形成及爆发的过程，后者关注磁绳爆发的灾变模型和磁重联在日珥形成中的重要角色。这两种模型分别描述了磁绳在爆发过程中的形成和爆发前已存在的情况。同时，我们还研究了磁绳爆发过程中的“中尺度”现象及其与 QPP 的关联，重现了多波段观测图像，并提出了 QPP 的形成机制。（2）行星际空间中的激波-湍流相互作用：太阳风中普遍存在湍流，而日冕物质抛射在太阳风中传播时驱动行星际激波，这些激波与太阳风湍流相互作用常导致太阳高能粒子事件。通过 MHD 模拟，我们发现湍流经过激波后，激波上下游的等离子体团（即太阳风中的小磁绳）尺度发生突变，激波下游比上游存在更多较小尺度的等离子体团。这些结构在等离子体加热和粒子加速方面具有重要意义。（3）太阳爆发过程中的粒子加速模拟：我们将展示太阳爆发过程中粒子加速的初步模拟结果，包括粒子在 2 维磁岛中的非绝热运动，以及行星际激波加速高能粒子的 PIC-MHD 方法初步设想。在 PIC-MHD 方法中，背景热等离子体被建模为磁流体，非热加速粒子受洛伦兹力影响，考虑了非热粒子与背景磁流体之间的电磁相互作用。总之，我们的研究关注太阳磁绳和日珥的动力学、行星际空间中的激波-湍流相互作用以及粒子加速过程，理解甚至预测这些过程对人类宜居环境的研究具有关键作用。

日珥和耀斑振荡研究

宁宗军中国科学院紫金山天文台

基于多模态大模型的耀斑预报方法研究

林佳本 中国科学院国家天文台

太阳耀斑与剧烈空间天气活动密切相关，因此准确的预测预报耀斑爆发对高科技社会有重要意义。领域内已经有了大量基于统计方法、机器学习方法和深度学习方法的耀斑预报工作，但是，到目前为止准确的预测太阳耀斑仍然是一项极具挑战性的任务。近年来，LLM 发展迅速，其推理预测能力不断增强，课题组探索实现了第一个基于 LLM 和 MLLM 太阳耀斑预报的模型方法，通过输入图像和物理参数文本两种模态的数据，预测未来 24 小时内爆发耀斑的可能性，并在公开的 DRYAD 耀斑预测数据集训练和测试，结果表明该方法能够获得较高的预报准确率。同时，我们利用 2024 年的最新观测数据验证发现模型具有较好的泛化能力。

偏振技术及偏振测量终端 VIPS 研制

郭晶　　中国科学院南京天文光学技术研究所

湍流磁重联驱动的太阳低层大气非均匀加热模拟

程冠冲 中国科学院云南天文台

我国球载白光日冕仪的观测结果

康凯锋 中国科学院云南天文台

太阳黑子衰退过程中运动磁结构磁场性质分布特点

彭洋　　河北科技大学

太阳 10830Å 高分辨率观测带来的新认识

季海生 中国科学院紫金山天文台

NVST 10830Å 通道 AR13743 耀斑观测结果

李怀明 中国科学院云南天文台

太阳耀斑是太阳活动区中能量释放的主要形式。He I 10830Å 的亚稳态能量较高，该条件较多存在于色球层和过渡区；同时该波长位置光学薄的特性使其携带有从光球层到日冕的多层太阳大气的物理信息；因此在太阳大气动力学、能量释放与积累、各层大气之间的能量耦合、高层大气的驱动等太阳物理研究中扮演着重要角色。

本次观测使用 1280×1024 的短波红外探测器；该探测器是首支国产 1K 级像元的高性能短波红外探测器，由云南天文台许方宇团队研制。基于 NVST 的高分辨率和窄带 Lyot 滤波通道，对太阳活动区 AR13743 进行了持续观测，记录了多次耀斑的发生过程；对 10830Å 日面图像的动态演变进行了全程跟踪。与此同时，借助时间序列图像与高采样帧率，我们观察到暗条爆发和耀斑前后的等离子体辐射和物质抛射现象，分析揭示 10830Å 线与太阳各层大气的响应关系。

由于 He I 10830Å 光学薄的特性，使其滤波图像带有明显的光球特征，观测结果表明，在视野内存在两个大黑子和多个小黑子以及明亮的米粒结构，黑色的吸收暗影和黑子旁边流动的暗条像是光球层上方流动的雾，纤维状的吸收特征与黑子存在明显的结构相关和动力学联系。

通过对 10830Å 通道的数据分析，我们发现了 AR13743 区耀斑爆发过程中辐射通量的显著变化。在耀斑之前，一个明显的暗条出现在视野中，随着暗条靠近黑子处与黑子上方物质发生交换，这驱动了暗条的破裂。暗条由条带中心开始破裂，同时迅速扭曲，由破裂位置被向两端驱散。在附近引发双带状耀斑并把吸收物质急速向外抛射。在此期间，10830Å 线呈现出快速增强，表明在此阶段能量迅速释放，并伴随着大量中性氦的激发与电离。

耀斑中期视野亮度保存平稳缓慢变化。随着耀斑的消失，后期整个视野的亮度变得均匀且明显增加，可以判断是耀斑的能量加热了光球层引起的增亮，因为米粒结构变的明显与色球层的吸收物质呈现更高的对比度。随着大量的色球物质的流入和同时的 10830Å 辐射减弱，观测区域恢复到爆发前的状态。

结论：我们首次基于 NVST 10830Å 通道系统性地记录了 AR13743 区耀斑活动中的 10830Å 线谱动态变化，发现了其与耀斑能量释放、等离子体运动及磁场演化的紧密关联。此结果表明 10830Å 通道观测在揭示太阳低层大气物理过程中的重要性，并为未来深入研究太阳耀斑中的能量传输机制提供了新的手段。此次观测表明云南天文台高分辨率 10830Å 通道和 1280*1024 红外探测器研制的成功。

动理学阿尔芬波共振衰变及其对湍流谱的潜在影响

沈可勋 浙江大学

剪切阿尔芬波是普遍存在于空间、天体与实验室等离子体物理环境中的一类

不可压缩电磁扰动，在太阳风、地球磁层、太阳日冕与星际物质等研究中有重要应用。通过由等离子体非均匀性引起的线性模转换、或非线性波-波相互作用过程，剪切阿尔芬波可以产生小尺度的动理学阿尔芬波，后者具有有限的平行电场分量且可以横越背景磁力线发生传播，最终演化为频率远低于离子回旋频率、平行于磁场的扰动波长远大于垂直波长的阿尔芬性电磁湍流。为此我们需要定量研究阿尔芬扰动的非线性动力学与湍流行为。

在本工作中，我们采用非线性回旋动理学理论，推导出描述均匀、低比压等离子体中动理学阿尔芬波三波共振相互作用的一般非线性方程，将其用于分析动理学阿尔芬波的参量衰变不稳定性，并由自发衰变条件得到垂直波数空间的级联行为。若三支动理学阿尔芬波沿磁力线同向传播，垂直波数空间具有双向级联(dual cascade)的特征，与非均匀等离子体中电子漂移波湍流的级联行为类似；而当其中一支动理学阿尔芬波边带模相对于母波反向传播，垂直波数空间的能量传递行为既可以是反向级联(inverse cascade)，也可以是双向级联(dual cascade)，且在扰动垂直波长较小时，反向级联行为具有更大的非线性反应截面。这些结果，尤其是描述动理学阿尔芬波三波共振相互作用的一般非线性方程，可以应用于对动理学阿尔芬波自洽湍流演化与饱和湍流谱的研究，包括守恒律、不变量、弱湍流谱、涡旋结构等，同时也帮助理解空间与星系中的湍流演化与自组织行为以及无碰撞粒子输运与非局域能量传递。

2、太阳、行星分会场报告摘要-行星部分

通过对原行星盘的观测来探索行星形成的过程

董若冰 北京大学

行星在原行星盘中形成。原行星盘分布在恒星形成区，是围绕着年轻恒星(通常年龄在数百万年)的吸积盘，主要由气体和尘埃组成。行星如何形成是目前的前沿热点研究方向。近年来成像观测在原行星盘中发现大量结构。理论上，行星作为 引力扰动源，会对盘造成扰动并影响盘中物质分布和运动，并制造结构。通过研究这些结 构，并和理论预言比较，我们可以预言盘中正在形成的行星的存在，并推测它们的性质。这些新生行星对检验行星形成理论有着至关重要和无可替代的作用。 我将介绍本组在这一领域近年来的工作，包括使用一系列大型地基和空间望远镜(Subaru，VLT，ALMA，JVLA， HST，JWST 等)对行星盘中的结构进行观测和刻画，以及利用数值模拟对观测进行拟合， 并研究其中正在进行的行星形成相关的物理过程。

高分辨率偏振观测揭示 HL Tau 系统中不同尺度上的尘埃沉降情况的不同：对尘埃湍流扰动图像的启示

杨海峰 浙江大学

First ALMA observations of the HD 105211 debris disc: A warm dust component close to a gigayear-old star

刘琼 贵州大学

Most debris discs consist of a gas-poor, cold dust belt located tens to hundreds of astronomical units away from the host star. Many cold dust belts exhibit distinct structures attributed to the dynamic interaction of planetary systems. Moreover, in a few systems, additional warm components can be found closer to the central star, resembling the

asteroid belt or zodiacal dust in our Solar System. In this work, we investigate the structure of the disc surrounding the nearby F2V star HD 105211, which has a warm excess and a potential asymmetry in the cold belt. We applied the CASA pipeline to obtain the ALMA 1.3 mm continuum images. Then we constructed the SED and performed MCMC simulations to fit a model to the ALMA visibility data. To characterise the disc asymmetry, we analysed the ALMA images of two individual observation blocks and compared them to the previous Herschel images. Our modelling reveals that the disc is a narrow ring (23.6+-4.6 au) with low eccentricity positioned at a distance of 133.7+-1.6 au from the central star, which differs from the broad disc (100+-20 au) starting at an inner edge of 87+-2.5 au, inferred from the Herschel images. We found that both observation blocks show excess emission at the stellar position, while OB1 shows an offset between the star and the phase centre, and OB2 shows brightness clumps. We used a two-temperature model to fit the infrared SED and used the ALMA detection to constrain the warm component to a nearly pure blackbody model. The relatively low ratio of actual radius to blackbody radius of the HD105211 debris disc indicates that this system is depleted in small grains, which could indicate that it is dynamically cold. The excess emission from the stellar position suggests that there should be a warm mm-sized dust component close to the star, for which we suggest two possible origins: in situ asteroid belt or comet delivery.

A radiation hydrodynamic model of circumplanetary disks

陈卓　清华大学

During the final stages of its formation, a gas giant will typically develop a circumplanetary disk (CPD) around the planet, which can accrete some of the surrounding material. Meanwhile, satellites can grow and evolve within the CPD. Currently, there are few observational constraints on the temperature, density, and state of CPDs. In the hope of uncovering the interior of the CPDs, we conduct axis-symmetric 2D radiation hydrodynamic simulations. Our simulations suggest that the CPD of a gas giant may have temperatures as high as 2000K, which can sublimate high-temperature-resistant dust such as silicates and dissociate H2. In addition, the spin of the gas giant can affect the transfer of mass and angular momentum in CPD-gas giant interactions. In this report, I will show some physical processes of gas giant accretion through CPDs and discuss the formation and evolution of gas giants and their satellites

under more realistic conditions.

Post-disk Dynamical Instabilities on the Configuration of Hot Jupiter Systems

何莹　安徽师范大学

The predominant formation channel of hot Jupiters remains a puzzle in exoplanet science. One potential way to distinguish the different mechanisms is to study the characteristics of close-in companions to hot Jupiters. In this study, our main focus is to investigate the post-disc evolution of planetary systems initially composed of one Jupiter and several super-Earths through numerical N-body simulations spanning a period of 107 yr. Our findings uncover a positive correlation between the presence of close-in companions and the orbital periods of the giant planets. Specifically, we find that approximately 10.9 ± 1.9% of hot Jupiters and 36.4 ± 1.8% of warm Jupiters have close-in companions after 107 yr. We also investigate the effects of general relativistic, tidal dissipation, and initial spacing between Jupiters and their neighboring planets on the frequency of close-in companions for these short-period Jupiters. Our simulations suggest that the general relativity effect plays a crucial role in contributing to the isolation of hot Jupiters. Furthermore, we observe that the more compact the planetary systems are initially, the less likely it is for Jupiters to host close-in companions.

通过多波段观测检验 HD 34282 原行星盘的旋涡假说

马潇依 北京大学

HD 34282 是一个原行星盘，在毫米尘埃连续谱中表现出方位角不对称性。该不对称性与近红外散射光外盘中的单臂螺旋和阴影相吻合，这与模拟中显示的旋涡特征一致。因此，HD 34282 是少数在近红外和毫米波观测中均有旋涡确凿证据的盘之一。旋涡的存在对于行星形成至关重要，因为它们是形成行星胚胎的主要场所，也是行星潜在的诞生地。在本研究中，我们将通过比较 HD34282 的观测和旋涡的理论预测，进一步检验 HD 34282 的旋涡假说:1) 在较短波　上追踪的较小尘埃在方位角上的集中度低于较　波　上追踪的较大尘埃; 2) 较　波　上追踪的较大尘埃多困于在旋涡前方; 3) 旋涡中心的尘埃大小比背景环中的尘埃大一个数量级或更多。我们将通过高分辨率的多波　尘埃连续谱观测，比较

多个波　下的不对称结构的方位角范围和位置，并通过多波　光谱能量分布建模来限制尘埃的属性。一旦预测得到验证，本项目将提供最明确的旋涡验证，并将毫米连续谱观测中的方位角不对称结构与旋涡联系起来。

晚期物质落入引发的次生盘：关于原行星盘 HD 142527 中的非对称亚结构

张铭浩 中国科学院国家天文台

传统的原行星盘形成理论认为，原行星盘和原恒星共同形成于分子云的塌缩。然而，对原行星盘的大样本观测数据显示，许多演化较久的原恒星周围仍存在大尺度的吸积流结构，这表明盘形成模型需要考虑晚期物质落入 (late infall) 的可能性。晚期物质落入作为另一种可能很普遍的盘形成机制，认为原恒星盘除由分子云塌缩形成之外，也可以通过原恒星多次俘获外来物质（如经过的云团碎片）而形成。这一观点挑战了目前对原行星盘与行星形成的传统认知：一方面，考虑晚期物质落入将促使对原行星盘的物质组成和行星形成环境和原料来源的重新评估；另一方面，晚期物质落入可能引发原生盘的不稳定性（如 Gravitational Instability 和 Rossby-wave Instability 等），影响盘的演化进程，进而影响行星形成过程。此外，晚期物质落入还为解释原行星盘中如旋臂、吸积流条(streamer)、不共面的内盘和外盘、中央空腔等的非对称观测特征提供了新的思路。

HD 142527 的主星是一颗约为 2 太阳质量的年轻恒星，具有一个约为 0.13 太阳质量的伴星，其伴星轨道平面与外盘近乎垂直。其原行星盘具有很多显著的非对称结构，包括一条约 600 AU 的长旋臂、一个半径约 100 AU 的中央空腔，以及由倾斜内盘遮挡而投射到外盘上的一对阴影等。这些结构曾被环双星盘（circumbinary disk）模型成功解释，但最新的 VLTI/GRAVITY 数据对伴星轨道参数进行了更新，将轨道半长轴限制在~10 AU，远比之前环双星盘模型中应用的~30-50 AU 更紧凑。目前认为在这样紧凑的轨道，环双星盘模型将无法完全解释这些结构。此外，ALMA 12CO 旋转发射线图像显示，HD 142527 的长旋臂可能绕转了超过 360 度，目前尚缺乏机制来解释这一现象。

我们希望以 HD 142527 为例，探讨晚期物质落入过程如何产生次生盘并形成非对称的亚结构。我们提出了一个小尺寸 (~100 AU)、处于流体静力学平衡的球状云团在主星引力作用下被潮汐瓦解并俘获的模型，通过平滑粒子流体力学（Smoothed Particle Hydrodynamics）方法对其动力学过程进行数值模拟，并将模拟结果转化为分子发射线图像和尘埃散射光图像，分别与 ALMA 和 VLT/SPHERE 的观测数据进行形态和动力学特征的对比。目前我们的模型能够复现大部分观测到的形态特征，如旋转超过一圈的长旋臂和 100 AU 的空腔等；此外，旋臂的动力学特征也与观测结果较为吻合。

*理解星团中行星的形成与演化 UPiC-II: 疏散星团和移动星群中的行星和行星*候选体星表

戴远哲 南京大学

年轻行星能够帮助我们理解行星的形成与演化。目前，绝大多数的年轻行星是在疏散星团或移动星群中发现的。然而，总体样本规模仍然不足。为了创建一个更完整的年轻行星星表并方便未来的搜寻和证认，我们利用了最新的星团表格，并将其与行星星表进行交叉匹配。这使我们得到了一个比我们之前的工作 UPiC-I 更为全面的年轻行星星表。由于疏散星团和移动星群在年龄、大小和质量上有不同的分布，为了加以区分这两类恒星群，并方便后续统计工作的开展，在本研究中，我们根据雅可比半径将恒星群划分为疏散星团和移动星群。通过拟合疏散星团和移动星群的径向密度分布，我们补充了行星宿主恒星周围的恒星密度和星团的形态参数。最终，我们得到了迄今为止最大的年轻行星星表，包括 102 颗已确认的行星和 169 个行星候选体。其中，103 个行星/候选体位于疏散星团中，168 个行星/候选体位于移动星群中。此外，我们还整理了一个对应的行星宿主星团表格，包括 83 个疏散星团和 137 个移动星群，总共包含接近一百万颗成员星。

利用旋转流体实验装置开展纬向天平动激发的三模共振研究

孔大力 中国科学院上海天文台

类地行星与天然卫星的液核流体运动需要驱动力维持。典型的液核动力学驱动机制包含内部因素（例如热对流、化学成分对流等），以及外部因素（例如自转轴进动、天平动、潮汐等）。本报告介绍了中国科学院上海天文台研发的三轴旋转行星流体动力学实验装置（SHADE-1），以及利用该装置开展纬向天平动驱动液核运动的研究。关注的科学问题聚焦纬向天平动激发惯性波三模共振这一非线性现象，试图理解地月系统演化过程中月球纬向天平动对月球液核动力学演化的影响。

探月雷达观测嫦娥三号和四号着陆区月球次表层熔岩管道

的研究

丁春雨 深圳大学

月球表面之下的熔岩管道由于能够作为天然屏障，有效隔离宇宙射线和潜在的撞击威胁，被视为未来月球基地选址的理想选择之一。本研究以探月工程四期建设需求为牵引，以我国嫦娥工程探月雷达数据为主，融合多源对月球观测的数据，开展联合分析嫦娥三、四号着陆区月球表面之下熔岩管道的分布及其探测机制的研究。建立一套快速、有效的探测月球表面之下熔岩管的方法，准确识别月球表面之下埋藏熔岩管道的机制。利用探月雷达数据厘定可能存在熔岩管道的区域之后，再基于嫦娥三号、四号降落相机高清图像和数字高程模型数据，分析着陆区微观地形地貌特征。最后基于 LROC NAC 高精度影像和 Kaguya SLDEM 等高程数据，分析着陆区域大范围的宏观地质地貌特征和解译月球表面之下熔岩管道的形成机制。目前这方面的工作国内外学者研究甚少，也是对我国自主探月雷达载荷观测目标的一种全新尝试。研究结果呈现了着陆区月表下熔岩管道位置和大小信息，可以为充分利用月球地下空间和未来月球科研基地建设选址提供新的视角。

基于月震的引力波探测方法

陈弦　　北京大学

轨道的进动与章动现象及其对天体观测的影响

欧建文 韶关学院

轨道的进动和章动是天文学中两个常用的重要概念，然而其涉及天体力学、引力定律等方面晦涩的专业知识，使得大部分研究者望而生畏。本报告通过两个简单且趣味的研究展示对进动和章动现象的理解。

首先，有网络传言认为地球南北两极的海冰增加或者减少会导致地球重量分布不平衡，地球将会发生翻转。通过计算了地球结冰时导致的总转动惯量变化，然后利用欧拉运动学和动力学方程分析了地球的自转状态，指出冰雪地球在融化的过程中经历了进动和章动急剧变化的阶段；而在南北纬度 80°~90° 结冰时，其进动和章动变化较小，地球自转稳定。这一分析不仅有助于澄清网络上的不实传言，更重要的是可以提供了一个学习章动以及地球（或类似的天体）的自转稳定性的生动案例。

此外，惯性质量与引力质量是爱因斯坦弱等效原理（WEP）的检验标准之一，对等效原理的高精度实验测量和测量理论发展都有助于人们加深对等效原理及

引力本身的理解。我们在经典的行星运动轨道方程的基础上考虑狭义相对论效应，利用泰勒级数对洛伦兹因子展，得到与广义相对论框架一致的行星运动方程，并成功得到行星进动角。本课题着重考察破缺因子，通过改变测量参数把 WEP 破缺因子隐含在 c^{-2}的组合参数中。传统的测量方法是关注行星运动轨道的径向方向，我们的研究指出轨道径向上，由于 WEP 破缺引起的位移小至 c^{-2}量级，非常微弱，传统的径向测量方法难以测量；如果从运动轨道的切线方向，测量轨道的进动角，通过改变测量参数，所得对应参数的精度可达 10^{-13}，可以很好地验证弱等效原理。本课题的关键是泰勒级数展开，具备高等数学基础的本科生均能完成，但是基于轨道进动的知识扩展却研究意义重大。

Detection of Earth's free oscillations utilizing TianQin

杨雨鑫 中山大学

The measurement of Earth's free oscillations plays an important role in studying the Earth's large-scale structure. Space technology development presents a potential method to observe these normal modes by measuring inter-satellite distances. However, the disturbance from the Earth's low-degree gravity field makes it challenging for low Earth orbit gravity measurement satellites such as Gravity Recovery and Climate Experiment (GRACE) and TianQin2 to extract signals from Earth's free oscillations directly. Here, we propose that by taking advantage of the high Earth orbit, the TianQin satellites can effectively avoid this disturbance, enabling direct measurement of Earth's free oscillations. We derive an analytical waveform to describe the response of Earth's free oscillations in TianQin. Based on this waveform, we use Bayesian analysis to extract the normal modes from numerical simulation data and perform parameter estimation. Our findings reveal that for a magnitude 9.2, Sumatra-like earthquake, the resulting free oscillations will generate a signal that signal-to-noise ratio (SNR) is 66 in TianQin, and approximately 8 different modes can be distinguished. This result shows TianQin can open a new window to examine the Earth's free oscillations and study the Earth's interior and earthquakes independently from ground-based gravity measurement.

Dynamical stability of planetary systems in star clusters

吴开　西交利物浦大学

The dynamical evolution of planetary systems is an important field that aims to explain how the majority of planets eventually obtain their actual architecture. In a star cluster, it may explain the diversity of their architectures due to their different encounter history. I will first generally introduce the work of my group on the numerical simulations of planetary systems in star clusters, and then describe my work. I use LPS+, a new approach to bridge NBODY6++GPU and REBOUND code for gravitational N-body simulations, to investigate how the joint effect of the star cluster environments and planets affect the dynamical evolution and stability of debris discs. This study finds that when a planet is present in a planetary system, it (i) destabilizes debris particle orbits and speeds up their dynamical evolution, (ii) expels most particles in nearby and resonant orbits, and (iii) results in the remaining particles to mostly have small inclinations, and reduces the number of particles that obtain retrograde orbits. Among debris particles that escape from the planetary system and remain bound to the cluster, most originate from the colder regions of the planetary system, or regions near the planet. For star clusters with higher densities, (i) the spatial extent of the remaining planetary systems decreases, (ii) the planet's domain of influence first increases and then decreases, (iii) particles escaping from planetary systems are more likely to remain bound to the star cluster, and (iv) the eccentricity and inclination of surviving particles are typically higher.

基于宿主恒星的星震学分析揭示系外行星的命运

林文徐 中国科学院云南天文台

类太阳振荡普遍存在于演化后期的恒星中，蕴含着关于恒星内部结果的丰富信息，因此结合星震学与系外行星学，将成为研究演化后期宿主恒星与系外行星的重要窗口。星震学能精确计算宿主恒星的物理参数，为计算系外行星的参数提供全新视角；星震学能确定宿主恒星的演化状态，为研究系外行星的轨道演化提供关键线索。随着此类样本量的增加，我们或许能够找到全新的演化规律，进而揭示系外行星的演化命运。

Resonance trapping and stability during Type I planet

migration

林灵鸿 浙江大学

基于凌星样本揭示超级地球的密度和系统架构特点

王雪凇 清华大学

大小介于地球和海王星的超级地球和迷你海王星是近期系外行星研究的热点。我们对于这些太阳系内并不存在的行星还缺乏一些最基本的了解，比如其一些最基本的属性，例如密度和系统架构方面的特点。对这些基本属性进行深入的研究可以揭示它们形成和演化中的一些重要物理过程。本报告将从凌星发现的超级地球出发，通过建立具有稳定统计属性和自洽性的行星样本，揭示超级地球密度分布特点，和具有超级地球的行星系统在系统架构和动力学属性上的特殊之处，揭示超级地球系统与我们太阳系的异同。

天邻计划：大型深空紫外光学红外天文台

王炜　　中国科学院国家天文台

人类已发现5800颗太阳系外行星，其中大约60颗与地球的大小和温度类似，可能孕育生命。搜寻太阳系近邻的类地行星，寻找这些行星中可能存在的生命信号是 21 世纪的重大科学目标。天邻计划是一个计划中的大型空间天文台，它包括了 6 米级整体式 3 镜离轴望远镜，口径≥6.6 米，视场~10 角分，光学波段（550nm)分辨率~0.03″，波段覆盖 0.2-1.7μ m。它计划配置高精度位置传感器、高对比度星冕仪和高色散光谱仪等先进的科学仪器，将对太阳系近邻（30 光年）内的上百颗恒星开展类地行星搜寻和生命信号探寻。它计划在紫外波段搜寻臭氧信号，在光学波段搜寻氧气、叶绿素和水，在近红外波段搜寻水和甲烷。这些分子的存在，能够揭示行星上是否存在生命。除此以外，天邻还能够对系外行星族群开展深入研究，能为星系宇宙学、宇宙极端天体、恒星形成区、星际介质、太阳系天体等几乎所有天体物理学领域带来划时代的数据。

基于近紫外透射光谱分析超热木星的大气逃逸

黄辰亮 中国科学院上海天文台

TESS Timings of 31 Hot Jupiters with Ephemeris Uncertainties

单素素 中国科学院大学

TESS 系外行星后随观测证认与研究进展

王佳琪 中国科学院国家天文台

随着 TESS 望远镜系外行星巡天任务的开展，地基望远镜有了更多机会探测和证认新的系外行星。自 2019 年 10 月以来，我们对 TESS 系外行星候选体（TOI 目标）进行样本筛选，基于国内外分布于 10 余个不同台址的 20 余台 1-2 米口径望远镜开展了系外行星凌食测光后随观测和视向速度光谱后随观测，截至 2024 年 9 月共 TOI 目标观测 200 余颗。结合后随测光观测数据，以及兴隆 2.16m 望远镜、丽江 2.4m 望远镜的高色散光谱视向速度数据分析结果，初步证认了 1 颗致密热木星 TOI-1194 b、1 颗极低质量 M 矮星 TOI-1251 B。报告将主要介绍这项工作的后随观测开展情况与已证认目标的参数分析、性质研究进展。

Kepler 背景光成分模拟与分析

朱嘉鹏 中国科学院上海天文台

目前搜寻系外行星最有效的方法是凌星法，由于对望远镜测光精度有极高的需求，黄道光、银河系背景等噪声成分会影响系外行星的搜寻效率，特别是对暗弱恒星目标。另一方面，这些背景光成分分别主要与观测天区的黄纬、银纬有关，而且对搜寻系外行星而言，它们是观测天区固有的噪声，即：不可以通过调节望远镜机械或光学结构等方式避免这些噪声。因此，有必要对背景光成分进行模拟与分析，从而选取更适合搜寻凌星信号的望远镜视场。我们以目前搜寻系外行星最有效的 Kepler 望远镜为例，开展对其观测背景光成分的模拟与分析。由于 Kepler 望远镜观测时处于 Earth-trailing 轨道，其观测到的背景光几乎可以认为只有两部分主导：随观测时间变化的黄道光成分和与银纬相关的其它背景光成

分。我们对这两部分分别建模，并进行计算：基于已有黄道光强度的分布，我们通过建模，建立了从模型对望远镜实测的转换关系；对于与银纬相关的背景光成分，我们基于 Pioneer10&11 观测数据，结合较完备的 Pan-STARRS 观测结果，得到了较为纯净的银道背景光成分。最终首次将 Kepler 观测到的黄道光成分和与银道背景光成分分开。基于此，我们将得到的结果扩展到其它天区，这将对后续搜寻系外行星望远镜（如 ET）的背景光噪声进行定量化评估。

小质量系外行星的轨道周期-偏心率关系

辛科霆 南京大学

测轨道周期-偏心率分布就为不同的“热木星”形成模型提供了有效的限制：如盘迁移理论和高偏心率迁移理论。巨行星的轨道周期-偏心率分布还能用于限制恒星与行星之间的引力潮汐作用以及行星和行星之间的引力散射作用。然而，近年来，随着观测技术的不断发展，各种质量更小的系外行星（如“超级地球”和“亚海王星”）通过凌星和视向速度等方法被发现。借助目前不断丰富的系外行星观测资料以及 LAMOST 和 Gaia 观测对系外行星宿主恒星的精确刻画，我们将揭示这些小质量系外行星的轨道周期-偏心率关系，并探讨其背后所蕴含的小质量行星形成与演化历史。

耀发驱动的宜居性——在低质量恒星周围扩展生命潜力

高东洋 山东大学

基于丽江 2.4 米望远镜的小天体观测研究

张西亮 中国科学院云南天文台

The Metallicity-Inclination Relation: Higher Metallicity, Higher Mutual Inclination

华心言 清华大学

Stellar metallicity is very often found to correlate strongly with occurrence of certain types of planets or planetary system properties. For instance, Jupiter analogs are more common around metal-rich stars, while compact multis tend to be metal-poor. In this study, we present a correlation between the stellar metallicities and the mutual inclinations of multi-planet systems, suggesting that metal-rich stars host planetary systems are dynamically hotter. After investigating 89 targets with measured mutual inclinations from photometry analysis, we observed that planets orbiting metal-rich stars tend to exhibit more dispersed mutual inclinations. Moreover, there is no clear evidence linking the high mutual inclination of these inner small planets with the existence of outer gas giants, though more data are needed to draw any definitive conclusion. We also observed a similar trend in the stellar mass - mutual inclination space, which is not as significant as with stellar matellicity. We hypothesize that such systems accumulate more material within their proto-planetary disks, leading to a more intensive dynamical evolution process that can perturb the planets into misaligned orbits, resulting in higher mutual inclinations. Planet formation and population synthesis models tracking evolution of mutual inclinations would be needed to provide explanation for this correlation.

行星的成分研究

李敏

The Impact of Fiber Cross Contamination on Radial Velocity Precision

季辰阳 清华大学

In pursuit of discovering Earth 2.0, forthcoming precise radial velocity (RV) surveys necessitate advanced spectrographs with exceptional resolution.My study compares two designs of CHORUS, the Canarian Hybrid Optical high-Resolution Ultra-stable Spectrograph, slated for installation on the Gran Telescopio de Canarias in 2027. Developed by NAOC and NIAOT in China, CHORUS aims for a RV precision of lower than 10cm/s in the visible band. We evaluated the impact of fiber cross contamination

on radial velocity precision of GKM type stars, based on the other instrumental setup. We found the photon contamination between fibers is neglectable, and achieved the targeted precision at a more favorable signal-to-noise ratio (SNR). Future simulations will explore additional aspects of CHORUS's design, contributing valuable insights into photon-limited RV precision and the performance of analogous instruments.

NVST 10830Å 通道 AR13743 耀斑观测结果

李怀明 中国科学院云南天文台

太阳耀斑是太阳活动区中能量释放的主要形式。He I 10830Å 的亚稳态能量较高，该条件较多存在于色球层和过渡区；同时该波长位置光学薄的特性使其携带有从光球层到日冕的多层太阳大气的物理信息；因此在太阳大气动力学、能量释放与积累、各层大气之间的能量耦合、高层大气的驱动等太阳物理研究中扮演着重要角色。

本次观测使用 1280×1024 的短波红外探测器；该探测器是首支国产 1K 级像元的高性能短波红外探测器，由云南天文台许方宇团队研制。基于 NVST 的高分辨率和窄带 Lyot 滤波通道，对太阳活动区 AR13743 进行了持续观测，记录了多次耀斑的发生过程；对 10830Å 日面图像的动态演变进行了全程跟踪。与此同时，借助时间序列图像与高采样帧率，我们观察到暗条爆发和耀斑前后的等离子体辐射和物质抛射现象，分析揭示 10830Å 线与太阳各层大气的响应关系。

由于 He I 10830Å 光学薄的特性，使其滤波图像带有明显的光球特征，观测结果表明，在视野内存在两个大黑子和多个小黑子以及明亮的米粒结构，黑色的吸收暗影和黑子旁边流动的暗条像是光球层上方流动的雾，纤维状的吸收特征与黑子存在明显的结构相关和动力学联系。

通过对 10830Å 通道的数据分析，我们发现了 AR13743 区耀斑爆发过程中辐射通量的显著变化。在耀斑之前，一个明显的暗条出现在视野中，随着暗条靠近黑子处与黑子上方物质发生交换，这驱动了暗条的破裂。暗条由条带中心开始破裂，同时迅速扭曲，由破裂位置被向两端驱散。在附近引发双带状耀斑并把吸收物质急速向外抛射。在此期间，10830Å 线呈现出快速增强，表明在此阶段能量迅速释放，并伴随着大量中性氦的激发与电离。

耀斑中期视野亮度保存平稳缓慢变化。随着耀斑的消失，后期整个视野的亮度变得均匀且明显增加，可以判断是耀斑的能量加热了光球层引起的增亮，因为米粒结构变的明显与色球层的吸收物质呈现更高的对比度。随着大量的色球物质的流入和同时的 10830Å 辐射减弱，观测区域恢复到爆发前的状态。

结论：我们首次基于 NVST 10830Å 通道系统性地记录了 AR13743 区耀斑活动中的 10830Å 线谱动态变化，发现了其与耀斑能量释放、等离子体运动及磁场演化的紧密关联。此结果表明 10830Å 通道观测在揭示太阳低层大气物理过程中的重要性，并为未来深入研究太阳耀斑中的能量传输机制提供了新的手段。此次观测表明云南天文台高分辨率 10830Å 通道和 1280*1024 红外探测器研制的成功。

永恒的气候变化模式及全球气候变化的原因和对策

钟萃相

“天有莫测风云”是一句古老的名言。即使古人通过长期观察太阳的周年活动总结出了二十四节气，但由于他们忽视了月球的活动在小尺度上对地球气候变化的影响，他们总结形成的二十四节气常常不能准确地预示地球气候的变化。于是，作者研究了月球的活动对地球气候变化的影响，发现了月球的活动在小尺度上对地球气候变化影响的规律，总结出了太阳和月球的活动所决定的永恒气候变化模式。另外，作者还揭示了全球气候变暖、极端天气频繁出现和环境突变的原因和对策。

3、恒星与银河系分会场报告摘要

恒星活动与行星宜居性--紫瞳小卫星

周济林 南京大学

恒星活动对行星宜居性的影响至关重要。为了探测太阳系近邻 20 光年内 200 余颗类太阳恒星的紫外辐射，我们提出紫瞳小卫星计划，载荷为 30 厘米口径小望远镜，工作波段 200~310nm，采用光谱观测，光谱分辨率 R~100。欢迎广大学者参与。

结合系外行星和恒星科学：建立近邻宜居带行星搜寻目标恒星数据库

王雪凇 清华大学

恒星研究是系外行星研究的基石，只有对于系外行星的宿主恒星有着足够详细和深入的了解，我们才能够更好的知道系外行星诸如大小、质量、年龄等最基本物理属性。在距离我们太阳系 100 光年左右的距离内，大约有 200-300 颗适合未来空间项目搜寻生命信号的恒星。然而我们尚未对这些恒星的基本参数进行均一和可靠的测量。本报告旨在向恒星和银河系方向的同行们介绍近邻宜居带行星搜寻目标数据库(The BNT Catalog)，并从 BNT 数据库出发，着重介绍一些系外行星领域和恒星以及银河系领域的交叉研究，希望能吸引更多的国内同行加入我们，展开合作。BNT 数据库由清华大学、国家天文台，以及北京师范大学联合创立，由清华大学天文系系外行星观测课题组维护运行，预计年底前发布 BNT 数据库网站。

长基线天文光干涉在恒星天文学中的应用

徐腾　　南京天光所

长基线天文光干涉技术的空间分辨能力与单元望远镜的口径 D 无关，而与望远镜之间的最大基线长度 B 成反比。通过延长基线长度至数百米，在光学红外波段的成像空间分辨率可以达到毫角秒甚至亚毫角秒级别，将在恒星角直径测量、恒星大气、恒星黑子、恒星表面细节结构等研究中发挥重要作用。依托国内首个百米级光学红外干涉阵列，南京天光所希望联合国内天文学家将高分辨天文观测技术应用于前沿天文科学的研究中，取得具有高显示度的科学研究成果。

LAMOST 数据发布系统全新升级

樊东卫 国家天文台

LAMOST 数据发布系统在 2024 年进行了大规模升级，在兼容原有功能的基础上更好地支持虚拟天文台数据访问协议及多种丰富特性。用户除了能够在网站上进行复杂的数据检索、下载外，还可以方便地在 TOPCAT 等软件中进行数据检索，支持用户编写 ADQL 语句进行检索。同时，系统还提供了 API 接口及 Python 开发包，用户可以在自己的 Python 程序中直接调用网站功能进行星表检索及光谱文件下载、可视化。本报告将对这些重要功能更新进行说明，以便用户更好地使用 LAMOST 数据。

大规模巡天时代下高精度流量标准星数据库的构建与应用

肖凯　中国科学院大学

高精度星际尘埃消光规律及改正工具包

王舒　国家天文台

Frog-eyes' in Astronomy: Monitoring Binary Radial Velocity Variations Through Ground-based Photometry

郑传杰 国家天文台

Spectroscopic observations are a crucial step in driving major discoveries in the era of time-domain surveys. However, the pace of current spectroscopic surveys in acquiring radial velocity (RV) curves is increasingly unable to meet the demands of rapidly advancing large-scale time-domain surveys. To address this issue, we propose the 'Frog-eyes' system, which employs a pair of filters: one positioned near a strong absorption line to capture signals from Doppler shifts, and the

other placed on the adjacent continuum to monitor intrinsic variations. The combination of observations from the two filters enables the efficient extraction of RV curves from a large sample of binary stars using photometric techniques. Comprehensive mock simulations demonstrate that the binary orbital parameters can be precisely measured from the extracted RV curves for binary systems where the primary star has an effective temperature greater than 6000 K. With a typical ground-based photometric precision of approximately 0.3%, the uncertainties in the derived semi-amplitude K and eccentricity e are less than 10% and 0.1, respectively, for binary systems with K>30 km/s. These encouraging results are further validated by real observations of the hot subdwarf-white dwarf binary system HD265435, using a non-specialized 'Frog-eyes' system installed on Chinese 2.16m telescope. Once this system is properly installed on large-field-of-view survey telescopes, the rate of acquiring RV curves for binaries will be comparable to their detection in leading time-domain photometric surveys.

双星快速物质交换过程及共有包层演化

葛宏伟 云南天文台

二维转动恒星演化模型进展

张钱生 云南天文台

利用锂和铍研究恒星结构和演化

杨伍明 北京师范大学

在太阳和类太阳恒星中存在著名的锂耗散现象。其起因至今仍然没有得到解决。锂和铍是极易被摧毁的元素，它们只能存在于温度较低的恒星表面。在恒星中需要一种机制把锂和铍带到温度较高的区域发生核反应。如果这种转移机制效率过高将导致锂和铍被完全消耗，如果效率过低又不足以产生锂损耗。因此，锂和铍将会是人们研究恒星内部物理过程最重要的工具之一。又因为铍的核反应温度高于锂，因此它们能反映出不同深度的恒星性质，是我们研究恒星内部结构性质的重要工具。这里，我们将介绍一种能同时解释太阳的氦、锂、铍元素丰度，

角速度分布和星团角速度演化
的模型。

熵校准对流对小质量恒星结构与演化的影响

黎正阳 北京师范大学

混合长度理论被广泛应用于处理小质量恒星表面的对流包层，其中有一个自由参数α 。其数值的选择存在问题，根据太阳定标的α 不适合用于所有恒星。另一个问题是观测与理论得到的小质量恒星的质量-半径关系存在明显差异，从分离食双星观测到的半径比由太阳定标α 构建的理论模型预测的偏大 5%-15%。我们使用数值模拟得出的绝热熵对不同质量不同金属丰度恒星的α 进行校准，得到α 随年龄和质量变化。我们的结论是更小质量的恒星适用于更小的α ，富金属恒星也适用于更小的α 。此方法计算出的模型，与经典的演化模型相比，它最多可以扩大 6%-20%的半径，在一定程度上解释了质量-半径关系的差异。

Bridging the gap between luminous red novae and common envelope evolution

陈卓　清华大学

Luminous red novae and their connection to common envelope evolution (CEE) remain elusive in astrophysics. Here, we present a radiation hydrodynamic model capable of simulating the light curves of material ejected during a CEE. For the first time, the radiation hydrodynamic model incorporates complete recombination physics for hydrogen and helium. The radiation hydrodynamic equations are solved with Guangqi. With time-independent ejecta simulations, we show that the peaks in the light curves are attributed to radiation-dominated ejecta, while the extended plateaus are produced by matter-dominated ejecta. To showcase our model’s capability, we fit the light curve of AT 2019zhd. The central mass object of 6 Msun is assumed based on observations and scaling relations. Our model demonstrates that the ejecta mass of AT 2019zhd falls within the range of 0.04 - 0.1 Msun. Additionally, we demonstrate that recombination energy and radiation force acceleration significantly impact the light curves, whereas dust formation has a limited effect during the peak and plateau phases. Future working directions include 2D axisymmetric models and physics informed neural network models for fast inverse problem solutions.

氦星双星系统物质交换的稳定性研究

张力夫 云南天文台

低质量沃尔夫-拉叶星的形成

李志 云南天文台

Gaia BH1 的可能形成通道：来自三星系统中的内双星并合

李卓文 新疆大学

大约有超过 50%到 80%的大质量恒星处于双星、三星或多星系统中，同时大约有超过 30%的大质量双星和三星的大质量恒星系统会与伴星发生相互作用。在这次报告中，我们研究了大质量恒星发生并合后对整个沃尔夫拉叶星的星群以及最近观测到的 Gaia BH1 的研究。我们的研究包括了经典的双星星族合成，三星演化模型，旋转，磁场，化学均匀演化，超新星爆炸等。我们的结论是有超过 50%的沃尔夫拉叶星来自于双星并合，并且能解释目前观测到的到的沃尔夫拉叶星非常高的单星比例的现象；此外，通过三星演化模型和强磁场快速旋转模型，我们能解释通过三星系统中的内双星并合解释最近观测到的一颗长轨道周期的黑洞双星 Gaia BH1。

Benchmark brown dwarfs: A mildly metal-poor M2 + T5 wide binary, and a triple system of a T6 + T9 close binary with an M4 wide companion

张曾华 南京大学

我们报告两个新发现的稀有的基准褐矮星。一颗是微贫金属的 T5 矮星，它有一颗相距 7100au 的 M2 矮星伴星，距离太阳 33pc。另一颗是一个未分辨的 T6+T9 双褐矮星系统，它还有一颗相距 1600au 的 M4 矮星伴星，距离太阳 25pc。这颗 M4 的主星具有 H-alpha 发射线，显示其较为年轻。更具年龄与 H-alpha 的强度关系得出，这个系统的年龄为 3-16 亿年。在这个年龄，这颗 T9 矮星是处在褐矮星与气态行星的边界。我们使用 SOAR/Goodman/TripleSpec 和 VLT/X-shooter 观测了这两个系统成员的光谱。

贫金属褐矮星的光学表征

章俊龚 加纳利天体物理研究所

基于 LAMOST DR9 和 TESS 巡天的 M 矮星物理参数与磁活动研究

李文杰 贵州大学

我们分析了一个包含 641,095 颗 M 矮星的 781,232 条光谱的目录，这些数据来自大天区多目标光纤光谱望远镜(LAMOST)的低分辨率光谱数据发布 9(DR9)。基于 Halpha 谱线的等值宽度，我们确定了这些恒星的活动特性，识别出 107,134 颗活跃恒星，其中 31,175 颗恒星表现出 Halpha 变化。此外，我们通过 TESS 光变曲线中的恒星黑子活动与 LAMOST 光谱观测的 M 型矮星的色球活动之间建立了正相关性。利用 LAMOST 和 Gaia 数据，我们基于 Halpha 和 Hbeta 谱线绘制了银河系中所有 M 矮星的二维活跃比例分布图，确认随着距离银河盘的高度增加，恒星活跃比例呈下降趋势。我们还研究了色球活动与不同 M 型亚型恒星距银河盘绝对高度之间的关系。研究结果显示：对于 M0 到 M5 型矮星，Halpha 和 Hbeta 谱线的活跃比例在 0-300pc 范围内迅速下降；在 300-500pc 范围内，M0 到 M4 型矮星的活跃比例逐渐增加，而在 500-1000pc 范围内再次下降。相反，M5 型矮星在 300-500pc 范围内未表现出显著的逐渐增加，而在 500-1000pc 范围内则出现下降趋势。要确认这一现象，还需要更多的数据。

Invasion of a free-floating planet into the Solar System

黎健　南京大学

Rogue planets, also known as interstellar free-floating planets, are flooding the cosmic void, and their number is believed to surpass even that of main sequence stars in our Galaxy. In the early history, rogue planets could occasionally penetrate into the Solar system, similar to the recently observed interstellar object 1I/`Oumuamua. If a massive rogue planet were to enter our planetary system, it would significantly reshape its architecture, leaving discernible footprints behind. It is quite amazing to find that, a single rogue planet invasion can perfectly

solve two long-standing mysteries: the number asymmetry of Jupiter Trojans and the missing of most stable Hildas. These two pieces of evidence suggest the early visit of a rogue planet with an eccentricity of 1-1.3, an inclination up to 30 degrees, and a mass ranging from about 50 Earth masses to 5 Jupiter masses. Additionally, the rogue planet scenario offers fresh insights into the formation and evolution of the Solar System, e.g. serving as a possible origin of the unseen ``Planet 9''

Intensities of the hydrogen Balmer lines of solar-like stars revealed by the LAMOST spectroscopic surveys

贺晗　国家天文台

The intensities of the hydrogen Balmer lines of solar-like stars are investigated for stellar chromospheric activity by using the co-source spectral data of the LAMOST Low-Resolution Spectroscopic Survey (LRS) and Medium-Resolution Spectroscopic Survey (MRS). The Balmer Hα , Hβ , Hγ , and Hδ lines in the LRS data and the Hα line in the MRS data are analyzed. The absolute flux indexes, defined as the ratios of the absolute fluxes at the centers of the Balmer lines to the stellar bolometric flux, are employed to indicate the intensity magnitudes of the Balmer lines in response to stellar activity. The Hα indexes derived from the LRS data and the MRS data, respectively, are calibrated to be quantitatively consistent with each other. It is found that, as the Hα index increases, the Hβ , Hγ , and Hδ indexes first present trend of increasing and then decreasing, and finally increase synchronously with the Hα index. The distributions of the Balmer line indexes also reveal the three distinct stages of stellar activity (normal stage, intense stage, and extremely intense stage), in which the extremely intense stage is characterized by the synchronous growth of the indexes of the four Balmer lines. The different behaviors of the Hβ , Hγ , and Hδ lines from that of the Hα line can be interpreted by the different mechanisms by which the line-core intensities are formed, and the three distinct activity stages imply the very different magnetic field environments and physical conditions of solar-like stars.

恒星活动性的多波段研究

韩恒赓 国家天文台

恒星磁场的起源与演化一直是天体物理学中的重要研究领域。长期以来，科学家们致力于探究恒星磁场的形成机制。依据现有的恒星发电机理论，恒星的自转与对流运动在磁场的产生过程中起着关键作用。观测上，我们经常借助多种探测手段来研究恒星磁场的统计特性。由恒星磁场引发的非热过程在不同电磁波段均有体现，不同波段的观测可以用于诊断恒星高层大气的各种结构，包括来自冕层的射电和 X 射线辐射、色球层的各种发射线以及光球层的自转调制现象。通过对这些恒星磁场探针的统计性质进行分析，有助于揭示磁场产生机制，并为恒星演化模型提供约束。此外，恒星磁场活动产生的高能辐射会对系外行星的宜居性造成显著影响。通过引入宿主恒星的高能辐射强度，我们可以量化系外行星的大气逃逸率，并进一步限制恒星宜居带的分布规律。

目前，我们利用从 LAMOST、GALEX、TESS、Kepler、ROSAT 等望远镜获取的多波段数据，开展了关于恒星磁活动性的统计研究。研究内容包括：

（1）建立了不同波段下恒星磁活动指标与恒星自转之间的关系。研究结果表明，恒星活动性与自转的关系不能简单地用先前采用的双段幂律函数来描述，这一发现极大限制了恒星发电机理论。

（2）通过量化恒星高能辐射对行星大气的影响，限制恒星宜居带距离中心恒星的距离。我们的结果显示，大多数恒星的 X 射线辐射能够剥离位于其宜居带内的行星的原始大气，为这些行星成为潜在宜居行星创造了条件。

恒星星冕物质抛射(CME)事件的探测与刻画

曹东涛 云南天文台

太阳耀斑通常伴随日珥(暗条)爆发和日冕物质抛射(Coronal mass ejection，简称 CME），所有这些爆发事件都会对日地空间天气产生重大影响；其中日冕物质抛射是空间天气最主要的驱动源，可以显著地影响地球大气和磁场，从而对人类的生产和生活产生严重干扰。晚型恒星具有和太阳类似的磁场活动现象，因此恒星星冕物质抛射（简称恒星 CME）也可能是太阳系外恒星与行星系统中空间天气最主要的驱动源，从而会对行星产生重要影响，并在一定程度上决定了行星上是否适宜生命的诞生和存续。从理论上讲，恒星 CME 事件会增加行星大气的逃逸、压缩行星磁场、以及改变行星大气的化学成分；除此之外，频繁发生的恒星 CME 事件还会造成恒星质量和角动量的损失，从而对恒星的演化产生重要影响。RS CVn 型活动星通常具有强烈的磁场活动，尤其可以爆发剧烈的耀斑事件和具有较高的耀斑爆发率，因此有利于探测被认为和耀斑密切相关的 CME 事件。该报告将介绍我们基于高色散分光观测在 RS CVn 型活动星上探测和刻画恒星 CME 事件的研究工作。

用星震学探测类太阳恒星 KIC8006161 的小尺度磁场

林桂芳 云南天文台

磁场在天体物理学中是一个重要且普遍的物理现象。小尺度的磁场在恒星大气中无处不在，并且与声波有很强的耦合，能够影响声波的传播速度，在恒星大气中具有重要意义。在这项工作中，我们通过考虑光球层内小尺度磁场对恒星震动频率的影响，用 Kepler 观测到的振荡频率来限制类太阳恒星 KIC 8006161 的内部结构以及恒星表面的小尺度磁场。结果表明类太阳恒星 KIC8006161 在恒星外层大气中小尺度磁场强度大约 96 高斯，其磁弧拼接层的位置在光球层上方大约 522km 的高度处。

Probing shock breakout signal and revealing the CSM structure of supernovae from high-cadence spectroscopy

张居甲 云南天文台

This talk explores two critical aspects of supernova (SN) science: progenitor mass-loss history and shock wave propagation through dense circumstellar material (CSM). The recent explosions of two rare SNe II, 203ixf and 2024ggi, provide a unique opportunity for the investigation. We observed the interaction between the SNe and CSM through high-cadence spectral monitoring, calculated mass-loss rates, and captured shock breakout signals.

吸积白矮星双星的观测性质

徐晓杰 南京大学

吸积白矮星双星对双星演化、双白矮星引力波源、星系背景 X 射线辐射等领域有重要研究价值。然而目前其演化、星族等性质仍存在一些问题。我们利用多波段数据，对太阳系近邻的吸积白矮星双星进行了研究。结果表明我们的近邻仍然存在大量吸积白矮星双星的候选体，进一步的证认和研究将有助于我们对此类天体的理解。

基于大规模巡天档案数据对致密双星族群的系统性搜寻研究

任亮亮 安徽科技学院

银河系极致密双星是轨道周期极短并且有可能在毫赫兹频段内产生连续引力波辐射的引力波源，也是 LISA、天琴和太极等空间引力波探测器的主要探测目标。极致密双星族群包含白矮星双星、毫秒脉冲星双星在内，并且在 X 射线、光学波段、甚至伽马射线波段等电磁波段可以观测到对应体，因此是理想的多波段、多信使研究对象。银河系极致密双星在天体物理学和基础物理学研究中发挥着一系列重要作用，例如：研究双白矮星和 AM CVn 型系统的演化机制；利用双白矮星的引力波辐射检验额外偏振模、检验毫秒脉冲星的“Recycling Process”模型等。目前，大规模巡天望远镜项目 Gaia、ZTF、LAMOST、SDSS 等提供了数十亿颗天体的天体测量、时域测光和光谱信息，这为系统性的开展极致密双星族群的调查研究提供了机会。本报告将应用空间和地基巡天望远镜数据，包括高精度天测数据和时域光变数据，4FGL-DR3 星表，考虑光变周期算法和数据爬虫技术筛选致密双星族群样本，利用光谱观测进行认证，结合空间引力波探测项目，旨在进一步发掘更多的引力波“检验双星”。

吸积致塌缩型超新星前身星研究

刘栋栋 云南天文台

A binary merger product likely as the direct progenitor of a Type II-P supernova

牛泽茜 中国科学院大学

Ia 型超新星遗迹的三维数值模拟研究

罗竞霄 云南天文台

Ia 型超新星是宇宙学标准烛光，但其前身星模型尚有争议。不同的前身星模型会产生不同超新星抛射物和星周环境，进而在爆炸后产生不同的超新星遗迹。本工作使用三维流体力学数值模拟程序 RAMSES 探究 Ia 型超新星演化为超新星遗迹的过程，并分析不同前身星模型所产生的 Ia 型超新星遗迹的异同。我们从简单的星周物质分布出发，逐步探究各类可能的 Ia 型超新星星周环境对其遗迹的影响--例如前身星物质转移过程中产生的外流，并与现有的观测进行对比。本工作

期望以此限制 Ia 型超新星的前身星模型。

Study on neutron star low-mass X-ray binaries

魏娜　华中师范大学

讨论了低质量 X 射线双星 2A 1822-371 的反常轨道膨胀。首先从守恒质量传输和非守恒质量传输两个方面分析了 2A 1822-371 的轨道演化，试图找出一种可能导致快速质量传输并产生源 2A 1822-371 中观察到的快速轨道膨胀的替代机制。最后，基于环绕双星盘模型，我们提出了源 2A 1822-371 形成的详细恒星演化模型，并讨论了输入参数对双星演化的可能影响。

通过研究毫秒脉冲星 PSR J1012+5307 的形成，测试了不同的磁制动模型。首先描述了这些不同的磁制动模型。在此基础上，对 PSR J1012+5307 的形成进行了详细的恒星演化建模，以寻找能够与其观测相匹配的最佳磁制动模型。最后，比较了不同的磁制动模型。

引力波源双黑洞啁啾质量的双峰分布

李磊　新疆大学

自 2015 年首次探测到引力波以来，LIGO-Virgo-KAGRA 现已观测到近 100 个 GW 事件，其中大多数来自双黑洞系统的合并。这些逐渐增加的 GW 事件揭示了合并的致密二元物体的啁啾质量分布在 8Msun,27Msun 处存在峰值。为了探明这种结果是否来自恒星演化，我们使用 COMPAS 代码进行星族合成计算，并对不同形成通道以及初始参数的影响进行讨论。

Dark Energy on Different Scales and Its Detection in the Milky Way

张镇　高能物理所

The mysterious dark energy remains one of the greatest puzzles of modern science. Current detections for it are mostly in-direct. The spacetime effects of dark energy can be locally described by the SdSw metric. Understanding these local effects exactly is an essential step to-wards the direct probe of dark energy. From first principles, we prove that dark energy can exert a repulsive dark force on astrophysical scales, different

from the Newtonian attraction of both visible and dark matter. One way of measuring local effects of dark energy is through the gravitational deflection of light. We ge-ometrize the bending of light in any curved static spacetime. First of all, we define a generalized deflection angle, referred to as the Gaussian deflection angle, in a mathematically strict and conceptually clean way. Basing on the Gauss-Bonnet theorem, we then prove that the Gaussian deflection angle is equivalent to the surface integral of the Gaussian curvature over a chosen lensing patch. As an application of the geome-trization, we study the problem of whether dark energy affects the bending of light and provide a strict solution to this problem in the SdSw spacetime. According to this solution, we propose a method to overcome the difficulty of measuring local dark energy effects. Exactly, we find that the lensing effect of dark energy can be enhanced by 14 or-ders of magnitude when properly choosing the lensing patch in certain cases. It means that we can probe the existence and nature of dark energy di-rectly in our Solar System. This points to an exciting direction to help unraveling the great mystery of dark energy.

基于 LAMOST 的恒星锂元素丰度和富锂巨星搜寻

丁明屹 南京天光所

锂元素是核天体物理中最轻的金属元素，也是宇宙大爆炸中产生的最重的核素之一，在星系的形成演化和宇宙学研究中扮演着重要的角色。但在天文观测中表明，恒星中的锂丰度表现出了许多与理论模型相悖的现象。LAMOST 巡天给我们提供了大样本、系统性测量恒星锂丰度并研究锂元素起源和演化的宝贵机遇。我们基于模板匹配 6707.8 Å, Li I 共振线来确定恒星中的锂元素丰度，确定了 LAMOST DR9 中的四十五万颗恒星对应约八十万条光谱的锂元素丰度，其误差的典型值约为 0.2 dex。在我们的锂丰度星表之中，存在一小部分的样本展现出了远超标准恒星演化模型预言的锂丰度。此外，我们的结果覆盖了从主序前阶段到巨星等各个恒星演化阶段，有迹象表明未演化恒星之中也存在相当程度的锂超丰现象，这将为恒星锂增丰相关理论提供重要的观测约束。

Stellar abundances from LAMOST and DESI low-resolution spectra with DD-Payne

张萌　国家天文台

恒星的化学元素丰度为研究银河系的演化提供重要信息。LAMOST、DESI 等光谱巡天项目的开展，得到了千万条恒星的光谱数据。然而，传统的光谱分析方法很难从低分辨光谱得到恒星的多种元素丰度。我们利用数据驱动和物理模型结合的方法（DD-Payne），从 LAMOST 和 DESI 低分辨光谱中得到了恒星大气参数

以及元素丰度。

Abundance – age relations of GALAH stars based on oxygen-enhanced stellar models

孙天成 国家天文台

Main-sequence turn-off (MSTO) stars and subgiant stars are good tracers of Galactic populations. We present a study of 41 034 MSTO and subgiant stars from the GALAH surv e y. Using a grid of stellar models that accounts for the variation of O abundances, we determine their ages with a median age uncertainty of ~9.4 per cent. Our analysis reveals that the ages of high-O stars based on O-enhanced models are smaller than those determined with α -enhanced models, resulting in a mean fractional age difference of −5.3 per cent at [O/ α] = 0.2 and −11.0 per cent at [O/ α] = 0.4.

This age difference significantly impacts the age distribution of thick disc and halo stars, leading to a steeper downward trend in the [Fe/H] – age plane from 8 to 14 Gyr, indicating a shorter formation time-scale and a faster chemical-enhanced history for these populations. We confirm the V-shape of the normalized age-metallicity distribution p (τ | [Fe/H]) of thin disc stars, which is presumably a consequence of the second gas infall. Additionally, we find that the halo stars in our sample can be divided into two sequences, a metal-rich sequence (Splash stars) and a metal-poor sequence (accreted stars), with the Splash stars predominantly older than 9 Gyr and the accreted halo stars older than 10 Gyr. Finally, we observe two distinct sequences in the relations between various chemical abundances and ages for disc stars, namely a young sequence with ages <~8 Gyr and an old sequence with ages >~8 Gyr.

Photometric Metallicities of 100 Million Stars Based on Gaia BP/RP Synthetic Colors

黄博闻 北京师范大学

Based on corrected Gaia BP/RP (XP) spectra of Huang et al. (2024), we present precise estimates of metallicity for over 100 million stars (0.6 < (BP-RP)0 < 1.9 for giants and 0.2 < (BP-RP)0 < 1.5 for dwarfs) using the Stellar Loci method, which relies on the synthetic BP-RP and BP-G colors.

The high precision (sub mmag level) of synthetic stellar colors has

enabled us to determine photometric-metallicity estimates to an unprecedented precision and down to [Fe/H] ~ -4.
The typical precision is between 0.04 -- 0.1 dex for both dwarfs and giants at [Fe/H] = 0 down to G ~ 17, and decreases to 0.15 -- 0.3 dex at [Fe/H] = -2.0, as validated by a number of tests including star clusters.
Our achieved precision is approaching the theoretical limit set by the signal-to-noise ratios in the XP spectra and about 3 times better than our previous work based on Gaia EDR3 colors. Our work achieved a better result in MP, VMP and EMP regions than the previous works using XP spectra.
Our huge number and high precision metallicity result opens up new possibilities for investigations of the formation and chemical and star formation evolution of the Milky Way galaxy, chemistry of stars and star clusters, and the identification of candidate stars for subsequent high-resolution spectroscopic follow-up.

The metallicity distribution in M31 and M33 based on Tip-RGB

李颖　北京师范大学

A Modified Initial Mass Function of the First Stars with Explodability Theory

江睿铮 国家天文台

The most metal-poor stars record the earliest metal enrichment triggered by Population III stars. By comparing observed abundance patterns with theoretical yields of metal-free stars, the physical properties of their first star progenitors can be inferred, including zero-age main-sequence mass and explosion energy. In this work, the initial mass distribution (IMF) of the first stars is obtained from the largest analysis to date of 406 very metal-poor stars with the latest LAMOST/Subaru high-resolution spectroscopic observations. However, the mass distribution is inconsistent with the Salpeter IMF, as reported by previous studies. Here we modify the standard power-law function using explodability theory. The mass distribution of Population III stars could be well explained by ensuring the initial metal enrichment to originate

from successful supernova explosions. Based on the modified power-law function, we suggest an extremely top-heavy or nearly flat initial mass function with a large explosion energy exponent. This indicates that supernova explodability should be considered in the earliest metal enrichment process in the Universe.

揭秘脉动模式相互作用的复杂交响

牛家树 山西大学

KIC 8840638: A newly discovered eclipsing binary with delta Scuti-type oscillations

杨涛只 西安交通大学

In this paper, we analyze the light variation of KIC 8840638 using high-precision time-series data from Kepler mission. The analysis reveals this target is a new detached eclipsing binary system with a δ Scuti component, rather than a single δ Scuti star previously known. The frequency analysis of short-cadence data reveals 95 significant frequencies, most of which lie in a frequency range of 23−32 d−1. Among them, seven independent frequencies are detected in the typical frequency range of δ Scuti stars and they are identified as pressure modes. In addition, a possible large separation value of $\Delta\nu = 36.5 \pm 0.1\mu$Hz is also detected with the Fourier transform and autocorrelation function analysis. The orbital frequency forb (=0.320008 d−1) and its harmonics are also detected directly in the frequency spectrum. The binary modelings derived from PHOEBE indicate this binary system is in detached configurations with a mass ratio of q = 0.33+0.06 −0.04, an inclination angle of 40.19+3.96−2.84 degrees. The derived parameters and binary evolutionary model suggest that the primary star is an object on the verge of leaving the main sequence with temperature ~ 7600 K, while the secondary appears to be a cool component entering the giant branch, with a temperature ~3100 K lower than the primary. Moreover, this system may have undergone a mass ratio reversal, where the more massive star is the gainer component, and the less massive one is the donor star.

大振幅盾牌座 delta 型脉动变星的脉动分析

阿衣扎达•居马哈力 中国科学院大学

高光度红巨星的星震学研究

熊强　北京师范大学

长周期变星 (LPVs) 是脉动周期从几天到几百天不等的红巨星或红超巨星，主要分为 Miras 和半规则变星 (SRVs)， Miras 由于其良好的周期-光度关系，经常被用作测距工具，与传统的三角视差法 (如 Gaia) 相比，这种方法可以测量更远的距离 (如 M 型巨星可以测量到最远 30Kpc). 然而，SRVs 的周期-光度关系包含多条序列，因此难以用于精确测距. 为了解决这一问题，我们从星震学的角度出发，对 Optical Gravitational Lensing Experiment (OGLE) 数据库中的数万颗 SRVs 进行了分析. 研究发现，相比于主周期，频率间隔与光度之间表现出更好的单调相关性，并且误差更小. 我们利用大麦哲伦云 (LMC) 中的 SRVs 对频率间隔-光度关系进行了定标. 结果表明，与传统的周期-光度关系相比，基于频率间隔的光度测量可以提高大约 6% 的精度. 鉴于 SRVs 已经积累了大量观测数据，这一方法有望进一步应用于测量银河系及邻近星系区域恒星的光度，为深空测距提供新的可能性.

Granulation in Red Supergiants: The Scaling Relations

张泽浩 北京师范大学

Granulations are structures characterized by convection cells reaching the stellar surface and are well-known through observations of the Sun. However, similar granulation structures may also be present on the surfaces of the largest and brightest cool stars in the Universe—the red supergiants (RSGs)—potentially serving as the primary mechanism of their irregular light variations. As predicted by basic physical processes, there is a correlation between the granulation parameters of RSGs and the stellar parameters (i.e., the scaling relation), which provides a new method for inferring the stellar parameters of RSGs. In this talk, I will present our recent findings on granulations with the complete and pure RSG samples in the Magellanic Clouds and long-term light curves from the Optical Gravitational Lensing Experiment (OGLE) and the All-Sky Automated Survey for Supernovae (ASAS-SN). The granulation amplitude and timescale are found to have well-defined scaling relations with stellar parameters, which coincide with previous results. Comparison of the results from the LMC and SMC indicates that metallicity affects the properties of granulation, with larger amplitude and longer timescale of granulation in metal-rich environments. Different modeling approaches for light curves—Continuous-time AutoRegressive Moving Average, Gaussian Process

regression, and direct fitting of the PSD—are discussed, and the advantages of each are compared.

星际分子建模研究进展

全冬晖 之江实验室

星际介质（ISM）中的分子，特别是生命前分子，如氨基乙腈（AAN）、乙醇胺（NH2CH2CH2OH）等，作为氨基酸和生命前体分子的潜在前体，在恒星形成区域和准静态分子云中被观测到，引起了广泛的关注。我们基于最新的化学模型，通过使用气-尘三相模型模拟了这些分子在热核区域和分子云中的形成与破坏机制。结果显示，AAN 等分子的丰度在热核中可以达到观测值的 10^{-8}量级，乙醇胺等分子在银河系中心 G+0.693 区域也有较高的丰度。此外，量子化学计算进一步揭示了这些分子的反应路径及其在星际尘埃表面和气相中的行为。例如，AAN 主要通过自由基反应在尘埃颗粒表面形成，随后随着温度升高进入气相。乙醇胺的形成则与其冰相物种的光解吸和电子解离复合有关。这些发现为我们理解复杂有机分子的星际化学提供了新的视角，进一步支持了星际介质中生命前体分子的存在及其化学进化的可能性。这些研究不仅丰富了我们对星际化学的理解，还为探索生命起源提供了重要的线索。未来的实验和观测将继续检验这些分子的形成机制，并探索它们与生命基本单元的潜在联系。

Identification and Spectroscopic Analysis of YSOs with LAMOST

王小龙 河北师范大学

年轻星（YSO）指的是处于恒星形成与演化早期阶段的一类天体，包括原恒星阶段和主序前星阶段。它描述了包含中心恒星和星周盘或星周包层在内的整个系统。作为恒星形成过程的直接产物，对年轻星的研究是理解恒星形成物理过程的重要一环。同时，年轻星系统中的星周盘结构是行星形成的摇篮，对年轻星的证认和研究为搜寻系外行星提供了重要的选源依据。一个可靠且完备的年轻星样本，是很多天体物理研究的数据基础。在本报告中，我们将结合 LAMOST 光谱巡天数据、Gaia 卫星天体测量数据和多波段测光数据对太阳邻域的年轻星进行系统的搜寻。我们发现在太阳邻域依然存在大量未被红外研究所证认的年轻星候选体，这些候选体中有一部分已经被 LAMOST 光谱巡天所观测。对这些存在 LAMOST 光谱观测的年轻星候选体进行光谱分析，表明它们确实是处于主序前演化的阶段。LAMOST 第三期光谱巡天还在持续地对这些年轻星候选体进行光谱观测，将会为我们提供更多关于年轻星的光谱。这些光学方法证认的年轻星是对利用红外超方法证认的年轻星样本的有效补充，为我们提供了更为可靠和完备的年轻星样本。基于这些

年轻星样本，我们对太阳邻域的恒星形成过程进行了讨论。

JWST MIRI/MRS Spectroscopy of the Taurus Dark Molecular Cloud Boundary Region

王盛柘 国家天文台

Turbulence dissipation has been recognized as a critical mechanism controlling the evolution of molecular clouds and star formation process. The direct imaging of turbulence dissipation within cold dark molecular clouds relies on integral-field spectroscopy of the low-energy transitions of the dominant molecular component, H2. Previous observational limitations have precluded finding direct evidence for turbulence dissipation within molecular regions that are exposed to only modest UV radiation. Leveraging the JWST MIRI MRS, which offers excellent angular resolution and sensitivity to resolve the spatial scales of turbulence dissipation regions in the mid-IR, we have successfully conducted observations of extensive contiguous regions at the boundary of the Taurus molecular cloud. Our findings reveal the presence of the rotational transition S(1) emission line, showing an unexpectedly high excitation intensity and a remarkably uniform spatial distribution. These observations provide the first direct confirmation of turbulence dissipation mechanisms in dark molecular clouds, with evidence of a locally homogeneous distribution. This result stands in contrast to models predicting turbulence dissipation in small vortices, thereby representing a significant advance in our understanding of the role of turbulence in regulating star formation and influencing galaxy evolution. We also present identifications of other molecular lines in the mid-IR wavelength regime covered by our MRS spectroscopy.

高速星起源研究进展

杜翠花 中国科学院大学

高速星是指在银河系中速度接近甚至超过银河系逃逸速度的恒星。高速星的存在意味着银河系中极端动力学过程的发生，对于高速星的研究有助于我们理解银河系的形成和演化。 基于我国郭守敬望远镜（LAMOST），Gaia 及其他大型巡天项目的数据，我们最近的研究识别数百颗高速星，其中大多数是贫金属晚型巨星。利用回溯轨道综合分析并且考虑银河系与大麦哲伦云之间的动

The Catalog of early-type Runaway stars from

LAMOST-DR8

郭彦君 云南天文台

Runaway stars are OB-type stars ejected from their birthplace with large peculiar velocities. The leading hypothesis addressed in their formation includes the supernova ejection mechanism and the dynamic ejection scenario.
Identification of runaway populations is the first step to investigating their formation and evolution.
Here we present our work of searching for Galactic runaway candidate stars from the LAMOST Medium-Resolution Survey DR8 database.
After studying the kinematic properties for a collection of 4,432 early-type stars, \GG{predominantly B-type stars}, using the radial velocity measurements from LAMOST DR8 and astrometric solutions made by \emph{Gaia} DR3, we identified 229 runaway candidate stars.
They span a wide distribution in projected rotational velocities.
We investigated the Galactic spatial distribution of the runaway population and noticed that most of them likely reside within the Galactic thin disk.
Based upon analyzing the Doppler shifts of the candidate stars, we found two binary runaway candidates displaying velocity variation with estimated orbital periods of 40 and 61 days.

OB 型脉动变星搜寻与研究

施相东 云南天文台

主序阶段的 OB 型脉动变星包括慢脉动 B 型星（SPB）和仙王座β 型脉动变星(BCEP)，它们是通过星震学来研究中大质量恒星结构和演化的重要天体，各种巡天（如：TESS，LAMOS，,Gaia 等）获得的海量数据提供了前所未有的机会来搜寻和研究这些变星。我们新发现了 1000 多颗 SPB 和 BCEP 星，这使得这些变星的数量翻倍。同时，我们还分别得出 SPB 和 BCEP 星的初步周光关系，并揭示出，除在 H-R 图中的位置外，周期—温度图和周期—光度图对于区分 SPB 和 BCEP 星是非常有用的。对这些新发现的样本进行详细的分析研究将极大地提升我们对 OB 型星的结构和演化的理解。

疏散星团中经典造父变星的搜寻以及周期-光度-金属丰度关系的校准

王华健 紫金山天文台

The first low-mass binary within the fully convective zone from TMTS

刘成　北京天文馆

A new route towards to hot subdwarfs: Common Envelope Ejection from Asymptotic Giant Branch Stars

李振威 云南天文台

Ultraviolet Photometry and Habitable Zones of Over 2700 Planet-Hosting Stars

李雪　国家天文台

The ongoing discovery of exoplanets has sparked significant interest in finding suitable worlds that could potentially support life. Stellar ultraviolent (UV) radiation may play a crucial role in determining the habitability of their planets. In this work, we conducted a detailed analysis of the UV photometry of over 2700 host stars with confirmed planets, using observational data from the GALEX and Swift UVOT missions. We performed aperture photometry on single-exposure images, and provided photometric catalogs that can be used to explore a wide range of scientific questions, such as stellar UV activity and planet habitability. By calculating the circumstellar habitable zone (CHZ) and UV habitable zone (UHZ), we found that fewer than 100 exoplanets fall within both of these zones, with the majority being gas giants. Furthermore, as host stars evolve into the red giant phase, most planets, including Earth, are likely to be engulfed. We also examined stellar activity based on their far-UV (FUV) and near-UV (NUV) emissions. We found the FUV$-$NUV color more effectively represents stellar activity compared to the $R^{\prime}_{\rm FUV}$ and $R^{\prime}_{\rm NUV}$ indices. The Sun's low FUV emission and moderate NUV emission highlight its uniqueness among (solar-like) stars.

基于 Gaia 数据的星团和双星团研究

李忠木 大理大学

初始质量函数对星团长期演化的重要影响

王龙　中山大学

LAMOST 二期中分辨率光谱巡天: 银河系疏散星团子项目（LAMOST-MRS-O）

张茜　上海天文台

Formation and Evolution of New Primordial open Cluster Group: Evidence of Supernova-Triggered Cluster Groups

刘桂梅 新疆天文台

The formation mechanisms of open cluster (OC) groups remain unclear due to limited samples and data precision. This study provides new observational evidence for sequential and supernova-triggered star formation in OC groups. We first present the identification of OC groups in the Cygnus region using high-precision astrometric data from the Gaia mission. We collect a sample of 36 open clusters (OCs) from existing catalogs and determine key parameters. We perform group identification in three-dimensional (3D) spatial distribution, 3D velocity, tangential velocity, and age. we finally find four new primordial OC groups: G1, G2, G3, and G4, comprising 6, 8, 3, and 3 member clusters, respectively. The spatial proximity and consistent velocities within each group indicate that the member OCs likely formed within the same giant molecular cloud. Further analysis of age spread and spatial scales of the OC groups implies

that the OCs within each group may have formed sequentially. The dynamical evolution analysis shows that these OC groups will gradually disperse over time, eventually evolving into independent OCs. Additionally, we investigate the formation mechanisms for G1 and G2, proposing a novel hypothesis of supernova-triggered star formation. Simulations of potential supernova regions reveal a strong correlation between the age of member OCs and their distance from the predicted supernova locations, reinforcing the previous hypothesis of multiple SNe events. We identify 3 candidate pulsars for G1 and 27 for G2 using pulsar data from the ATNF Pulsar Catalogue further supporting this hypothesis. These findings offer new insights into the complex formation mechanism of OCs.

疏散星团 NGC 752 中蓝离散星光谱性质研究

李春燕 西华师范大学

NGC 752 是一个中等年龄的著名银河系疏散星团，最近的研究表明，这个星团有一个非常长的潮汐尾。我们在潮汐尾的远端新发现一颗蓝离散星，本报告将详细介绍我们对这颗新发现蓝离散星的分析结果。

我们通过 Gaia DR3 的视向速度数据再次确认了这颗蓝离散星的成员性。此外，我们还通过 LAMOST 的低分辨光谱和多个星表中的多色测光数据，分别估算了这颗蓝离散星的投影自转速度 v sini 和质量。结合 SED 和光变曲线特征，我们推断这颗大质量、快速旋转（的蓝离散星很可能是一颗通过双星并合新近形成的单星。

Open Cluster Dynamics under the Influence of Outflow-Ambient Interactions

刘牧鑫北京大学科维理天文与天体物理研究所

Outflowing stars impinging upon ambient gas experience accelerations due to the gravitational feedback from the interaction morphology between the outflow and the ambient gas. Such ``negative dynamical friction'' (NDF), in contrast to the conventional ``dynamical friction'' (DF), is studied for its impact on the dynamics of open clusters (OCs) immersed in a uniform ambient gas. We modify the N-body integration code \rebound with both NDF and DF implemented according to the outflow conditions of each star in a consistently constructed OC. The evolution of stars is also involved in determining the gas-star interactions throughout their stellar lives.

Compared to DF-only and gas-free models with identical initial conditions, the NDF-affected cluster is puffier and evaporates faster, as indicated by various diagnostics, including lower velocity dispersions and larger half-mass and half-light radii. Neutron stars with fast winds are expelled from the cluster due to their intensive NDF effect, even without the ``kicks'' by asymmetric supernovae. Exploration of parameter space confirms that the NDF effect is generally enhanced with higher ambient gas densities, in qualitatively agreement with the expression of acceleration. Outflow-ambient interactions should be considered for the proper interpretation of the stellar dynamics evolution in clusters.

A Potential Dynamical Origin of The Galactic Disk Warp: The GSE Major Merger

邓明吉 中国科学院大学

Previous studies have revealed that the Galactic warp is a long-lived, nonsteady, and asymmetric structure. There is a need for a model that accounts for the warp's long-term evolution. Given that this structure has persisted for over 5 Gyrs, its timeline may coincide with the completion of Gaia-Sausage-Enceladus (GSE) merger. Recent studies indicate that the GSE, the significant merger of our Galaxy, was likely a gas-rich merger and the large amount of gas introduced could have created a profound impact on the Galactic morphology. This study utilizes GIZMO simulation code to construct an idealized gas-rich GSE merger. By replicating the observed characteristics of the GSE, we successfully reproduce the disk warp and capture nearly all of its documented features that aligns closely with observational data from both stellar and gas disks. This model demonstrates the possibility that a single major merger can produce the Galactic warp. Furthermore, the analysis of the warp's long-term evolution may offer more clues into the formation history of the Milky Way.

Formation of the Two-Armed Phase Spiral from the Multiple Perturbations

林俊贤 上海交通大学

Dynamical Origin of the Vertical Metallicity Gradient in the Milky Way Bulge

陈斌辉 上海交通大学

The existence of a vertical metallicity gradient in the Milky Way bulge is well-established. Yet, its origin has not been fully understood within the Galactic secular evolution scenario. Using N-body simulations, we construct a single-disk model with an initial radial metallicity gradient and a triple-disk model with a radially independent Gaussian metallicity distribution for each disk. The single-disk model reproduces a vertical metallicity gradient through a “two-step heating” mechanism: the outer, metal-poor particles move inward via the bar instability and then undergo more significant vertical heating during the buckling instability, so they are scattered to higher positions. The “two-step heating” mechanism transforms the initial radial metallicity gradient into a vertical metallicity gradient in a nearly linear fashion. The triple-disk model reproduces the vertical metallicity gradient as a surface density-weighted metallicity distribution, which additionally displays a positive longitudinal metallicity gradient akin to the one in the Milky Way. Although its metallicity gradients arise from a different mechanism, the triple-disk model exhibits similar “two-step heating” processes in each disk component as in the single-disk model, and the heating strength in the three disk components is nearly linearly correlated. Therefore, we claim that the “two-step heating” mechanism is inevitable in the secular evolution of a boxy/peanut bulge, and should operate in the formation of the Galactic vertical metallicity gradient.

利用天琴座 RR 变星探测银晕：具有 7 维参数空间的 RR 变星分光样本构建

刘高潮 三峡大学

2020 年我们基于当时一些大型的测光巡天，如 Catalina、 QUEST、 NSVS、LINEAR、LONEOS、SDSS Str82 等观测的 RR 变星测光数据（共约 3 万颗 RR 变星），结合 LAMOST DR4 及 SDSS DR12 的光谱数据，我们一共测定了 5290 颗 RR 变星的金属丰度及 3642 颗 RR 变星的质心视向速度（其中 RRc 型由于模板的缺乏，测量可能不准确）。如今，LAMOST 数据已更新到 DR11（光谱数量是 DR4 的 2 倍多），并且 Gaia 发布了目前最大的 RR 变星测光星表（约 27 万颗 RR 变星），本报告将基于最新的 LAMOST/SDSS 巡天提供的海量（无缝）光谱数据与 Gaia 提供的光变

曲线及自行、视差信息，测量 RR 变星的金属丰度、质心视向速度、距离，形成一个近一万颗有 7 维相空间信息（三维位置、三维速度、金属丰度）的天琴座 RR 变星分光样本，该样本将有助于我们进一步细致的研究银晕的结构，化学和运动学性质。

Tracing Perseus, Taurus, and Orion Clouds with the Diffuse Interstellar Band λ 6614

时纪伟 国家天文台

Diffuse interstellar bands (DIBs) are absorption features observed in stellar spectra across different regions of the interstellar medium (ISM). This study employs DIB λ 6614 to trace molecular cloud distances and examine the distribution of interstellar material within the Perseus, Taurus, and Orion clouds. Based on LAMOST MRS DR10 survey data, there are 684 sources for Orion, 556 for Taurus, and 315 for Perseus in the sightlines of these molecular clouds, with cloud boundaries identified using CO emission data (Dame et al. 2001). A comparison between DIB λ 6614 and extinction data reveals that the cloud distance estimates are consistent with those derived from dust extinction measurements. The distances for the Perseus, Taurus, and Orion clouds are approximately 288 pc, 158 pc, and 464 pc, respectively. The DIB-derived thicknesses suggest that DIB carriers may extend beyond the denser regions of dust. The mean VLSR values for DIB λ 6614 are 1.08 km/s for Perseus, 1.8 km/s for Taurus, and 4.76 km/s and 9.08 km/s for Orion A and Orion B, respectively. These values highlight velocity differences between DIB carriers and CO gas, showing that they do not always perfectly overlap. Additionally, in the Perseus region, two distinct intensity jumps are observed along the sightline, with the first occurring at 155.6 pc, likely due to the Local Bubble's shell.

Connecting the Light Curves of Type IIP Supernovae to the Properties of Their Progenitors

彭泽岳 河北大学

对有平台期的超新星（IIP）的观测揭示了有关超新星喷射物动力学及其成分的大量信息，但有关其前身的直接信息仍有待研究。本工作通过处理 ZTF（Zwicky Transient Facility)观测到的大量 IIP 型超新星光学光度测量数据，得到 IIP 型超新星的统计分析结果。这些结果直接或间接的将超新星前身星的物理性质呈现出来。

Evidence for the pericentric passage of Sagittarius through the age-velocity relation revealed by stars in LAMOST

张芸艳 天津师范大学

We investigate the variation in the vertical velocity dispersion of different-aged stars with respect to their Galactocentric distance using OBA-type stars and red clump stars from the LAMOST survey. We observed distinct jumps in the vertical velocity dispersion of outer disk stars at ages of 1 and 3–4 Gyr. By comparing these time points with the pericentric passages of the Sagittarius dwarf galaxy through the Milky Way's disk, we found that they coincide with the times predicted by previous orbital models. The three identified jump time points correspond precisely to the three pericentric passages times of Sagittarius. This study, for the first time without relying on models, identifies the pericentric passage times of Sagittarius based on the observed jumps in vertical velocity dispersion, providing significant evidence for understanding the dynamic evolution of the Milky Way.

天琴 RR 型变星的恒星大气参数

王江涛 国家天文台

TESS 望远镜中两颗 G 型相接双星的观测与研究

郭梦　　中国石油大学（北京）

与太阳相比较，大多数 G 型相接双星的子星表面存在较强的磁场活动，而且部分系统轨道周期存在周期振荡。对于非严格正弦或余弦形式的周期性振荡，Applegate 指出该种周期变化是子星表面的磁场活动引起的。研究表明，光变曲线的主次极大不等高及其变化是恒星表面黑子等磁场活动的直接证据。而鉴于地面望远镜的观测不连续性，导致我们对这一现象以及磁场活动的认识不够深入。TESS（Transiting Exoplanet Survey Satellite）巡天望远镜的公开数据是高精度短时间曝光观测，为我们提供了较好的机会。通过对两颗样本星(BO Ari、TIC 440657189）的连续监测分析，既可以探究 G 型相接双星磁场活动的连续变化，也可挖掘短时间内轨道周期变化，同时挖掘获得磁场活动与轨道周期变化的关系，提高我们对磁场活动的认识，充实短时间磁场活动与轨道周期连续变化的研究。

Stellar Encounter Rates in Star Clusters

杜创　西交利物浦大学

Stellar Encounter has strong influence on the dynamical evolution of planetary systems. In this work we developed a formula of the mean number of encounters for a star moving in a star cluster central force potential that allows people to calculate the number of encounters exactly based on the the basic information for the star cluster and the star.

基于 TESS 巡天数据寻找围绕晚型相接双星转动的第三天体

江林巧 乐山师范学院

一维模拟共生双星物质转移过程

柳潭　云南天文台

共生双星是一类由白矮星（或中子星）和红巨星组成的系统，白矮星吸积较冷伴星的物质发出强烈辐射。由椭圆光变效应可知 S 型共生双星中红巨星的半径很大，十分接近洛希瓣半径，因此会受洛希瓣势能分布影响在还没达到洛希瓣半径时就开始物质转移。根据观测证据，共生双星由于较大质量比会快速进入不稳定的物质转移阶段，这与观测到的共生双星数目不符合，这是共生双星领域存在的一大问题。本研究将三位模拟中得到的洛希瓣等效势能加入一维模型中，考虑供体星非刚性表面，修改物质转移速率模型，模拟 S 型共生双星物质转移过程。得到的物质转移得到了提高，使白矮星更易爆发从而更容易被观测到，更加符合观测结果。

Am 食双星中质量转移与 Am 特性的研究

田晓慢 山东交通学院

基于中国科学院国家天文台兴隆观测站的 LAMOST 观释放的谱数据，筛选出了新的 Am 星表（大概 21,600 个样本星），并识别出更多的 Am 食双星，有效

的扩充 Am 星及 Am 食双星样本星库。其中 Am 食双星候选体中周期小于 1.2 天的样本星有近 300 个。这对 Am 食双星的 1.2 天的周期截断现象来说是极大的挑战，且短周期样本星是探究周期对演化影响的重要研究对象。我们已经主要对一批周期小于 1.2 天的重点样本星进行了观测研究。发现样本星多是临近相接或次星充满洛希瓣的半相接系统。周期普遍长期减小或增加，子星具有演化过的特征。已演化子星的质量转移，可能是这类星 Am 特性的主要来源。基于 TESS 巡天数据，已搜寻多个重点样本星的光变曲线数据。我们发现光球活动广泛存在一些相接或半接 Am 食双星中。

A New Method for Detecting Contact Binary Stars in the Era of Large Surveys

吴婷　新疆天文台

基于巡天与地面望远镜数据对部分 G 型相接双星的观测与分析

王晶晶 中国石油大学（北京）克拉玛依校区

与太阳相比较，G 型相接双星中子星表面存在较强的磁场活动，且部分系统轨道周期长期变化中存在周期性振荡。而对于非严格正弦或余弦形式的周期性振荡，Applegate 曾指出这种现象可能是子星表面的黑子活动引起的。光变曲线的 O'Connell 效应及其变化，目前被认为是子星表面黑子等磁场活动的直接证据。考虑地面望远镜观测的非连续性，导致我们对这一效应以及黑子的短时间内变化规律认识不够深入。巡天望远镜数据是高精度短时间连续观测，为我们提供了较好的机会。通过对 G 型相接双星的监测（含地面和巡天望远镜）研究，既可以探究子星表面黑子在短时间内连续变化特征，也可进行 O-C 分析挖掘长时间和短时间内轨道周期变化规律，同时研究磁场活动与轨道周期变化的关系，丰富我们对磁场活动、双星演化的认识。

A Study of Stochastic Low-Frequency Variability for Galactic O-type Stars

沈冬祥 新疆大学

In order to explore how the ubiquitous stochastic low-frequency (SLF)

variability of O-type stars is related to various stellar characteristics, we compiled a sample of 150 O-type stars observed via ground-based spectroscopic surveys, alongside photometric data obtained from the Transiting Exoplanet Survey Satellite (TESS). We analyzed 298 light curves obtained from TESS sectors 1-65 for the stars in our sample. Leveraging the spectroscopic parameters, we used Bonnsai to determine masses, radii, fractional main sequence ages, and mass-loss rates for stars of our sample. Subsequently, we identified possible correlations between the fitted parameters of SLF variability and stellar properties. Our analysis unveiled four significant correlations between the amplitude and stellar parameters, including mass, radius, fractional main sequence ages, and mass-loss rate. For stars with $M \gtrsim 30 M_{\odot}$, we observed a decrease in characteristic frequency and steepness with increasing radius. Finally, we compared various physical processes that may account for the SLF variability with our results. The observed SLF variability may arise from the combined effects of FeCZ and IGWs, with IGWs potentially more dominant in the early stages of stellar evolution, and the contribution of FeCZ becoming more significant as stars evolve. Meanwhile, our results indicate that the SLF variability of O-type stars bears certain signatures of the line-driven wind instability and granulation.

利用 CSST 大视场紫外巡天研究星流多星族

李霞　中山大学

观测发现，球状星团普遍存在多星族现象，表现为恒星之间存在具有特别关联性的元素丰度差异，而这种现象在年轻星团和恒星形成区并未发现，暗示了球状星团恒星形成的特殊性。然而，解释多星族的形成机制颇具挑战，目前还有待更多观测数据支持。HST 的紫外观测能力是过去测光观测多星族的重要天文观测工具。CSST 具有和 HST 类似的紫外观测能力，并且具有大视场的独特优势，适合对球状星团形成的大尺度星流结构展开多星族测光观测研究。本研究使用自主研发的高性能多体数值模拟工具，为银河系有星流结构的球状星团，如 Pal 5 等建立能够追踪每个恒星和双星的精细数值模拟，并根据 CSST 的仪器特性建立测光仿真模型。通过星流所记录的独立星团动力学演化信息，本研究将探究星流上的多星族 CSST 可观测特征与星团初始状态的关联，挖掘未来的中国空间站巡天望远镜在多星族研究上的潜能，做好理论研究准备。

Assessing the Atmospheric Parameters of Gaia DR3 with

Open Clusters

唐通　上海天文台

Reliable stellar atmospheric parameters are essential for probing stellar structure and evolution. Gaia DR3 published atmospheric parameters for a large number of stars. However, various deviations appear in comparisons with different ground-based spectroscopic surveys. We aim to employ the atmospheric parameters provided by the theoretical isochrones of open clusters as a benchmark to assess the quality of stellar atmospheric parameters from Gaia DR3. We selected 130 open clusters with well-defined main sequences within 500 pc of the solar neighborhood as a benchmark sample to estimate the reference atmospheric parameters of the members from the best-fit isochrones of those clusters. By comparing the GSP-Phot, GSP-Spec, and ESP-HS modules of Gaia DR3 with PARSEC isochrone parameters, it is found that different catalogs in Gaia DR3 have individual average deviations and dispersion. The degeneracy of Teff with extinction is also detected. Our approach provides an independent and conducive way of accessing the quality and consistency of stellar atmospheric parameters of Gaia DR3.

The radius variations of accreting main-sequence stars and mass transfer instability

赵梓琪 云南天文台

Many previous works studied the dynamical time-scale mass transfer stability criteria based on the donor response with neglecting the stellar structure of the accretor. In this letter, we investigate the radial response of accretors with mass accumulation and its effect on the binary mass transfer stability. We perform a series of detailed stellar evolution simulations with different types of accretors and obtain the radial variations of stars accreting at different rates. Since the time within which the donor loses half of the original mass has a correlation with the donor mass, we approximately obtain the mean mass transfer rate as a function of mass ratio. Assuming that the common envelope (CE) phase occurs if the accretor radius exceeds the outer Roche lobe radius, we obtain the critical mass ratio of dynamically unstable mass transfer. We find the critical mass ratios for donors filling their Roche lobes at the Main Sequence (MS) and Hertzsprung Gap (HG) stages are smaller than that derived from the radial response of the donor in the traditional way. Our

results may suggest that the binary is easier to enter into the CE phase for a donor star at the MS or HG stage than previously believed.

KIC 10855535: an elegant Delta Scuti with amplitude and phase modulation

沈丽娴 新疆天文台

我们利用开普勒长曝光数据对KIC 10855535的光变曲线进行了详细的分析。我们探测到了两个独立频率：一个是脉动频率F_0，它被分裂成了一个等距五重线，另一个是调制频率f_rot。F0被判断为径向频率。基于五重线和相位调制现象，这颗星应该是一个在轨道周期为411.5(2)天的双星系统中的δ Scuti 脉动变星。经过凌星系外行星巡天卫星(TESS)数据光变曲线的研究，长期相位调制被确认。这颗星呈现出一个缓慢而稳定的振幅增长，最有可能是由于恒星演化导致的脉动腔扩张所致。调制频率f_rot和它的两个谐波可能是由于恒星自转以及表面大规模黑子引起。进一步的分析展现出它们随时间变化的演化特征。根据自转频率可以推算出自转投影速度(vsini)的上限，由此看来，KIC 10855535 在δ Scuti 中属于相当缓慢的一类，自转速度在 37.6(1)km/s 左右。总之， KIC 10855535 表现出极干净的频谱并且旋转缓慢，只有一个脉动模式在经历着振幅和相位调制。

中微子磁矩对氦闪及红团簇星演化的影响

芦锡震 新疆大学

氦闪发生在在质量介于0.6至2.0太阳质量的红巨星分支末端恒星中，无法通过光学手段观测到，原因是这一过程的能量被用来使简并氦核发生退简并。中微子与氦闪中引发的反应点火有关，是简并氦核唯一的冷却过程，有助于描述内部结构的变化。在这项工作中，我们将超出标准模型的中微子磁矩加入我们的模型，讨论了不同中微子磁矩系数对氦闪及对后续红团簇演化的影响，并且我们讨论了氦闪可能引发的重力波混合机制，并且讨论了其是富锂红团簇星产生机制的可能性。

南极红外双筒望远镜2024年观测数据的初步结果

杨浩楠 中山大学

南极冰穹A由于气温低、空气干燥，在红外波段的天光背景暗、大气透过率高，是优秀的红外天文台址，为我国红外天文观测的发展带来了机遇。为此，我们提出了南极红外双筒望远镜AIRBT项目，以开展红外时域天文观测，研究冰穹

A 的红外观测条件，为未来南极红外望远镜的发展积累技术经验。AIRBT 为口径 15 公分的双筒望远镜，装配了铟镓砷相机，分别安装了近红外 J、H 波段滤光片，视场 1.2*1 平方度。AIRBT 于 2023 年安装到冰穹 A，2024 年维护后首次获得了 J、H 波段观测图像，观测天区为赤纬-74.2°~-75.5°的带状区域，观测图像超过 100 万幅。我们对 2024 年图像进行了处理，包括图像改正、孔径测光、位置定标、提取光变曲线等。目前单幅 2 秒曝光下 J 波段极限星等达到 10.9 等，相对测光精度最高可以达到 1%；叠加 100 幅图后极限星等达到 13.4。我们正在利用这些数据分析红外天光背景，并开展时域天文研究，包括变星光变曲线、探测恒星耀发与异常光变、搜寻瞬变源等。
2025 年计划安装中心波长 1.4 微米滤光片，该波段在其他台址由于水汽吸收几乎不透明，而冰穹 A 由于极为干燥，打开了新的窗口，能够观测在该波段有光谱特征的天体，如超冷矮星等。

G 型类太阳食双星磁活动的分析研究

孟芳斌 云南天文台

Ia 型超新星的一维辐射转移模拟

郭博洋 云南天文台

Ia 型超新星作为标准烛光，被广泛应用于宇宙学距离的测量之中。但目前的 Ia 型超新星形成理论仍具有很强的不确定性，这使得作为距离测量基础的 Phillips 关系依然只能是依赖于观测的经验公式，无法真正由现有理论导出。本工作使用了基于一维超新星辐射转移模拟程序 TARDIS 的机器学习工具，将 Ia 型超新星早期光谱作为输入，得到 Ia 型超新星抛射物的密度轮廓，进而得到包括 Ni56 在内的 Ia 型超新星元素丰度。从而在一定程度上建立 Ia 型超新星光谱和光变曲线之间的联系，并对 Ia 型超新星爆炸机制做出一定限制。同时，机器学习方法的引入极大降低了计算成本，加快了参数拟合速度，在天文大数据时代具有独特意义。

The neutrino luminosity and energy spectrum of nova outburst

王浩 新疆大学

金属丰度、旋转对超新星致密度的影响

罗仁钰 新疆大学

大质量恒星演化晚期，可能形成失败超新星，以往大多根据致密度参数ξ 2.5作为判断爆发的简单依据，然而该理论主要根据非旋转前超新星得出，对预测高速旋转前超新星爆发仍有一定误差。本文，使用 MESA 模拟不同旋转速度（0、300km/s、600km/s）和金属丰度（1/50 Ze、1/10 Ze、1/2 Ze、Ze）的恒星，直到前超新星阶段，并利用开源软件 GR1D 模拟核心坍缩过程，从而建立起零年龄主序(ZAMS)金属量和旋转对于形成失败超新星形成所需前超新星致密度的联系。

揭示系外行星的命运：对宿主恒星的星震学分析

林文徐 云南天文台

通过星震学，我们能了解演化后期恒星的内部结构和演化信息。将星震学与系外行星学相结合，我们能通过对宿主恒星的星震学分析，找到系外行星系统演化的关键线索，进而揭示系外行星的演化命运。

Unveiling the Binary Nature of NGC 2323

蒋悦悦 上海天文台

As a well-known open cluster, NGC 2323 has been widely investigated for over a hundred years and has always been considered a classical single cluster. In this work, with the help of Gaia DR3, we study the binary structure nature of this cluster. Although indistinguishable in the spatial space, the small but undeniable difference in the proper motion indicates that they may be two individual clusters. After investigating the properties of the two clusters, it is found that they have very close positions and similar velocities, indicating the existence of their physical association. Moreover, the best isochrone fitting ages of the two clusters are the same (158~Myr), further proving their possibly common origin. To comprehensively understand the formation and evolution of this binary cluster, we employ the PETAR N-body code to trace back their birthplace and deduce their dynamical evolutionary fate. With observational mean cluster properties, the simulations suggest that they may form together, and then orbit each other as a binary cluster for over 200~Myr. After that, because of their gradual mass loss, the two clusters will eventually separate and evolve into two independent clusters.

Meanwhile, the numerical N-body simulation suggests that the less massive cluster is unlikely to be the cluster tidal tails created by the differential rotation of Milky Way.

AGB 星的内部重力波混合效应及锂产量

王祉竣 新疆大学

背景：宇宙中锂元素的来源一直是个谜团，其中中等质量 AGB 星对星际介质锂元素有多大的的贡献一直存在争议。AGB 阶段恒星通过星风会抛射大量物质到星际介质中，表面和星风中的锂元素含量对于 AGB 阶段对星际介质的锂元素贡献率具有决定性影响。而恒星内部湍流对流运动激发的重力波可以向外传递能量并诱导非对流区的混合，并对恒星表面和星风中的化学组成产生巨大影响。

目标：研究渐近巨星分支阶段氦壳层点燃时激发的内部重力波对混合的影响，内部重力波可以将混合延伸到非对流区将铍元素带到对流区并带到表面，进而增加锂产量。本文将通过此模型结合初始质量函数得到中等质量 AGB 星的锂元素总产量。并通过观测验证部分模型参数。

方法：利用恒星天体物理实验模块(MESA)模拟了中等质量恒星从零龄主序至 AGB 结束的演化过程，加入了内部重力波诱导产生的混合系数和元素扩散效应。建立网格计算出不同质量金属丰度 AGB 星的锂产量。然后利用初始质量函数及银河系诞生率，使用 MOBSE 程序进行大样本模拟并估算出对星系锂产量产量的贡献率。

Investigating lower limit of metallicity for Galactic thin disk

胡国真 河北师范大学

Dependence of Multi-band Absolute Magnitude and Color Index of the Tip of Red Giant Branch on Metallicity in the Galactic Globular Clusters

邵珍珍 北京天文馆

LAMOST 数据中 S 型星的搜寻和研究

陈静　南京天光所

S-type stars are cool giant stars with C/O ratios between 0.5 and 1.0. They have prominent ZrO molecular bands in their spectra and show an enrichment of s-process element. The largest catalog of S-type stars contained only slightly over one thousand stars, and there was no quantitative method to classify S-type stars suitable for large-scale photometric and spectroscopic surveys. We found 2939 S-type stars from LAMOST Data Release 10 using two machine-learning methods, and 2306 of them were reported for the first time. We divided S-type stars into intrinsic and extrinsic stars with photometric data and LAMOST spectra. Using infrared photometric data, the model trained by input features with 2MASS, AKARI, and IRAS data has the highest accuracy of 95.52%, and 381 intrinsic and 495 extrinsic stars were classified. Using these photometrically classified intrinsic and extrinsic stars, we retrained XGBoost model with medium-resolution spectra, and the 2939 stars were divided into 855 intrinsic and 2056 extrinsic stars with an accuracy of 94.82%. We also found four spectral regions of Zr I (6451.6 Å), Ne II (6539.6 Å), (6564.5 Å), and Fe I (6609.1 Å) & C I (6611.4 Å) are the most important features, which can reach an accuracy of 92.1% when using them to classify S-type stars. In addition, due to the possibility of symbiotic stars existing among the extrinsic S-type stars, we searched for symbiotic stars in the LAMOST spectra and found nine confirmed symbiotic stars, including two new discoveries.

中国数字化天文底片:流量定标及星表

马铭阳 北京师范大学

中国天文底片数字化项目已经将来自中国 5 个天文台的 11 台望远镜拍摄的约 30,000 张天文底片进行了数字化，涵盖了近 100 年的观测数据。

在这项工作中，我们使用了一种复杂的方法对 15696 张单次曝光的天文底片进行了光度校准。通过利用从修正的 Gaia XP 光谱构建的标准星，我们已识别并修正了各种系统性效应（包括色差项、星等项和平场项），其精度达到了约 1%。

最终上海天文台、国家天文台、紫金山天文台、云南天文台和青岛天文台的底片的光度定标精度分别为 0.11、0.19、0.15、0.17 和 0.23 等。变量源候选对象也已被识别。

这样的数据集将为长时间尺度的天文研究提供宝贵的资源。我们的校准方法也可以应用于其他数字化的天文底片。

基于 LAMOST 数据的“单年龄星族”的银盘垂向金属丰度梯度研究

龙高欢 北京师范大学

我们利用 LAMOST-LRS 年轻早型恒星样本，研究了银盘金属丰度垂向梯度。随有效温度升高（或恒星年龄越年轻），在不同银心距情况下，金属丰度垂向梯度均越接近于零。为了进一步验证这一结果，我们选取了 295 个已知年龄小于 3 Gyr 的疏散星团和 500 余颗银盘上的经典造父变星进行研究。结果显示，在给定年龄的情况下，银盘金属丰度垂向梯度为零。因此，银盘的垂向金属丰度梯度主要反映了银盘随时间的“自上而下”的形成过程，与数值模拟结果一致。这些发现有助于更好地理解银河系的化学演化和结构特征。

基于 MRS-N 数据的银河系 HII 区样本研究

赵韵宁 国家天文台

基于 LAMOST 中分辨率星云巡天（MRS-N）数据和 WISE HII 区星表，我们构建了一个包含 286 个银河系 HII 区的样本。利用 LAMOST 光谱数据，我们得到了 HII 区的线比、视向速度和速度弥散等信息，并计算其金属丰度、电子温度、电子密度等物理参数。另外，在 286 个 HII 区样本中，只有 67 个在之前的研究中给出了距离，且大多为运动学距离。我们利用 HII 区内的 OB 星视差距离，确定了 150 个 HII 区距离，为更多 HII 区提供了距离，并提高了测量精度。最后，我们讨论了银河系内 HII 区的金属丰度、电子温度随银心距的梯度变化，为银河系形成和演化模型提供观测支持。

Identification and Spectroscopic Analysis of YSOs with LAMOST

王小龙 河北师范大学

年轻星（YSO）指的是处于恒星形成与演化早期阶段的一类天体，包括原恒星阶段和主序前星阶段。它描述了包含中心恒星和星周盘或星周包层在内的整个系统。作为恒星形成过程的直接产物，对年轻星的研究是理解恒星形成物理过程的重要一环。同时，年轻星系统中的星周盘结构是行星形成的摇篮，对年轻星的证认和研究为搜寻系外行星提供了重要的选源依据。一个可靠且完备的年轻星样

本，是很多天体物理研究的数据基础。在本报告中，我们将结合 LAMOST 光谱巡天数据、Gaia 卫星天体测量数据和多波段测光数据对太阳邻域的年轻星进行系统的搜寻。我们发现在太阳邻域依然存在大量未被红外研究所证认的年轻星候选体，这些候选体中有一部分已经被 LAMOST 光谱巡天所观测。对这些存在 LAMOST 光谱观测的年轻星候选体进行光谱分析，表明它们确实是处于主序前演化的阶段。LAMOST 第三期光谱巡天还在持续地对这些年轻星候选体进行光谱观测，将会为我们提供更多关于年轻星的光谱。这些光学方法证认的年轻星是对利用红外超方法证认的年轻星样本的有效补充，为我们提供了更为可靠和完备的年轻星样本。基于这些年轻星样本，我们对太阳邻域的恒星形成过程进行了讨论。

Measuring the Diffuse Interstellar Bands at 5780, 5797 and 6614 Å in Low-Resolution Spectra of Cool Stars from LAMOST

马晓骁 国家天文台

The limited number of high-resolution spectra of hot stars is inadequate for statistical studies of DIBs. In contrast, the vast quantity of low-resolution spectroscopic survey on cool stars holds great potential for investigating the relationship between DIBs and known interstellar medium (ISM), as well as the spatial distribution of their unidentified carriers.

We attempt to measure the DIBs λ 5780, λ 5797 and λ 6614 in over two million low-resolution spectra of cool stars from LAMOST. Based on the DIB measurements, the correlation between DIBs and extinction, the kinematics of DIBs, and the Galactic distribution of DIBs are reviewed and investigated from the perspective of statistics. A pipeline is developed to measure the DIBs λ 5780, λ 5797 and λ 6614 in the LAMOST low-resolution spectra. Four modules in the pipeline consist of building the target and reference dataset, extracting the ISM residual spectra from the target spectra, measuring the DIBs in the residual spectra, and quality control of the measurements. We obtain the DIB measurements of spectra of late-type stars from LAMOST, and screen out 176,831, 13,473 and 110,152 high-quality (HQ) measurements of the DIBs λ 5780, λ 5797 and λ 6614, respectively, corresponding to 142,074, 11,480 and 85,301 unique sources. Utilizing these HQ measurements, we present the Galactic maps of the DIBs λ 5780 and λ 6614 in the northern sky for the first time. The central wavelengths of the DIBs λ 5780, λ 5797 and λ 6614 in air are determined to be 5780.48 ± 0.01, 5796.94 ± 0.02 and 6613.64 ± 0.01 Å, respectively, based on their kinematics. The equivalent widths of these three DIBs per unit extinction are statistically fitted to be 0.565, 0.176 and 0.256 Å mag−1 . As a part of our work, three catalogs of the HQ measurements for the DIBs λ 5780, λ 5797 and λ 6614 are provided online.

To the best of our knowledge, this is the largest number of measurements of these three DIBs to date. It is also the first time that the Galactic maps of the DIBs λ 5780 and λ 6614 in the northern hemisphere are presented, and the central wavelengths of the DIBs λ 5780, λ 5797 and λ 6614 are estimated from the kinematics.

贫金属星流的金属丰度分解研究

张仕超 河北科技大学

星流是宇宙中的一种特殊的天体结构。在星流形成后的很长一段时间，其恒星表面化学组成仍会保留着前身星系或星团的化学丰度模式。研究星流中恒星的元素丰度可以帮助我们了解星流的演化历史，从化学丰度的角度还原星流的演化过程和天体物理来源。

我们研究了三条星流：Nyx，Typhon 和 WuKong/LMS-1，它们是位于银河系的贫金属星流。我们分析了它们的轻元素、α 元素、铁族元素以及中子俘获元素的化学丰度模式，得到了各天体物理过程对不同元素的贡献，并研究了这些元素在不同金属丰度下的变化趋势。

球状星团 M92 元素丰度的天体物理来源

陈笑旭 河北科技大学

球状星团作为宇宙中较为独特的群体，具有较低的金属丰度，其恒星表面化学组成的研究可为恒星演化提供了重要线索。

球状星团 M92 是一个古老且稠密的星团，位于猎户座星座中。它的元素天体物理来源主要来自早期宇宙的恒星形成过程。其元素成分反映了当时的核合成过程和超新星爆发。这些古老的恒星释放出重元素，逐渐丰富了星团中的化学成分。本工作对球状星团 M92 中的 25 颗样本星的元素天体物理来源进行了研究。研究其恒星的α 元素，Fe 族元素，中子俘获元素，分析各过程在金属丰度下的变化趋势。我们的研究为快中子俘获过程提供了参考，同时为进一步研究星团 M92 的形成和演化提供了线索。

基于 N 体数值模拟研究 Gaia 疏散星团的动力学演化

郑泽鹏 中山大学

疏散星团是银河系中普遍存在的天体结构，是一种包含几十到几千颗恒星的、具有松散引力约束的星团。疏散星团在银河系的分布和性质反映了银河系的结构和

演化。本课题基于 Gaia 观测，通过 N 体数值模拟对疏散星团的物质分布和动力学演化进行大量仿真，建立了精确的动力学演化模型。通过对这些模型中双星的质量比、周期等相关参数变化的研究，我们尝试理解疏散星团的动力学演化轨迹，理解双星演化轨迹与疏散星团初始参数、演化过程之间的关系。同时，大量基于 Gaia 观测、具有不同初始参数的 N 体数值模型，也可为疏散星团观测结果的验证和研究提供约束。

大小麦哲伦星系中红超巨星的双星比例

代敏　北京师范大学

Red supergiants (RSGs) are the evolved descendants of OB-type main-sequence stars. Previous studies show that the binary fraction (≈ 15\% - 40\%) of RSGs is significantly lower than that of its predecessor with ≈ 50\% - 70\%. In this work, we investigate the binary fraction of RSGs with the recently selected largest samples of 4695 and 2097 RSGs in the Large Magellanic Cloud (LMC) and Small Magellanic Cloud (SMC), respectively. The binary system with a hot companion (O-, B- and A-type star) is identified by detecting the Ultraviolet (UV) excess in the observed spectral energy distribution (SED) ranging from ultraviolet to mid-infrared after subtracting the model SED of RSG since RSGs are very weak in the UV band. It is found that the lower limit of binarity is 30.2% and 32.2% in the LMC and SMC, respectively. If the sample is limited to luminous RSGs with log L/L_sun > 4.0, the binary fraction becomes 26.6% and 26.4% in the LMC and SMC, respectively. In addition, 15 RSGs are additionally identified as binary by fitting the HST/STIS spectra. Moreover, a handful of the binaries identified by the SED fitting are confirmed by their light curve and radial velocity dispersion. Furthermore, the stellar parameters of the companions, i.e. T_eff, R, L and log g, are calculated by model fitting.

Identifying OB associations using LAMOST and Gaia OB star sample

柳志存 河北师范大学

OB associations are gravitationally unbound stellar groups including numerous O- and B-type stars. They play a important role for us to understanding the star formation process, distribution of young stars and

spiral arms structure in the Milky Way. In this work, we construct a lager OB stars sample with 3D positions and 3D velocities by combining the distances from Bailer-Jones et al. (2021), radial velocities obtained by using the LAMOST low-resolution spectra, and Gaia EDR3 proper motions. There are 19,933 OB stars, most of which are located within 6kpc of the Sun. Combining the friends-of-friends clustering algorithms, we identify 64 OB associations and 223 OB association candidates. The distribution of 64 OB associations indicates that most of them are located in the near spiral arms of our Milky Way. We find that OB associations shows a velocity dispersion similar to previous results.

Multi-mode delta Sct stars from the ZTF, with their Period-Luminosity Relations and Period-Luminosity-Metallicity Relations

贾淇　西华师范大学

Analysis of the layered structure of open clusters in the solar system’s neighborhood by dynamic simulation

郎凯祥 新疆天文台

起源于人马座矮椭球星系的球状星团

张健　中国科学院大学

通过频率调制来区分剑鱼座γ 型变星中的超奈奎斯频率

王轩　北京师范大学

超奈奎斯特频率（SNFs）的反射会与真实脉动信号混叠，给星震学分析带来潜在挑战。尽管已有部分脉动变星的研究涉及 SNFs，但系统性的调查仍然较少。我们提出了一种方法，通过滑动傅里叶变换表征其周期性频率调制，从 Kepler 和 TESS 光度数据中识别 SNFs。分析 Kepler 卫星的长节奏光度数据后，我们在

约600颗剑鱼座γ 型变星的45607个频率中，识别出56颗恒星中的304个SNFs，分别占比约为0.67%和9.2%。大多数SNFs在压力模式频率范围（超过120 μHz）中被检测到，且随着频率的增加，SNFs的检测比例上升至约7%。我们仅在两颗剑鱼座γ 型变星中发现了与重力模式混叠的潜在SNFs。这些发现表明，SNFs对剑鱼座γ 型变星的重力模式星震特性（如从周期间隔推导的特性）的影响可以忽略不计。然而，我们建议在其他脉动变星（特别是盾牌座δ 型变星和B型热亚矮星）中，采用该方法仔细且系统地检查 SNFs，以为各类脉动星的精确星震学奠定坚实基础。

银晕中的子结构

刘浩洋 中国科学院大学

4、仪器、时频分会场报告摘要

JUST 望远镜研制进展

杨德华 中国科学院南京天文光学技术研究所

JUST 望远镜三镜支撑系统研制进展

胡守伟中国科学院南京天文光学技术研究所

交通大学光谱望远镜（Jiaotong University Spectroscopic Telescope，JUST）是上海交通大学计划在青海省冷湖天文观测基地建设的一台口径 4.4 米的大口径多功能光谱望远镜，望远镜采用 R-C 光学系统，第三反射镜为椭圆平面镜（1485mm x1025mm x120mm 厚），反射镜的支撑设计对其性能和稳定性至关重要。在本报告中，我们提出了一种新的支撑设计方法，采用 18 点 whiffletree 轴向支撑和 6 点侧向杠杆平衡重支撑。采用有限元分析方法对反射镜及其支撑系统进行建模，并对 whiffletreee 的参数进行优化，使反射镜的变形和应力最小。结果表明，该方法在光学质量和结构强度方面取得了较好的效果，证明了该支撑方式的可行性。

充气式薄膜望远镜

杨光 中国科学院南京天文光学技术研究所

光学/红外空间望远镜的口径是决定其灵敏度和角分辨的重要因素。近些年发射的空间望远镜也向着大口径的方向发展，比如 JWST 采用拼接镜面技术达到了史无前例的 6.5 米口径。但是由于传统材料（如超低膨胀玻璃、碳化硅和铍）自身的限制（质量/面积比≥30 kg/m2），基于它们的望远镜口径难以进一步提升。新型基于薄壳/薄膜材料的望远镜有望突破这一瓶颈，达到≤3 kg/m2。充气式薄膜望远镜是其中一种较为成熟的技术路线，该技术利用气压造成的薄膜应力来保持镜面形状。我将在报告中梳理充气式望远镜的发展历史，并介绍一个目前 NASA 正在推动的一个 14 米充气式红外望远镜 SALTUS。最后，我将介绍一些充气式望远镜具体的设计和制造方法以及我的研究进展和计划。

四孔径斐索型光干涉望远镜样机研制介绍

陈欣扬 中国科学院上海天文台

斐索型光干涉望远镜基于光干涉原理，将若干子望远镜组成阵列，通过多轴光束合成在像平面直接成像。与光学长基线干涉阵相比，该形式望远镜具有较充分的空间频率覆盖特性，并且通过共机架结构，能够有效避免长尺度外部光程差的光学延迟线补偿，适用于天体和空间目标在较大视场中的实时成像。我们研制了一架四孔径斐索型光干涉望远镜样机。虽然每个孔径尺寸仅为 100mm，但通过优化阵列配置，该望远镜等效角分辨率，相当于 280mm 孔径尺寸的单镜面望远镜。一些新颖的光机结构设计和误差控制方法已成功应用于该望远镜。例如，为了提高机械系统的刚度，采用了一种独特的 C 形结构来取代传统的方位轴；通过从调制传递函数中提取信号，可以同时检测所有孔径之间的共相误差，因此可以去除一些经典的分束器，减少光损失。在实验室完成了望远镜组装调试后，我们近期开展了户外天文观测，成功实现了子孔径共相和干涉成像，获得的星像 FWHM 和理论仿真相符。

望远镜驱动控制系统可靠性提升策略研究

李运　　中国科学院南京天文光学技术研究所

望远镜驱动控制系统是天文观测顺利进行的动力保障，其运行可靠性直接影响天文观测效率，故对驱动控制系统可靠性提升策略展开研究对于提升望远镜运行效率具有重要意义。本研究建立在望远镜驱动控制系统运行框架的基础上，并结合当前望远镜研制项目的实际需求，从预期故障诊断、非预期状态识别和设计阶段的可靠性优化三方面开展多维度的可靠性提升策略机制研究。针对不同的特征表现，分别提出针对预期故障的诊断及自愈专家系统、非预期状态的通用过程模型和研制阶段的优化设计一系列可靠性提升方案，并在不同应用场景下证明了方案的可行性。本研究为望远镜的可靠性提升策略发展指明了方向，对正在研制中的 4 米级望远镜和 14.5 米望远镜驱动控制系统的可靠性提升和安全防护与健康管理系统的构建都具有实际实用价值。

南京天光所盱眙百米级长基线光干涉阵列原理样机的研制及观测

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长基线光干涉技术已成为当前以及未来实现高分辨率天文观测的重要手段之一，国际上已有 VLTI、CHARA 以及 MROI 等百米级大型长基线光干涉阵列，南京天光所研制的百米级长基线光干涉阵列已于紫金山天文台盱眙观测站完成基建工程。南京天光所根据建设中的百米级长基线光干涉阵列同步研制了缩比原

理样机，并实现了对星观测，捕获了超红巨星参宿四的干涉条纹，从实测上进一步论证了干涉阵列总体方案的可行性与可靠性。本报告将对该原理样机的研制及观测情况做汇报。

成长型通用光学望远镜 EAST 进展

吴学兵 北京大学

大型通用光学望远镜是我国天文学发展的短板，急需迎头赶上国际先进水平，尽快为我国天文学家提供多功能、能满足多样化观测需求的设备。本报告将介绍成长型通用光学望远镜 EAST 项目的最新进展，包括镜面拼接、光学系统、仪器系统、台址等最新进展。希望通过多样化科技投入，在多方共同努力下早日建成 EAST 望远镜。

中山大学 80cm 红外望远镜调试的初步结果

马斌　　中山大学

红外是多波段天文观测中的重要一环，但长期以来在我国几乎是空白。随着我国红外探测器性能的提高，开展红外天文观测成为可能。中山大学提出了 80cm 红外望远镜项目，开展红外时域天文观测，并作为我国红外技术的测试平台。望远镜口径 80cm，焦比 f/8，地平式机架，两个耐式焦点分别安装铟镓砷（J 波段）、碲镉汞（K 波段）相机。该望远镜于 2022 年底立项，2024 年 6 月安装到青海冷湖天文观测基地，海拔 4100 米。本次报告将介绍望远镜及相机的系统设计，以及在冷湖调试的初步结果，特别是对天文目标的测光精度。望远镜投入正式运行后，将对国内天文学界开放，欢迎有红外观测需求的单位开展合作。

南极冰穹 A 与青海冷湖近红外天光背景监测的初步结果

李晋基中山大学物理与天文学院

近红外天光背景亮度是衡量红外天文台址条件的重要评价参数，对于望远镜的观测图像信噪比等指标有显著影响。南极冰穹 A 与青海冷湖，在其他评价参数上达到国际一流天文台址水平，但缺少近红外天光背景数据，因此我们在此开展了近红外天光背景监测。在南极冰穹 A 和青海冷湖，分别安装了南极红外双筒望远镜 (AIRBT) 和 f/2.25 的小口径镜头并均配备了铟镓砷相机，通过望远镜对天顶天区成像后，利用视场内的恒星定标从而实现对天光背景亮度的测量。在此，我将汇报于 2024 年取得的近红外天光背景初步监测结果，包括南极冰穹 A

以及青海冷湖的 J、H’波段天顶天光亮度，并与其他世界一流台址对比。此外，我将根据初步结果分析太阳高度角、月亮高度、月相等对近红外天光背景的影响，以及分别从长、短时间尺度探讨近红外天光背景与太阳活动的关系。

南极近红外望远镜设计与初步观测结果

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由于具有极低的天光背景和优越的视宁度,南极冰穹 A 成为近红外波段理想的观测站点。2024 年 1 月，中国第 40 次南极考察队在南极冰 A 成功安装了我国首台南极近红外大视场望远镜,并顺利实现了运行。本文首先详细介绍了该望远镜的光学系统设计、公差分析以及杂散光分析。其次，论述了基于视觉检测的望远镜装调方法，并对装调后的像质进行了详细评估。针对南极极端环境的挑战，设计了一种带有迷宫结构的直驱跟踪机构，有效地抵御了风雪的影响;同时，通过镜筒的热补偿设计，成功避免了低温导致的焦面漂移问题。望远镜在南极极昼期间进行了初步观测，对南极极昼期间的天空背景亮度、望远镜极限星等进行了测量并在不同时间段进行了多次空间目标观测实验。实测结果表明，该望远镜不仅成功探索了极端环境下望远镜的新技术，还具备了与 AST3-2 望远镜进行长达 2670 小时不间断协同观测的能力。这一独特的特性使其在多个天文学领域具备重要的科学价值，同时也能有效监测空间碎片和近地小行星的动态变化。

基于 Express-80 的欧亚卫星双向时间传递链路性能分析

高喆 中国科学院国家授时中心

卫星双向时间比对是国际标准时间协调世界时（UTC）计算中的首选远距离时间比对技术。针对欧亚 ABS-2A 卫星双向链路运行不稳定且频繁中断的情况，2021 年 6 月国际时间频率咨询委员会（CCTF）停止运行该链路，并于 8 月重新建立了基于俄罗斯 Express-80 卫星的欧亚卫星双向时间比对网。为使欧亚链路早日用于 UTC 计算并长期稳定运行，需尽快对基于 Express-80 的欧亚链路开展性能测试。因此选取组网中四条长、短基线双向比对链路 2024 年 1 月的观测数据，以已校准的 GPS 精密单点定位（GPS PPP）链路数据为参考，利用修正阿伦方差和与参考链路作差结果的标准偏差等指标对双向链路开展性能分析，结果表明通过 Express-80 卫星构建的欧亚链路双向时间比对的天稳为 10-15 量级，与 GPS PPP 链路作差结果的标准差小于 0.5ns，与 GPS PPP 时间传递结果一致，说明新建立的卫星双向链路可以用于 UTC 的计算。

铯原子喷泉钟 NTSC-CsF2 的频率不确定度评定

王心亮 中国科学院国家授时中心

脉冲星时校准铯钟

王琳琳 中国科学院国家授时中心

毫秒脉冲星长期稳定度高，能够作为一种频率源。我们研究了脉冲星时作为一种频率源校准铯钟的可行性。使用 IPTA 2 发布的 PSR J1909-3744 和 PSR J1713+0747 的实际观测数据，分别建立单脉冲星时与综合脉冲星时，探究建立好的脉冲星时在分别半年、一年、两年和三年的时间尺度上校准铯钟的能力，同时与 TT(BIPM)和 TT(TAI)的校准结果进行对比。实验结果表明，在一年的时间尺度上综合脉冲星时校准铯钟的结果可以与 TT(BIPM)相媲美。

基于 XPNAV-1 观测的空间授时应用研究

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通过对比 XPNAV-1(X-ray Pulsar Navigation-1)和 NICER（Neutron Star Interior Composition Explorer）关于蟹状星云脉冲星（ Crab Pulsar）同一时段（108 天）观测数据的计时处理结果，发现在周期跃变发生前的时段（95 天），NICER 数据的拟合前计时残差的 RMS（root mean square）为 5.77 μs, 远优于 XPNAV-1 数据的拟合前计时残差的 RMS 51.56 μs；而在周期跃变发生后的时段（13 天），发现 XPNAV-1 数据的拟合前计时残差的 RMS 为 55.87 μs，而 NICER 数据的拟合前计时残差的 RMS 为 167.27 μs，周期跃变对 NICER 的影响更大，说明在处理周期跃变发生后时段的 NICER 数据时，由于 NICER 的观测精度非常高，需要更频繁地更新 Crab 星历。

对于脉冲星试验 01 星的两年实测数据,针对 Crab 星历经历了多次更新的特点,提出了更新标准脉冲轮廓进行 X 射线计时的改进方法。以一系列观测时长为实测数据分组,再采用改进后的方法进行计时分析并与改进前的结果进行对比。通过对比改进前后的计时结果,发现改进方法得到的计时残差的均方根(rootmeansquare,RMS)平均降低了 14.2%,体现了改进方法处理经历多次星历更新的 Crab 脉冲星观测数据的合理性和优越性。此外,改进方法对脉冲星试验 01 星两年观测数据的稳定度σ_z没有量级上的改进。

基于国产光抽运小铯钟噪声特性的 Kalman 滤波时间尺度算法

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时间尺度算法对于时间保持工作具有重要作用。目前守时工作中的时间尺度算法主要针对国外微波钟采用“可预测性”加权算法，但由于国产光抽运小铯钟（下称国产钟）的工作原理和性能不同于国外钟，因此需要发展新的方法以适应国产钟。为了提升我国标准时间的自主性和安全性，以精准分析国产钟的性能为切入点，基于国产钟的噪声特性，建立国产钟的状态模型，通过 Kalman 滤波算法计算时间尺度。国产钟的状态模型同时考虑了调频白噪声，调频闪变噪声和调频随机游走噪声的影响。新方法对国产钟的调频闪变噪声建模，并加入原子钟的状态向量进行滤波估计，有效提高了时间尺度的稳定度。该项工作通过 Markov 过程的线性组合对调频闪变噪声建模，分析了 Markov 过程个数的不同对时间尺度稳定度的影响。该算法比较了“可预测性”加权算法，计算得到基于国产钟噪声特性的 Kalman 滤波时间尺度的稳定度优于“可预测性”算法。以 UTCr 为参考得出基于国产钟的时间尺度 15 天的频率稳定度为 1.14×10-14，30 天的频率稳定度为 5.50×10-15。

北斗三号时间比对中的 B1C 和 B2a 信号直接校准研究

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GNSS 时间比对是当前 UTC 计算采用的主要时间比对技术之一，链路必须经过校准来保证其准确性。北斗三号自建成以来一直稳定运行，对其进行校准是北斗系统成为 UTC 备份链路的先决条件。我们完成了对北斗三号 B1C 和 B2a 信号的直接校准。采用矢量网络分析仪完成了对天线时延的校准，采用 GSS7000 卫星模拟器完成对接收机内部时延的校准，校准不确定度为 1.3 ns。

北斗三 PPP AR 时间传递性能分析

郭栋 中国科学院国家授时中心

为促使北斗时间传递链路早日用于 UTC 计算，在法国(OP)和德国(PTB)守时实验间开展了北斗三号双频组合 PPP 和 PPP AR 时间传递试验。试验结果表明：短基线 OP71-OP73 北斗三 B1I&B3I PPP AR 共钟比对链路的噪声最小，其标准偏差（STD）相比 B1I&B3I 和 B1C&B2a PPP 浮点解链路分别降低 85%和 68%。当平均时间大于 3840s 时，B1I&B3I PPP AR 链路的稳定度相比 B1I&B3I 和 B1C&B2a PPP 浮点解链路有明显提升，平均提升 29%和 28%。此外，当平均时间大于 3840s 时，长基线 OP73-PTBB 北斗三 B1I&B3I PPP AR 链路的稳定度相比 B1I&B3I PPP 链路也有所改善。

基于光纤束的积分视场高效率多通道光谱仪设计

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积分视场光谱仪能够提供天体在二维视场内所有位置的光谱信息，这对于研究星系的结构、动力学、化学组成以及恒星形成区域等具有重要意义。基于光纤束的积分视场单元因其在焦面的灵活性，可以开展单个面源或多目标的同时观测而受到天文学家的青睐，如：SDSS-MaNGA，AAO-SAMI 等。本报告根据现有的高效率透射光栅工艺，针对不同口径的望远镜，系统地研究了高效率多通道光谱仪的最佳光谱分辨率配置。以 JUST 望远镜为例，设计了一种基于光纤束的积分视场高效率三通道光谱仪，该光谱仪波长覆盖 380-950nm,光谱分辨率 R=1800-5000，探测器 4K@15 微米，仪器峰值效率优于 65%。

用于慕天望远镜（MOST）的新型宽波段高通量双通道光谱仪（SCUTUM）的设计研制进展

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1.93m 慕天望远镜（MOST）是目前正在研制的一款新型赤道式望远镜，用于 MOST 的宽波段高通量双通道光谱仪（SCUTUM）是其配置的首台科学终端。SCUTUM 采用了改进的 FOSC 型设计和双通道配置，其光学设计主要包括一套共用的折反式准直分色系统，两套通过旋转切换的光栅-滤光片切换系统，以及每个通道单独配置的透射式相机系统。在此基础上，SCUTUM 能够将望远镜的 F/8 光束转换为近似 F/4.3 的光束，并在一次曝光中可实现 310-1000nm 的全波段范围内光谱观测。根据光学设计结果，理论上 SCUTUM 的单波长 RMS 均方根直径大小在 0.04 "至 0.26"之间。同时，SCUTUM 根据科学需求配置了分辨率在 250-7500 之间的多种光栅和狭缝选择切换功能，并根据仪器的高通量需求在工作波段范围内采用了高效率光学元件和镀膜工艺以及灵敏度增强型探测器。因此，在 R≤3000 模式下工作时，从准直器到探测器的仪器理论效率超过了 20%@330nm，在波长高于 355nm 时仪器理论效率更是能够超过 40%。此外，SCUTUM 采用了轻量化的结构设计，使得仪器的设计总质量保持在 280 千克左右。目前，SCUTUM 在实验室阶段的整体装调已经初步完成，仪器各项功能均已初步实现，计划于 2024 年底可以具备交付能力，并于 2025 年在 MOST 上投入使用。

MOST 望远镜 SCUTUM 光谱仪结构设计与优化

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SCUTUM 光谱仪是安装于慕士塔格 1.93 米 MOST 望远镜上的首光中低色散光谱仪，计划于 2024 年随望远镜一同建成并安装在望远镜的卡塞格林焦点平台中间块上。该光谱仪具备 310 nm 至 1000 nm 的全波段覆盖能力，提供多分辨率模式（R=500, 2000 及>5000）快速切换，并且在 310-560 nm 的蓝通道波段与 540-1000 nm 的红通道波段实现双臂分区成像，具有高光学效率。仪器整体设计紧凑，主要采用铝合金材料，使得重量仅约 280 kg。为应对铝合金的高冷缩效应，仪器结构采用了多项消热设计，并经过有限元仿真验证与优化，满足光学性能要求。最终结构设计在 40° C 温差下，关键抛物镜的 PV 值为 72 nm，RMS 值为 10 nm；双臂结构在温度和重力变形下的焦点偏移不超过 5 角秒，均符合设计指标要求。

武汉大学大视场光学望远镜终端仪器的研制

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用于高精度视向速度测量的法珀标准具定标技术

叶慧琪 中国科学院南京天文光学技术研究所

亚毫米波射电望远镜面板单元的有限元分析和成型研究

贾诺娴 中科院南京天文仪器有限公司

亚毫米波段在研究冷暗宇宙、早期遥远天体、星际尘埃和星际分子发射谱线等方面具有独特优势，亚毫米波天文学也是国际天文界最热门的研究领域之一。自 20 世纪 80 年代开始兴起以来，各国竞相建造了多台亚毫米波望远镜，但我国大口径亚毫米波望远镜的研制远远滞后于发达国家，目前仅有中德合作的西藏羊八井 3m 亚毫米望远镜移建经验，在 10 米级大型亚毫米望远镜建设方面尚属空白。制约我国大口径亚毫米波望远镜发展的难点，除了高性能亚毫米波探测器研制难度极大外，望远镜所需的米级尺寸、大径厚比（口径与厚度比一般都大于 30）反射面板的高精度制造是另一个瓶颈技术。针对大口径、高精度射电望远镜面板的制造，其表面精度可以通过主反射面板的实际节点坐标与理想抛物面之间的拟合误差的均方根（RMS）来评估。结构重量、温度效应和风荷载是影响主反射镜表面精度的三个主要因素。对于建造在高海拔地区、通常露天状态的亚毫米波射电望远镜，研究面板在温度变化下的稳定性同样不容忽视的。面向我国大口径亚毫米波望远镜建设需求，聚焦于米级尺寸大径厚比铝蜂窝夹层面板成型关

键技术研究，本文将设计并制作了一种高精度低成本的铝蜂窝夹层面板单元。通过 ANSYS 等有限元分析软件仿真对比不同工况中重力、温度场作用下面板单元的应力分布，拟合出最佳曲面面形，再结合新型面板精度再提升方案构建出一种应力形变小、精度高的面板结构；研究了一种高精度低成本的射电望远镜镜面面板成形方法，把加工工作面过程拆解为先从平面加工成球面再热负压成非球面，该方法在缩减模具成本之外，更利于提高面板工作面的成形精度，也避免工作面在从平面压制成非球面过程中因曲率过大对蜂窝造成的破坏或引起工作面出现褶皱。综上，该研究有效填补了我国亚毫米波段望远镜面板成型的空白，对建设大口径亚毫米波望远镜具有重要应用价值和显著的支撑作用。

高分辨光谱芯片

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集成光子光谱仪可为天文观测提供新一代低成本、高集成度、高性能的光学终端仪器。然而，这些光谱仪仍然面临着高光谱分辨率的挑战。在本团队实现了级联相位调制波导阵列光谱仪的研制，其设计和测量的光谱分辨率分别为 100,000 和 68,000。为了减小芯片制造过程中相位误差的影响，提出了一种光谱重建方法，并将光谱对比度提高到 20 dB。此外，进行了基于氮化硅材料的高分辨光谱芯片设计与研制。

基于光强分布的波前传感技术

吴之旭 南昌大学

谐振腔多次反射法测量镜面反射率的空间分布

赵志军 河南师范大学

光学系统中镜面在使用和维护过程中可能造成不同位置反射率差异化下降，为了准确测量镜面不同位置反射率分布，本文在多次反射法基础上提出了利用标准镜和待测镜构造谐振腔实现镜面反射率测量的新方法。首先，根据谐振腔法测量镜面反射率的原理，推导了反射率计算表达式并分析了理论误差，确定了合适的激光反射次数。其次，采用光学仿真软件进行了仿真分析，验证了本方法的可行性。最后，搭建了测量平面镜反射率的测试光路，分别对无污染和有污染待测镜面进行了测量。实验结果表明：通过扫描测量，可以获取镜面不同位置的反射率，测试光路对镜面反射率空间分布测量的分辨率可以达到厘米级，测量精度随

反射次数变化，本次测试采用 5 次反射，理论测量精度比单次反射可提升 2.2 倍。该方法测量装置结构简单、易装调、测量精度高，能够在实验室、外场等多种场景下测量镜面反射率。

LAMOST 近红外光谱仪的研制进展

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LAMOST 中低分辨率光谱巡天主要工作在光学波段（低分 370nm~900nm，中分 495nm~535nm 及 630nm~680nm），随着 LAMOST 研究领域不断拓展的迫切需要，亟需将 LAMOST 光谱仪延展到近红外波段，维持在重大科技基础设施维修改造项目支持下，为 LAMOST 增加一台近红外光谱仪。LAMOST 近红外光谱仪在光谱仪原基础上进行升级，近红外通道采用了透射式相机设计，波长覆盖范围为 900~1380nm，光谱分辨率可实现 1500，峰值效率优于 35%。

长基线天文光干涉中关键控制技术研究

刘超 中国科学院南京天文光学技术研究所

长基线光干涉技术广泛应用于宇宙学测距、高分辨率天体成像等科学领域，其中的控制系统设计问题是保障长基线光干涉系统能够为天文学家提供微角秒级精度的天体测量能力以及毫角秒级精度的成像观测能力的关键。长基线光干涉控制系统是集光学、机械、电子为一体的复杂高精度跟踪设备，可辅助安置于其上的载荷实现对目标的精确定位与跟踪。随着实际应用中跟踪目标机动性的增强，传统 PID 控制下系统的跟踪性能明显下降。因此，急需探索研究跟踪更快速信号的相关控制策略。提升系统的型别可以达到系统跟踪能力改善的目的，但是，高阶控制回路的设计问题在学术界和工程界一直充满挑战性。除此以外，在实际应用中长基线光干涉控制系统不仅要求能够跟踪期望的轨迹，而且系统还要满足一定的控制性能指标，如最小跟踪时间、最小成本等。同时，长基线光干涉控制系统会受到来自载体和外界环境带来的各种不确定扰动，系统状态也会因工作环境、工作姿态以及负载发生变化而产生一定范围内的摄动。这些扰动会使系统在目标跟踪过程中面临严峻的挑战。因此，在保证系统具备优良动态响应性能、跟踪能力的同时，如何大幅提升系统的扰动抑制能力显得尤为关键，对保障长基线光干涉技术高分辨率天体测量的精度，具有重要的科学意义和研究价值

两米环形太阳望远镜

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两米环形太阳望远镜（2m Ring Solar Telescope，简称 2mRST），是由云南天文台、南京天光所和南京天仪公司合作研制的新一代太阳高分辨率观测平台，该系统将安装在抚仙湖太阳观测基地，专注于太阳磁场的高精度高分辨率测量，与 NVST 一起对太阳光球和色球进行高分辨率观测研究。

太阳高分辨率观测的最大难题是太阳强辐射引起的镜筒内部湍动的严重干扰，太阳磁场观测的最大挑战是高精度的偏振光谱观测。2mRST 针对难题与挑战，创新性的提出了环形主镜方案，在主光学系统的对称结构的前提下，消除了镜筒内部湍动对成像光路的影响，确保太阳磁场的高精度高分辨率观测能力。

2mRST 做为中国巨型太阳望远镜（CGST）关键技术平台，在此平台开展多项 CGST 的关键技术攻关和验证工作。

2m 环形太阳望远镜副镜六杆机构研制

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太阳望远镜及双折射滤光器的研制

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中国科学院南京天文仪器研制中心（南京天光所、南京天仪公司前身）上世纪 60 年代开始研制完成了国内首台双折射干涉滤光器，在此基础上研制了十多台台太阳色球、磁场望远镜。还有数十台双折射干涉滤光器与其它望远镜配合用于国内外天文台的太阳观测。本文将叙述这方面的情况。

太阳自适应光学技术进展

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基于激光跟踪仪的环形拼接望远镜子镜对准方法的研究

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中国巨型太阳望远镜（Chinese Giant Solar Telescope，CGST）是新一代大口径太阳望远镜，其主镜的对准是实现共焦和共相调整的重要前提。目前，拼接镜面望远镜的对准大部分由空间坐标测量系统来完成，如经纬仪、全站仪等。而测量精度同样高的激光跟踪仪，虽在大型望远镜光学元件定位和对准上已有广泛应用，但是拼接望远镜上却使用较少，其主要原因是：大部分拼接主镜采用紧密的六边形子镜，导致采用接触式测量的激光跟踪仪缺少基准，从而无法完成子镜之间的对准。而 CGST 采用独特的环扇形子镜拼接方式，子镜内外圈可放置目标，那么利用激光跟踪仪完成环形子镜对准是有可能的。因此，本报告提出了基于激光跟踪仪的环形拼接望远镜对准方法，并通过仿真分析和实验验证了该方法的可行性。

面内位移对环形拼接望远镜共相调整的影响

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800mm 环形拼接实验系统是云南天文台天文技术实验室搭建的主动光学实验平台，该系统的主镜由 8 块环扇形子镜拼接而成，口径为 800mm，环宽 120mm，焦比为 2。搭建此系统旨在研究环形拼接镜面主动光学的关键技术。拼接镜面主动光学控制系统可以控制三个面外自由度（tip/tilt 和 piston），而其余三个面内自由度（面内平移和 Clocking）则通过机械装调来保证。安装误差属于静态误差，例如，TMT 子镜的面内平移安装误差约为 200μ m，Clocking 的安装误差约为 285μ rad。800mm 环形拼接实验系统的探测系统采用 Shack-Hartmann 波前传感器（SHWFS），放置在拼接镜的出瞳面处。每块子镜对应的微透镜阵列内部的子孔径用于倾斜和大范围的 piston 探测，而边缘的 2 个子孔径用于纳米级 piston 探测。通过几何分析和数值分析，得出子镜面内位移会导致探测系统探测到等效倾斜。在 ZEMAX 中对拼接镜面进行建模，验证了理论分析的结果，两种方法得出的结论一致，可以通过调整倾斜来补偿面内位移的影响。然而，当面内位移误差较大时，补偿后仍可能存在波前误差，从而影响面外自由度的探测。本报告主要分析了 800mm 环形拼接系统的子镜面内位移误差对探测系统和共相调整的影响，同时对面内位移安装误差提出了要求。

用于太阳观测的高分辨率 VIPA 光谱技术研究

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南京大学 2.5m WeHoST 太阳望远镜主镜温度控制系统的研究

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大口径太阳望远镜在观测过程中会持续受到大量来自太阳的热辐射，并且在主镜上形成热应力、热变形和观测区域内的气体湍流流场。而其主镜表面的温度场分布以及主镜表面与环境间的温差是影响太阳望远镜观测成像质量的关键因素。

本报告介绍了全球范围内几台大口径太阳望远镜所采取的温度控制方案，目前国内对于这一领域的技术和设备尚处于起步状态，本报告基于南京大学 2.5m 大视场高分辨率太阳望远镜（WeHoST）进行研究，设计了一套太阳望远镜主镜温度控制系统，并对其工作流场进行详细分析，利用 k-ε 计算流体力学模型对整体流场的流动情况和换热能力进行评价。依据分析结果进行了 5 个阶段的优化迭代和仿真模拟，最后总结出一套高效率、高均匀性的主镜温度控制系统流场结构。

模拟和分析结果表明：这一方案下的主镜反射面温度场分布情况均匀，表面平均气温为 20.064℃，主镜面内的温差值为 0.809℃，与环境温度之间的差异减小到 0.411℃，主镜表面的热变形量最大值小于 0.2μ m，RMS 值为 18.05nm，达到理想效果。

本报告中所叙述的研究内容可以为未来的大口径太阳望远镜主镜温度控制研究提供理论基础以及重要思路。

大口径音圈自适应变形镜散热系统研究

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在大口径的地基光学红外望远镜中采用音圈自适应变形镜，具有减少星光反射次数，提高望远镜的效率以及充分利用望远镜视场，做到大视场兼具高分辨率成像的优势。但音圈自适应变形镜基于音圈电机驱动，产生大量焦耳热，引起镜面热变形以及镜面视宁度的恶化。故需要通过合理的热设计，将电机产生的热量导出。本报告采用了三维模拟与实验验证的方法，通过调整物性参数、运行工况、换热方式以及相关结构，对 200mm 的大口径音圈自适应变形镜的散热系统进行了初步研究，并根据模拟与实验结果对散热系统进行了参数优化以及结构设计，以实现 36 个线圈的有效散热，保证系统的正常运行。

大视场光学系统的 RSVA 评价方法

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时域天文是当今天文学领域的热门研究方向之一，大视场望远镜是研究时域天文学的利器。报告人在我国前几代南极天文光学望远镜的研究基础上，创新性的提出了一种从像斑形状分布角度出发的大视场光学系统像质评价新方法（基于光线追迹—向量夹角分布的像质描述方法，RSVA）。相较于现有的方法，该方法采用全新的维度来观察光学系统，有效补充了其他方法在使用过程中丢失的信息。由于新的描述方法沿着光轴方向分析光学系统的全成像过程，能在光学系统各表面、全波段、多视场记录光学系统信息，有助于充分发掘光学系统潜力，理解光学系统成像过程和特点，从而进一步指导新一代大视场光学系统的设计和状态评估。

面向深空探测和天文观测的光电探测技术

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天文及深空科学是主要由实测驱动的学科。观测设备的实测精度和能力的显著提高会大大促进人类对宇宙的认知，包括 21 世纪所面临的几个重大挑战包括暗物质、暗能量研究，高红移宇宙，以及外行星和生命起源。这些重大科学问题的攻克、前沿研究的突破性进展，已经越来越依赖于观测设备能力的不断提升，包括提高观测的灵敏度、谱分辨率、时间分辨率、角分辨率以及拓展波段覆盖区域。这些观测设备就需要功能强大性能卓越的焦面仪器系统，包括大视场相机，波段从可见光到红外。从可见光的科学级 CCD 相机，分析近年来国际上主要大视场巡天望远镜和宽视场光谱成像望远镜项目以及相应的科学级相机，同时基于国内望远镜建设的现状以及需求，介绍科学级 CCD 相机研制的关键技术以及科大在此方面取得的成果，包括 WFST 拼接式主焦相机的研制情况以及寻找地球 2.0-ET 凌星巡天项目 CCD 相机关键技术攻关情况。然后基于国内红外天文观测的需求，分析国内外红外望远镜的现状，从红外天光背景测量出发，介绍近红外天光背景测量仪的研制以及自主研制近红外相机及相关应用。

天文光学用超低膨胀微晶玻璃的结构、性能及应用

范仕刚 中材人工晶体研究院有限公司

超低膨胀微晶玻璃是指以 Li2O、Al2O3、SiO2 为主要成分的玻璃经过严格的受控晶化处理后形成的以负膨胀β -石英固溶体纳米晶相和正膨胀玻璃相构成的一种复合材料，具有优异的光学、热学、力学性能，是目前变温环境尺寸稳定性最好的材料，在航空、航天、电子、兵器、船舶、精密机械等诸多领域得到广泛应用。β -石英固溶体是β -石英和β -锂霞石形成的连续固溶体，随着晶化过程的进行，固溶程度增加，更多的 Li+、Al3+、P5+等离子从玻璃相进入β -石英固溶体中，改变着β -石英固溶体晶体和残余玻璃相的热膨胀系数，进而影响微晶玻璃整体的热膨胀性能，微晶玻璃的热膨胀系数从玻璃相的 10-6 数量级逐渐减

小到 10-7 数量级，10-8 数量级乃至零膨胀。合适的组成和工艺形成科研工作者设计所希望的微晶玻璃结构，微晶玻璃因此具备优异的综合性能，从而实现微晶玻璃的极端环境应用。

基于月面特征的高精度指向校正方法研究

王冠一 中国科学技术大学南京天文仪器研制中心

月球激光测距（LLR）技术用于准确测量地月距离，对全方位了解地月系统具有重要意义。该技术是一项综合性技术，涵盖了高功率短脉冲激光技术（包括飞秒和皮秒激光器）、单光子雪崩二极管（SPAD）技术、时间相关单光子计数（TCSPC）技术以及高精度指向系统等。其中，高精度指向系统在月球激光测距中扮演着至关重要的角色。它不仅直接影响测距精度和数据质量，还对控制系统、传感器系统、光学系统和数据处理系统产生深远影响。通过精确的指向和稳定的跟踪，高精度指向系统确保了激光测距任务的成功和科学研究的可靠性。

为了进一步提升望远镜的指向精度，我们研究并应用了基于月面特征的高精度指向校正方法。利用月球表面的特征进行校正可以有效补偿由于月球表面不规则形状和动态变化引起的指向误差。这种校正方法不仅能提高望远镜的指向精度，还能增强激光测距数据的可靠性，为科学研究提供更为精确和详细的观测数据。因此，基于月面特征的高精度指向校正方法将是未来提升月球激光测距技术的重要方向。

在我们的研究中，我们提出了一种基于月面特征的高精度指向校正方法，该方法主要包括以下三个步骤：首先，我们对预处理后的月面局部图像进行标注，并将其输入 YOLOv5 模型进行训练，从而获得一个能够识别月球坑的目标检测模型，该模型生成月面局部区域中月球坑的分布图。其次，利用局部分布图，我们将应用图匹配算法，将局部图像中的月球坑分布与月面全局月球坑分布图进行对比，此步骤通过构建特征点的图模型，精确地对齐和匹配局部图像中的月球坑位置，从而计算出其在全局图中的精确坐标。第三，根据这些坐标，我们反算出图像中心所指向的坐标，从而确定望远镜指向月球表面的具体位置。

此方法为未来月球探测任务和科学研究奠定了坚实基础，并有望在实际应用中发挥更大的作用，支持月球及其他天体的精确测量和探测。

司天工程观测控制系统进展

王政 国家天文台

龙虾眼光学技术进展

张臣　　国家天文台

云南天文台天文科学级红外探测器研究进展

许方宇 中国科学院云南天文台

云南天文台研发的短波红外探测器，采用铟镓砷技术方案，响应波长 1.0~1.7 微米，像元数为 1280*1024。读出噪声约 14 个电子每像元；暗电流小于 20 个电子每秒每像元。主要技术指标，包括像元规模和读出噪声等，国内均具有显著优势。

该探测器是国内首支实现天文科学观测的 1K 级红外探测器。目前已在 NVST 实现常规观测，稳定产出科学数据超过半年。我们将展示部分实验室测试结果和部分太阳 10830Å 观测结果。

阿里原初引力波探测探测器模块研发进展

舒诗博 中国科学院高能物理研究所

AliCPT1 是我国首个原初引力波实验项目，计划在我国西藏阿里地区海拔 5250 米的台址建设一台有效口径为 72cm 的 95GHz/150GHz 原初引力波望远镜，建成后将成为世界上海拔最高，北天唯一的原初引力波观测站。AliCPT 焦平面可容纳 19 个模块，是目前同类型望远镜中单个镜筒探测器数量最多的。团队已实现 6 英寸 444 个像素双极化双频段共 1776 个探测器的设计，并完成单像素的光学效率测试，本报告将介绍探测器模块的研究进展。

背照式 CCD 像元间响应不均匀性与波长关系的建模

罗尊　　中国科学院国家天文台

随着天文观测精度要求的不断提高，各个天文望远镜项目对其探测器效应造成的误差限制也不断增强，这就要求对探测器效应进行精确的建模与改正。在各类探测器效应中，像元间响应不均匀性(PRNU)的改正将直接影响天体测光及形状测量的精度。传统的平场改正方法较少考虑 PRNU 对波长的依赖，如果目标源与平场的光谱不匹配，就可能会影响精确测光以及 PSF 建模。在本报告中，

我们使用了一个四参数的半物理模型对背照式电荷耦合器件(BSI CCD)的量子效率与波长关系进行了建模，并提出了稳定的全靶面参数拟合方法。依据此方法，我们对一片采用了激光退火工艺的 BSI CCD 拍摄的 290nm-950nm 范围内的 9 幅平场图像进行了参数拟合与图像重建。结果表明该模型可以在很大程度上复现出砖墙结构与年轮结构这两种典型的 PRNU 图案，拟合的残差均方根在大多数情况下低于 0.2%，而改正了光照等因素导致的大尺度不均匀性后，残差均方根会进一步降低。我们还评估了模型对各个波长平场的插值能力，结果表明与三次样条插值相比，此模型的在使用更少参数的前提下取得了更准确的插值结果。CSST、LSST 等下一代巡天项目均有采用激光退火 BSI CCD 作为其探测器，该模型可以应用于这些项目的平场改正。此外，该模型未来可以与光谱能量分布(SED)拟合相结合，依据单个目标源的 SED 进行 PRNU 改正，从而在系外行星探测、弱引力透镜等对测光或形状测量精度要求很高的项目中发挥作用。

基于恒星光度测量的全天相机云层识别与重建方法

支挥　　中国科学院国家天文台

云量是影响地基光学天文观测的主要气象要素之一，可见光全天相机则是夜天文观测常用的云检测手段。现有的全天云图处理算法需要较多的人工干预，对于呈现消光特征的云层识别存在困难，且缺少详细的云量分布可视化结果。为此，本文提出基于全天相机恒星提取和识别的算法，利用测量恒星消光实现了云层分布和厚度的一体化重建。文中首先研究基于自然天体的鱼眼相机高精度定标方法，定标后正向成像模型的全天误差优于 0.87 像素。在成像模型基础上，构建适配全天相机探测能力的可见光全天星表，采用 SExtractor 算法提取全天云图中的恒星。通过恒星匹配和消光测量，计算出云层的光学厚度。最后提出了基于网格划分和机器学习的六种云层重建方式，重建精度可达 1.8°。通过对实测图像的处理结果表明，该方法标定流程简单，云量提取与重建的效果良好。在望远镜动态调度、观测策略制定等研究领域具有较高的应用价值。

1 米车载人卫激光测距望远镜伺服系统研制

赵金标中科院南京天文仪器有限公司

1 米车载人卫激光测距望远镜用于精确测量卫星与望远镜之间的距离，是卫星位置测量与轨道预报的重要地面设备，具有能快速移动部署的优点，且需满足大转速范围、大加速度、高精度指向与跟踪控制的技术要求。该望远镜主接收系统通光口径为 1 米，伺服系统采用基于 ARM 硬件架构的直接驱动控制，控制系统由电流环、速度环和位置环三环串联构成。ARM 通过解析光栅 BISS-C 协议实时获取望远镜高度轴与方位轴的转角信息，对卫星轨道预报数据进行插值运算，

得出当前时刻的卫星预期位置坐标，结合前馈控制与反馈控制算法，实现高精度的卫星跟踪控制。该望远镜已通过出厂验收，具备全天区指向精度 5″，在最大转速 8°/s、加速度 1°/s2 的条件下，卫星跟踪精度优于 0.5″ (RMS)。

14.5 米望远镜观测环境初步分析

李陶然 中国科学院国家天文台

光学天文观测环境是影响望远镜观测精度与效率的重要因素之一，由于受到天文台站建筑布局和圆顶内部湍流的影响，望远镜附近的观测环境发生改变。为了解 14.5 米望远镜的观测环境、提供圆顶设计参考依据，基于台址条件和圆顶初步方案开展研究。本次报告将从台站和圆顶两方面介绍相关研究工作，包括气象环境、望远镜布局、圆顶通风和热环境等。

天文气象参数的评估与预测

胡天柱 中国科学院南京天文光学技术研究所

天文气象参数包括视宁度、等晕角、相干时间等，是评估台站观测条件的重要指标，也是设计自适应光学系统的重要依据，对天文气象参数的预测还能帮助实现望远镜观测的灵活调度。使用专门仪器可以获得大气折射率结构常数或者直接获得天文气象参数，然而使用仪器无法获得仪器安装前的历史数据，无法进行数据预测，往往只安装在已建成的台站及潜在的优秀站点。本报告主要介绍如何结合天气预报数据及数值模型实现天文气象参数的评估及预测，介绍常见的数值模型及提高数值评估精度的方法。

自由曲面气囊高效抛光关键技术研究

武兆平中科院南京天文仪器有限公司

空间光学元件对面形精度和表面质量有着极高的要求，气囊抛光采用了新型的抛光工具和特殊的运动形式，是一种高精度、高效率的光学元件加工方法，尤其适用于非球面及自由曲面，具有广阔的应用前景。本研究中设计并搭建了基于工业机器人的气囊抛光系统，利用坐标系的齐次变换原理分别建立了定角度、离散进动以及连续进动的运动模型，并仿真绘制了气囊进动抛光的运动空间。建立了抛光材料去除模型，分析了气囊转速、进动转速与工件曲率半径对抛光过程的影响机理。以正交试验作为研究方法，对气囊抛光工艺参数对工件的材料去除率和表面粗糙度的影响进行了分析，得到了各工艺参数的影响规律并对其进行优选，

得到了最优工艺参数组合。最后，采用优化后的工艺参数进行了自由曲面光学工件的抛光实验，获得了质量稳定的加工表面，且较常规小磨头抛光提高了 2 倍以上的效率，验证了上述研究的可行性。该气囊抛光系统已投入应用，有效提高了抛光效率，尤其是对 SiC、单晶硅自由曲面光学元件的加工。

激光标线仪在大口径镜面测试中的应用研究

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光学镜面测试一般是基于光干涉原理通过干涉仪检验光学镜面的面型误差，对于不同的镜面类型，测试的方式也各不相同。镜面在测试之前要先构建测试光路，需要调整仪器和光学元件的空间位置，判断光学元件的受力姿态，校正光学元件的光轴，以保证测试的完整性与准确性。而如何快速科学地构建好测试光路，对于有多块镜面的组合测试尤为重要，同时也是大口径镜面测试中普遍需要解决的问题。

基于激光标线仪能够非接触式输出连续参考基准这一特性，提出了将其用于辅助构建光学镜面测试光路的设想，分别研究了其在平面镜测试、球面镜测试、Ritchey-Common 法测试、非球面镜测试等测试光路构建中的作用以及在光路调整中的操作事项，科学系统地展示了其在空间定位、光轴校正中的特殊优势，并讨论了其误差对于测试的影响以及相应的修正措施，研究结果表明用激光标线仪能替代传统的辅助对准调试设备和方法，其对于不同类型的光学镜面测试都有很好的适应性。

微波动态电感探测器阵列串扰抑制

黄厚曾 上海师范大学

亚毫米天文成像芯片像元数正朝着万量级发展，微波动态电感探测器由于其自带的频分复用属性，简化读出电路，成为大阵列成像的首选技术。然而在使用微波动态电感探测器阵列时，必须考虑相邻谐振器之间微波串扰的影响。本文研究了微波动态电感探测器谐振器间隔离地的宽度和频率间隔对串扰的影响，并且提出了降低串扰的用于阵列排布的遗传算法。首先，通过改变水平和垂直方向两个谐振器之间的隔离地的宽度和频率间隔对串扰进行估算。模拟结果表明，当两个谐振器频率差大于等于 20 倍设计频率间隔，水平方向隔离地的宽度 G 大于等于 80μ m，垂直方向隔离地的宽度 g 大于等于 100 μ m 时，微波串扰小于 5%。进一步，通过遗传算法排布 64 像素微波动态电感探测器阵列，实现水平和垂直方向相邻的谐振器频率差大于等于 20 倍设计频率间隔。模拟结果表明，经过算法排布后的阵列，串扰小于 0.5%，响应错误率低于 1%。为了验证上述解决方案的有效性，我们设计并制备了两个具有不同阵列排布的 256 像素微波动态电感探

测器阵列，并在 70mK 制冷机下进行测试。实验结果表明，经过算法排布后的阵列串扰显著降低。

亚毫米波天文成像多窗口宽带阵列天线设计

孙仕霖上海师范大学

在亚毫米波天文探测高速发展的背景下，由于探测器技术的进步，分辨率随着时间的推移而提高，但目前的焦平面天线设计难以平衡宽频段和高增益两个特性，往往足够宽的频率范围反而使得天线光学效率较低，这对更多像素的集成仍有较大限制。为了在有限的焦平面上实现大阵列像素的集成，我们选择用工作频率 230Ghz、350Ghz 的天线组成阵列，优化空间布局保证两个工作频率兼具高增益与宽频段的特性。因此我们基于 LCT 望远镜的透镜系统设计了一种用于亚毫米波天文探测的平面缝隙天线阵列。我们通过调整接地金属层上矩形缝隙的尺寸，以微带线耦合馈电的方式实现 230Ghz、350Ghz 亚毫米波信号接收，并采用阻抗渐变式并联馈电网路进一步拓展天线工作带宽。优化缝隙的空间布局，在保证与 LCT 望远镜透镜系统焦比匹配的情况下抑制副瓣。仿真结果表明该阵列天线在中心频率 230Ghz、350Ghz 分别有 50Ghz 的绝对带宽，增益 15.5dBi。

基于噪声空间特性先验的红外图像去噪方法

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本文提出了一种结合噪声空间特性与交替方向乘子法（ADMM）的红外图像去噪算法，旨在同时处理稀疏噪声和低频噪声。算法首先基于先验信息提取有效图像块，对噪声的空间分布特性进行精准估计，进而建立多项优化目标，包括稀疏噪声、低频噪声和图像结构保真项。通过 ADMM 迭代，拉格朗日乘子的更新在各项约束之间实现平衡，达到稀疏、低秩噪声抑制与图像保真度的综合优化。结合詹姆斯韦伯（JWST）中 NIRCAM 仪器实测图像，实验结果表明，该方法在有效去除稀疏和低秩噪声的同时，显著提升了图像质量，并能够较好地保留深空结构细节。

基于 LCT 望远镜接收机可调波导衰减器的设计与制造

袁忠玉 上海师范大学

亚毫米波衰减器是 LCT 望远镜 SIS 接收机本振链路中的关键器件，具有调节本振功率、减少回波损耗，实现阻抗匹配等要功能。本文基于吸收式波导衰减

器工作原理，提出了一种新型的可调波导衰减器，它与微分平台集成在一起。波导中插入有双面镀有钛金属的三氧化二铝圆弧形薄片，可以吸收通过波导的电磁波。薄片吸收的电磁波能量由金属镀层的电阻和薄片在波导中的位置决定，采用微分平台对信号的衰减进行控制，可以实现精确和精细的衰减步进值。在 170-260 GHz 频段，衰减器使用 15mm 长的三氧化二铝圆弧形薄片和 80nm 的钛金属镀层实现了高达 20 dB 的信号衰减。所提出的衰减器设计具有高精度、紧凑性和高稳定性，并且易与本振源和混频器集成。此外，整个装置还具有很好的扩展性，只需更换波导和薄片，即可改变衰减频率，我们现已将衰减器应用频率扩展到 400GHz。该工作为 LCT 望远镜 SIS 接收机系统升级提供了关键技术支持。

5、天力、天测分会场报告摘要

重绘银河系结构--从 0 到 1 的变革

徐烨　　紫金山天文台

联合 Gaia 和 CSST 的天体测量研究

廖石龙 上海天文台

AI 赋能的空间物体光学观测研究新范式

孙荣煜 紫金山天文台

长春人卫站空间目标光谱研究现状（2024 年度）

邓诗宇 长春人造卫星观测站

自行引起的长期光行差漂移

王圳伟 南京大学

Abstract. The motion of the Solar System barycenter (SSB), the spatial origin of the International Celestial Reference System, causes a directional displacement known as secular aberration. The secular aberration drift caused by the galactocentric acceleration of the SSB has been modeled in the third generation of the International Celestial Reference Frame. We aim to address another secular aberration drift effect due to the change in the line-of-sight direction and study its implications for stellar proper motions. We derived a complete formula for the secular aberration drift and computed its influence on stellar proper motion based on the astrometric data in Gaia Data Release 3. We find that the secular aberration drift due to the change in the

line-of-sight direction tends to decrease the observed proper motions for stars with galactic longitudes between 0 °and180 °, and increase the observed proper motion for stars in the remaining region. If this secular aberration drift effect is ignored, it will induce an additional proper motion of > 1 mas / yr for 84 stars and > 0.02 mas / yr for 5 944 879 stars, which is comparable to or several times greater than the typical formal uncertainty of the Gaia proper motion measurements at G < 13. The secular aberration drift due to the change in the line-of-sight direction and the acceleration of the SSB should be modeled to make the stellar reference frame consistent with the extragalactic reference frame.

摘要：国际天球参考系统的空间原点，即太阳系质心（SSB）的运动，会导致一种称为长期光行差的效应。由于 SSB 的加速度引起的长期光行差漂移已经在第三代国际天球参考架中被建模。我们的目标是解决由于观测源视线方向变化引起的另一种长期光行差漂移效应，并研究其对恒星自行的影响。我们推导出了完整的长期光行差漂移公式，并基于 Gaia DR3 中的天体测量数据计算了其对恒星自行运动的影响。我们发现，由于视线方向变化引起的长期岁差漂移会减少银经在 0° 至 180° 之间的恒星的视自行大小，并增加剩余区域恒星的视自行大小。如果忽略这种长期岁差漂移效应，它将为 84 颗恒星引入超过 1 毫角秒/年的额外自行，为 5,944,879 颗恒星引入超过 0.02 毫角秒/年的额外自行，这与 Gaia 在 G < 13 时典型的自行测量的形式误差相当或更大。因此，由于视线方向变化和 SSB 加速度引起的长期岁差漂移都应该被建模，以使恒星参考架与河外参考架保持一致。

基于高精度时频传递中的天文地球动力学研究

王彬　　上海天文台

随着时间频率 E-18 量级相对测量精度的实现，人类进入量子精密测量时代。量子时频传递精度的大幅提升为天文地球动力学理论的进一步发展提供了新的机遇。以地面光纤、空间激光以及北斗时频传递为例，讨论近地空间高精度时间传递中，需要考虑的与天文地球动力学相关的一些因素（如地球自转、地球重力场、相对论、轨道动力学模型等）。通过实测数据以及仿真分析，尝试给出一些为实现 E-18 量级的时频传递有参考意义的研究建议。

通过 Gaia 小行星观测研究动力学参考架与 Gaia-CRF3 的连接

姚俊　　南京大学

Gaia DR3 中提供了对太阳系小天体毫角秒 (mas)精度的观测。考虑到 Gaia -CRF3 是国际天体参考系(ICRS)的光学实现，使用 Gaia 太阳系小天体观测来研究行星历表与 ICRS 的对准是一种新的可能途径。基于这一想法，我们使用了小行星观测研究 Gaia -CRF3 与太阳系行星历表 DE440 所代表的动力学参考系之间的对齐精度。我们计算了在每个 Gaia 观测历元时小行星的历表位置，并且将其与在 Gaia 中的位置进行比较。在赤经和赤纬方向上，小行星在两个参考系中位置差值在几百毫角秒左右；而在精度较高的 Gaia 扫描方向上，位置差值只有几个毫角秒。由于小行星的快速运动和相位效应，位置偏差在赤经和 Gaia 垂直扫描方向上显现不对称性。我们利用精度更高的 Gaia 扫描方向上的位置偏差拟合了 Gaia-CRF3 和 DE440 之间的欧拉角，发现两者之间绕 z 轴的旋转约为 0.25 mas，而倾角约为 0.05 mas。

Gaia 星表亮端视差偏差检验

丁页　上海天文台

使用 GaiaDR3 预报脉冲星的天体测量微引力透镜事件

卢旭　紫金山天文台

测定中子星的质量对认识其形成演化和内部结构至关重要。然而，目前仅已知少数位于双星系统中的中子星质量，大量孤立中子星的质量仍然未知。在不依赖于物理模型的情况下，天体测量微引力透镜已成功用于测量暗弱的天体质量。未来对中子星开展类似测量的前提是对有关的引力透镜事件进行预报。基于 ATNF 中子星数据库和 Gaia DR3 源的天体测量数据，本文预报中子星充当引力透镜体或受引力透镜的天体测量引力透镜事件。本文共预报 60 起中子星充当引力透镜体的事件，并通过蒙特卡洛采样得到了引力透镜像偏移等观测量的概率分布。。此外，本文发现 4 起中子星受引力透镜的候选事件。其中几起较显著事件有望被未来天体测量观测和脉冲星计时观测所验证。通过对预报结果的分析和与先前预报工作的对比，本文发现预报结果对天体测量数据的不确定性和脉冲星射电观测数据的更新十分敏感。

CSST 密集星场天体测量参数解算及其挑战

曹子皇 国家天文台

地基专用天体测量望远镜研制

李正阳 南京天文光学技术研究所

地基专用天体测量望远镜是一台口径 4.2 米的高精度历表研制望远镜，主要针对太阳系内天体开展常态化观测和高精度的天体测量观测，预期望远镜研制成功后，充分满足我国自主研制太阳系天体高精度历表的需求。望远镜整体性能满足对 18 等太阳系天体 30 秒曝光实现 10 个毫角秒的定位精度，以及太阳系天体 30 秒曝光深度达到 23.5 星等的观测能力。在报告中，将主要地基专用天体测量望远镜的整体设计和光学系统设计等，以及在研进展。

月面角反射器阵列倾斜对月球激光测距的影响

曹进　　云南天文台

报告主要介绍角反射器(CCR)阵列的倾斜对月球激光测距（LLR）的影响。对角反射器阵列建立数学模型，用于研究由其倾斜引起的随机误差。研究发现，在理想情况下，当激光测距脉冲宽度为 10ps 或更小时，可以区分回波信号中每个峰值来自 CCR 阵列的哪些特定角反射器。因此，可以提取部分回波数据进行信号处理，显著减少随机误差并提高 LLR 的单次测量精度。通过提取部分回波获得的距离可以归算至阵列的中心位置，从而为每次测量提供多个高精度测距结果。这不仅提高了 LLR 的精度，还增加了数据量。基于云南天文台 1.2 米激光测距系统进行的仿真实验表明，通过提取一个峰值进行信号处理，单次测量精度从 32.24 毫米提高到 2.52 毫米，验证了理论分析的结果。随后，基于云台 53 厘米双筒望远镜系统搭建了实验测距系统，用于地面实验。实验结果表明，回波信号能够识别 CCR 阵列的倾斜状态。通过提取由中心 CCR 返回的峰值进行信号处理，测距精度大大提高。通过理论分析、仿真实验和地面实验，提供了一种减少 CCR 阵列倾斜引起的随机误差的解决方案，为未来 LLR 的单次测量精度提升提供了方法，并为未来激光测距站地面设备的升级提供了参考。

边缘不稳定光球附近的光线偏折

张景　　紫金山天文台

虫洞时空中存在 2 种新的边缘不稳定光球。一种是光球和喉并合而成的，另一种是光球、反光球和喉并合形成的。二者都是虫洞时空所独有的特征。本报告将专注静态、球对称虫洞时空边缘不稳定光球附近的强偏折引力透镜。在强偏折极限下，该光球附近光子的偏折角不再以对数形式发散，而是以指数形式发散。此外，本报告还将阐述此时观测量的表达形式，并将该方法应用至霍恩代斯基理论下的虫洞时空。

中性大气时延修正方法及在深空探测中的应用

周伟莉 上海天文台

无线电信号穿过地球大气层时会发生信号传播速度的改变和信号传播路径的弯曲。中性大气时延随着仰角而变化，天顶方向中性大气时延约为 2.4 米，仰角为 6°时中性大气时延可达到 20 米。为消除中性大气时延的影响，我们开展了中性大气时延修正方法的研究，构建了适用于不同条件的中性大气时延修正模型。尤其在深空探测 VLBI 测定轨应用方面，基于我国 VLBI 测站，构建了可用于探测器实时定轨的中性大气天顶时延预测模型，并提出了可用于探测器 3 小时时延定轨的基于小时更新全球导航卫星系统实测数据反演中性大气天顶时延修正方法。同时，开展了不同映射函数模型在 VLBI 测站的应用精度验证，评估了低仰角（30°以下）情况下不同实时映射函数模型的精度差异。为深空探测任务中 VLBI 等测定轨技术的中性大气时延校准提供了有效的技术支持。

低轨巨型星座光度特性研究

支挥　　国家天文台

近年来，航天技术和通信技术的蓬勃发展，催生了以 Starlink 为代表的低轨巨型通信星座。自 2019 年 Starlink 开始组网以来，近地空间的卫星数量快速增长，其频繁出现在地基光学望远镜的视场中，严重影响了天文观测。为研究低轨巨型星座的光度特性，本文使用国家天文台兴隆 1m 望远镜对 Starlink 和 Oneweb 这两个巨型星座的卫星开展大样本高精度多色光度观测研究，并基于卫星的轨道参数解算光照可视关系，从实测数据中构建低轨卫星光度模型，并着重分析各版本卫星的光度特性和多色特性。数据分析表明 Starlink 卫星的相位角是影响其光度的主要参量，拟合结果较好，，OneWeb 卫星光度变化对相位角不敏感且平均光度较暗；装备遮阳板的 Starlink v1.0 版本 VisorSat 卫星光度相比其余版本有显著降低，消光比例达 55.1%；Starlink v1.5 的消光比例中位数为 40.4%。本研究可为评估低轨巨型星座对天文观测的影响提供量化数据和光度预测模型。

亚毫米精度的上海佘山 VGOS 望远镜归心测量

张志斌上海天文台

图像增强技术在天然卫星 CCD 观测数据处理中的的应用

王泽禹 上海工程技术大学

河外射电源坐标时间序列精度评估

张夏轩 南京大学

当前的基本天文参考系选取河外源作为参考基准，是由于河外源距离遥远从而可以假定没有可观测的自行运动。然而，由于河外源内部活动、太阳系质心加速度和原初引力波、多黑洞系统等物理因素和不同观测网及观测误差等测量因素，由甚长基线干涉测量（VLBI）技术测定的河外源视位置并非完全不变。也因此，河外源的坐标时间序列中包含有丰富的信息，可用于筛选国际天球参考架（ICRF3）的定义源、评估 ICRF3 的轴稳定性、测定太阳系质心加速度和原初引力波的多极矩信号等。在以往的研究中，缺乏对由测量因素引起的河外源视位置变化的系统研究。本研究通过比较不同 IVS 分析中心提供的河外源坐标时间序列数据，研究不同分析软件、算法和解算设置对测定河外源视位置的影响，由此评估河外源坐标时间序列的真实精度。

基于灰度共生矩阵和 Mini Batch K-Means 聚类的含云图像分割研究

付豪　紫金山天文台

云层覆盖对依赖于地基光学望远镜的夜间天文观测影响显著，面对巡天获取的海量数据，含云图像的处理存在丢弃或者有效信息利用率较低的问题，造成大量观测资源的浪费。本文针对含云图像有效信息的提取问题，采用灰度共生矩阵处理平滑后的图像，将处理结果作为聚类指标输入 Mini Batch K-Means 方法，给出了一种可划分厚云区、薄云区和无云区的图像分割方法。实际观测图像的处理结果表明，该方法能有效实现云层分割，实现巡天数据的高效利用，并给目标区域的测光和暗弱天体的提取提供参考，对望远镜动态调度、观测站点特征分析以及巡天策略制定提供应用价值。

区域并置站的本地连接算法

袁淑珍 上海天文台

在地球科学领域，通过整合多种空间大地测量技术，构建高可靠性、高精度和高稳定性的综合地球参考框架，是实现 1mm 精度和 0.1mm/yr 稳定性的全球大地测量观测系统（GGOS）目标的重要技术。要实现这样的一个参考框架，需要在各并置站点开展多种空间大地测量技术设备参考点的测定，并在综合参考框架的构建中引入并置站本地连接信息来作为约束。区域并置站是指相隔数公里内且光学可通视的多座并置站，这类并置站对开展多技术系统差的监测、识别与改正具有重要意义。上海佘山地区的激光卫星测距（SLR）站与天马 VGOS 站间隔约 5 公里，具备光学通视条件，满足构成上海佘山区域并置站的条件。为实现区域并置站间的本地连接以及长基线多技术监测系统差研究，我们提出一种区域并置站的本地连接算法，该算法包含了全球卫星导航系统（GNSS）和光学测量两类连接方法，还包括基于旋转角的光束法平差来完成多个并置站参考点坐标由局部坐标系到地心坐标系转换，实现区域并置站多台多技术设备信息间的有效连接，且可吸收不同园区垂线偏差对多技术设备参考点地心坐标的误差，这为多技术综合参考框架的构建提供了更新颖和更广泛的约束方法。

基于自动微分的猎鹰九号火箭体姿态反演

李徽　云南天文台

空间目标的光度测量是通过地面或空间望远镜对目标进行连续观测，记录其光度随时间的变化。这些观测数据包含了目标的亮度信息，而目标的亮度会随时间发生变化形成光变曲线。通过分析光变曲线的特征，可以估计出目标的旋转状态，包括旋转周期、旋转轴指向等参数。对目标建立封闭元模型后可以建立目标的光度模型，结合光度模型和实测光变数据可以有效估计目标的姿态。但是通过

该方法建立的目标光度函数表达式十分复杂，参数估计过程耗时长、精度低。为了解决该问题，本研究创新性地将自动微分方法应用到空间目标的旋转状态估计。应用自动微分方法后，参数寻优速度大大提高，并且发现了由于对称性导致的多解现象。

史瓦西星相对论像的干涉测量信号

高原兴 紫金山天文台

无视界史瓦西星具有光球，其强偏转引力透镜可以产生独特的光球内相对论像，这一现象在史瓦西黑洞时空中并不存在。为了认识史瓦西星光球内、外相对论像的观测特征，本文考虑光源的有限距离效应，拓展了极致密天体的强偏折极限方法，并解析计算了史瓦西星所有相对论像的干涉测量复可见度。本文发现史瓦西星相对论像的干涉图像具有丰富的观测特征，未来有可能被空间甚长基线干涉测量技术探测到。

How Different Stellar Environments Shape the Planetary Systems

刘慧根 南京大学

不同质量恒星周围的行星形成与演化：行星出现率及轨道特征

潘梦睿 浙江大学

系外行星观测表明，行星出现率及轨道特征与恒星质量等特征相关。基于卵石吸积模型，我们通过蒙特卡洛方法，利用行星种群模拟代码对 0.1-1 倍太阳质量恒星周围的行星形成与演化进行了大量模拟，研究并对比了不同恒星质量周围形成的行星系统及其种群特征，包括宜居行星、超级地球、超级海王星和气态行星的出现率与恒星质量和金属丰度的关系。此外，本项研究还选取了部分行星系统，分析其长期动力学演化，探讨行星轨道分布（如偏心率、轨道倾角等）与恒

星金属丰度之间的相关性，并将模拟结果与观测数据进行了对比。研究表明，超级地球的出现率在红矮星周围随着恒星质量的增加而提升，在接近 0.5 倍太阳质量时达到峰值，随后行星出现率随着恒星质量的继续增加而减少。相比之下，大质量行星的出现率则随恒星质量的增加呈现单调下降趋势。岩石类小质量行星的出现率与恒星的金属丰度没有明显相关性，而气态巨行星的出现率则随着金属丰度的增加显著提升。行星轨道偏心率和轨道倾角也随恒星金属丰度增加而增加。研究结果与观测一致，并为未来观测提供理论依据与指导。

伴星对宜居行星形成与演化的影响

苏湘宁 海南大学

双星系统中行星观测提供寻找新的宜居行星候选体的新思路。伴星的存在使得系统宜居行星的形成与演化变得复杂，丰富了行星形成演化理论。本课题从目前观测到的双星分布出发，根据摄动理论和数值模拟行星动力学演化，分析不同双星系统中伴星对宜居行星动力学演化的影响。定性和定量给出稳定宜居行星分布区域，并提供双星宜居行星候选体。

一种对于共振柯伊伯带天体建立的多弧模型--以类冥天体为例

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在行星历表中纳入柯伊伯带天体（KBOs）的引力影响时，通常采用均匀环模型。在本次报告的论文中，为了表示位于与海王星 2:3 平运动共振（MMR）位置的 KBO 群体——类冥天体（Plutinos），我们引入一个考虑到 Plutinos 共振特性的三弧模型。每个“弧”指的是均匀环的一段，由适当数量的点质量组成。然后通过太阳-海王星距离的变化来数值测量冥王星类天体的总扰动。我们考虑了冥王星类天体的共振振幅（A）和偏心率（e）的相关径向和周向分布。结果表明，在 100 年的时间尺度上：

（1）对于最小偏心率 e=0.05 的情况，随着共振振幅的减小，Plutinos 引起的太阳-海王星距离变化减小。它与环模型得到的结果相差约 100 千米；

（2）对于中等偏心率 e=0.1~0.2 的情况，随着偏心率的增大，多弧模型与环模型引起的太阳-海王星距离变化差异越来越显著。

（3）对于偏心率较大 e>0.25 的情况，无论共振振幅如何，弧模型引起的太阳-海王星距离变化都可以趋近于零，并且与环模型差异较大，最大可达 170 km。

我们认为，该多弧模型可以更准确地描述冥王星类天体的扰动，从而提高行星历表的精度。并通过将三弧模型与消除观测偏差的实际观测类冥天体轨道数据、

L7 模型中类冥天体轨道数据进行比较，进一步验证了该模型的适用性。此外，这一多弧模型的概念可以很容易地应用到其他密集分布的共振小天体中。

地月系多种轨道不确定性传播方案的研究

宋玟瑄 紫金山天文台

本研究聚焦于地月空间态势感知中的误差传播分析问题，误差传播分析是实现初轨确定、精密定轨、空间目标碰撞概率计算及再入等问题的基础。在地月系统中，由于其宽广的空间跨度、多样的动力学环境和复杂的轨道类型，传统的基于线性化模型的误差传播方法已不再适用。在高度非线性的地月动力学场景中进行误差外推分析时，需要结合具体的引力模型和扰动因素，采用更高阶的 Taylor 级数来逼近非线性轨道解。

目前，非线性系统中的不确定性传播方法主要包括基于线性化模型的方法和蒙特卡洛(Monte-Carlo ,MC）模拟。然而，这些方法要么在处理高度非线性情况时精度不足，要么计算成本过高。其他如高斯闭包(Gaussian closure)、等效线性化(Equivalent Linearization)、随机平均(Stochastic Averaging)等方法因依赖于线性模型，不适用于高度非线性场合。无迹变换(Unscented Transformation ,UT)法虽可以计算非线性模型不确定性传播的结果，但由于仅能计算前两阶统计矩，在描述高度非线性系统的概率分布时存在局限。常用的常微分方程计算高阶状态转移张量(State Transition Tensor ,STT)以逼近非线性轨道解以进行轨道不确定性传播的方法计算成本较高。

本研究提出将微分代数(Differential Algebra ,DA) 方法应用于地月空间多种轨道的不确定性传播。微分代数技术通过将函数展开成泰勒多项式，实现了快速微分，有效计算了传播状态的高阶统计量。同时，引入局部非线性指标衡量传播结果的质量。

研究主要在圆形限制性三体模型(Circular Restricted 3 body problem ,CRTBP)下进行，以 MC 方法和 UT 法为对比，使用微分代数技术建立了不同阶数的误差传播模型，并探讨了 DAMC 法在地月空间轨道误差传播中的精度与效率。通过研究地月空间中的 8 种不同轨道，基于 DA 本研究给出了地月系不同轨道在多种不同的情况下传播所需要考虑的多项式逼近的阶数，并基于精度与效率的评估，给出了不同情况下所需要的传播方案的参考。

Extreme Resonant Eccentricity Excitation of Stars around Merging Black-Hole Binary

刘彬 浙江大学

On the isolation of hot Jupiters

吴东红 安徽师范大学

The formation and evolution of hot Jupiters have long intrigued the exoplanetary science community, particularly due to their unexpected presence in close-in orbits, challenging traditional models of planet formation. In our recent studies, we explore various aspects of hot Jupiter formation and dynamical histories, particularly focusing on the prevalence of nearby planetary companions.Through a comprehensive analysis of transit timing variation data from the full 4-year Kepler dataset, we find that at least 12% ± 6% of hot Jupiters and 70% ± 16% of warm Jupiters likely possess nearby planetary companions. This suggests that a subset of short-period Jupiters may form via disk migration. However, disk migration dose not guarantee the presence of nearby companions for hot Jupiters. Our N-body simulations of early formation history reveal that hot Jupiter systems are highly susceptible to dynamical instabilities following gas disk dispersal, regardless of whether they initially emerge in resonant chains. Post-disk instabilities tend to isolate hot Jupiters more than warm Jupiters, with general relativity playing a crucial role in the formation of solitary hot Jupiters.

倾斜轨道对主星自转轴的相对论进动的影响

王颖 上海工程技术大学

Through the Rossiter-McLaughlin effect, some hot Jupiters were found spin-orbit misalignment or even retrograde orbits. The reasons for the high obliquity of hot Jupiters can be divided into two cases, summarizing the earlier literature. First, the host star's spin becomes misaligned with the planetary disk primordially due to chaotic accretion during the late stage of star formation, the magnetic interaction between the stars and the planetary disk, etc. Second, the orbital inclination of the individual planet can be excited due to dynamical mechanisms such as planet-planet scattering, the Lidov-Kozai cycle, and secular chaos within the framework of Newtonian mechanics. This article reveals the third case: with the framework of general relativity, the post-Newtonian spin-orbit coupling term causes precessions of the host star's spin around the orbital angular momentum. Moreover, the deviation of the spin orientation of the star from the normal planetary disk becomes larger due to higher inclined orbits of the close planets or companion stars. The varying amplitude and period of the precession of the spin of the star and planet have been obtained

theoretically which agrees well with the numerical results.

地月空间平动点航天器的精密定轨光压模型

李昊翰 南京大学

伴随着人类航天能力的不断进步以及近地空间的日益拥挤现状，地月空间的常态化利用已被各国提上日程。可预见的是，在不远的将来长期驻留在地月空间航天器数量将迎来显著增长。与近地目标不同，太阳光压对地月空间目标的轨道有着显著影响。为了提升地月空间航天器的定轨精度，需要对于太阳光压进行较为精确的建模。对于地球导航卫星，已经有了诸如 ECOM、ECOM2、ECOMC 等成熟的经验光压模型，这些模型是否直接适用于地月空间目标？是否需要做必要修改？这些问题目前尚无学者进行系统研究。在这项工作中，我们对运行在地月平动点的几种常见轨道上的航天器，分析不同姿态下的光压特性，构建了相应的光压模型。进一步，我们仿真生成了观测数据，利用精密定轨方法，对相应的光压系数进行了求解分析以验证模型精度。这项工作可以为未来的地月空间平动点航天器定轨精度提升提供一定的参考。

地球自转变化与液核磁流体波运动的定量关系研究

段鹏硕 上海天文台

8.6 年周期两个主成分信号，且两者均不能由地球表面因素(e.g., AAM/OAM/HAM)解释。

目前上述两个周期信号之精确物理起源机制问题仍不清楚且存在争议。近来，国际上出现了两种年际液核波模式试图解释它们，其一，电磁力作用下的“纯地转”的快速扭转波机制(e.g., Gillet et al, 2010)，该波存在于整个液核内部，且呈现出轴对称和沿自转轴方向不变的液核流速特征；其二，电磁力-科里奥利力相互作用下的“拟-地转”的 QG-MC 波(e.g., Finlay et al, 2023; Istas et al, 2023), 该波呈现非轴对称且主要集中于赤道区域的明显特征。通过深入探索液核磁流体波（尤其是 QG-MC 波）与亚年代尺度日长变化的定量关系，本文旨在解决亚年代尺度日长变化的起源机理问题。我们的工作及结果总结如下：

1）、根据 1999-2022 年的近代地磁卫星观测数据反演的液核表面流资料，计算了作用于地幔的电磁扭矩，确认其中存在 6 年和 8.6 年周期分量，其揭示液核运动存在同样的周期分量，提供了亚年代日长变化起源于液核运动的新证据;

2）、基于标准小波变换方法仔细分析了液核扭转波模型预言的日长变化结果(1962-2022)，从中分离出日长 6 年和 8.6 年分量，将其与观测的日长结果作比较，结果表明，日长 6 年（而非 8.6 年）振荡可由扭转波机制解释，支持日长 6 年振荡起源于液核扭转波的观点;

3）、首次建立 QG-MC 波的理论模型并得到其与日长变化的定量关系，我们发现该模型可以定量解释日长 8.6 年（而非 6 年）信号，其约束的 QG-MC 波沿圆柱体径向的空间波数为~4.8、品质因子 Q~16, 预言在内核边界处存在幅度(r.m.s)5~20km/yr 非轴对称且西向传播的方位向液核流，给出从日长变化角度推测液核运动的新方法；
总之，本文结果为日长 8.6 年和 6 年信号不同起源机制给出了自洽和定量的解释，在区分不同的液核波激发机制方面做出了新进展，从地球自转变化角度为理解液核深内部动力学提供了新途径。

太阳系天然卫星的光谱观测研究

张会彦上海工程技术大学

非合作巨型星座的实时机动检测

张籍丹 紫金山天文台

非合作卫星机动检测是空间态势感知的重要组成部分。如果没有对机动的正确检测和估计，机动前的编目轨道将很难与机动后的观测弧段相关联，这将降低编目的准确性和可靠性。本研究提出了一种基于非奇异推力傅里叶系数模型的滤波方法来估计机动引起的轨道变化。光学观测数据由超过一千颗星链卫星的 14 天星历仿真而来。仿真观测作为滤波的输入，经估计得到轨道的长期变化，随后作为特征量训练朴素贝叶斯分类器。实验结果表明，该方法能够正确识别不同的空间机动事件。

基于 SpaceX 发布星历的星链卫星机动检测研究

刘媛荣 紫金山天文台

面对星链巨型星座带来的巨大的低轨空间碰撞风险，星链卫星的未知轨道机动已成为重要的研究课题，SpaceX 公司发布的星链星历恰好为该工作带来良好契机。通过分析星链星历数据，提出了针对 SpaceX 星链星历的平根数-斜率检测方法，成功检测出星链卫星发生的 10 m 以上的机动事件，并给出机动开始和结束的时间及其标准差等信息。该方法还可应用于一段时期内的不同阶段的星链卫

星星历，揭示了星链星座在这段时间内采用的机动策略，包括工作和停泊阶段卫星的轨道维持机动、抬升阶段的轨道抬升机动和再入阶段的轨道降低机动的机动频率及特征。利用该方法提取出的星链星座的机动策略有助于优化星链卫星系统的观测计划，为星链卫星的精密定轨奠定基础，在实际工作中具有较广阔的应用前景。

基于深度学习方法的星座卫星机动预测

刘函　　紫金山天文台

近年来随着低轨巨型星座的迅速发展，高机动星座卫星的数量急剧增加，导致低轨空间环境日趋复杂。新的空间环境对太空目标编目及空间态势感知（SSA）提出了更高的要求。目前，在卫星频繁机动的情况下进行轨道预报仍然是一项具有挑战性的任务，未知机动会导致现有的轨道预报方法精度迅速下降。机动力作为一种非自然摄动力，受到多种因素的影响，很难直接预测。一方面，由于大气阻力的影响，低轨卫星在轨运行时通常需要周期性的机动来抬高到目标轨道高度，另一方面，随着低轨卫星密度的急剧增加，目标间关系表现复杂，卫星需要在可能有碰撞发生时进行及时规避，由此产生机动分布和机动大小的不规律性。深度学习方法具有强大的特征提取和表示能力，在处理这一问题时显示出独特的优势。它能很好地处理大规模数据和复杂任务的建模问题。本研究基于星座卫星机动变化的时间序列特征，对星座卫星中多颗卫星的历史机动变化进行建模。通过引入深度学习方法中的注意力机制来训练模型，最终实现机动预测。结果表明，训练后的模型可以有效预测未来较长时间内的机动，包括机动时间和机动幅度。同时，它还有助于更全面地了解机动策略，为避免卫星间的碰撞提供先验信息。

弯曲时空自适应时间步长显式辛算法

马大柱 湖北民族大学

虽然我们前面建立的黑洞时空的时间变换显式辛方法原则上可采用自适应时间步长，但实际计算时却难以实现。基于 Preto & Saha 提出的步长控制方法，我们将非自适应时间步长的时间变换显式辛方法稍作调整，使其成为自适应方法。自适应方法仅增加了两步，计算成本略有提升，但实际操作简单有效。该方法在模拟粒子或光子靠近黑洞视界的动力学问题中，显著改善了非自适应方法的不足。在研究 Schwarzschild-Melvin 时空中光子动力学时，我们找到了稳定有界的光子有序轨道与混沌轨道，并且光子的混沌运动区域会随着磁场强度的增加而扩大。该自适应方法可应用于具有显式可积分解的哈密顿量或时间变换哈密顿量的弯曲时空，也可应用于逆向光线追踪积分方法，用来研究光子的运动和黑洞阴影。

利用极端质量比旋近检验带毛黑洞

訾铁光 华南理工大学

天体轨道运动能区分尺度依赖普朗克星和重整化改正史瓦西黑洞吗？

黄立　　紫金山天文台

为了解释黑洞奇点和视界问题，量子引力理论的提出是必不可少的一环。目前，量子引力理论的主流思想之一是通过对引力常数随空间尺度变化的修改。由此诞生了两类致密天体：尺度依赖普朗克星和重整化改正史瓦西黑洞。本报告将从天体轨道运动角度来研究尺度依赖普朗克星和重整化改正史瓦西黑洞的不同。首先，讨论他们的的圆轨道特性。其次，结合 GRAVITY 和 EHT 的观测结果，对尺度依赖普朗克星和重整化改正史瓦西黑洞进行了初步限制。最后，讨论了强引力场中两类黑洞近旁的周期轨道及其对应的引力波辐射。其结果表明除了要加入新的高精度观测数据打破参数简并外，未来对于原初黑洞或迷你黑洞的搜寻将有助于区别两类黑洞。该研究结果发表在国际自然指数(NI)期刊《Physical Review D》(SCI 二区)上，影响因子为 5.407。

小行星光变曲线分析及形状参数反演

高豪　　南京大学

小行星是太阳系内的常见天体，其光度变化与多个因素相关。光变曲线是在一段时间内对小行星进行连续观测后得到的其光度随时间变化的曲线，通过综合考虑小行星的形状、自转状态以及相位角，分别使用椭球体模型以及与高斯曲率相结合的凸多面体模型对小行星的光变曲线进行拟合，可以求解小行星的自转以及形状参数。同时能够利用椭球体模型，分析该模型的各个参数对光变曲线的影响，并研究小行星在主轴旋转和非主轴旋转情形下光曲线的变化特征，从而对小行星的光变曲线进行深入全面的了解。

6、高能分会场报告日程

史上最亮伽玛暴 GRB221009A 中 MeV/TeV 辐射相关性和 MeV 发射线的发现对喷流物理性质的揭示

熊少林 中国科学院高能物理研究所

Soft X-ray prompt emission from a high-redshift gamma-ray burst EP240315a

刘元中国科学院国家天文台

Long gamma-ray bursts (GRBs) are believed to originate from core collapse of massive stars. High-redshift GRBs can probe the star formation and reionization history of the early universe, but their detection remains rare. Here we report the detection of a GRB triggered in the 0.5–4 keV band by the Wide-field X-ray Telescope (WXT) on board the Einstein Probe (EP) mission, designated as EP240315a, whose bright peak was also detected by the Swift Burst Alert Telescope and Konus-Wind through off-line analyses. At a redshift of $z=4.859$, EP240315a showed a much longer and more complicated light curve in the soft X-ray band than in gamma-rays. Benefiting from a large field-of-view ($\sim$3600 deg^2) and a high sensitivity, EP-WXT captured the earlier engine activation and extended late engine activity through a continuous detection. With a peak X-ray flux at the faint end of previously known high-z GRBs, the detection of EP240315a demonstrates the great potential for EP to study the early universe via GRBs.

Magnetar emergence in a peculiar gamma-ray burst from a compact star merger

孙惠 中国科学院国家天文台

The central engine that powers gamma-ray bursts (GRBs), the most powerful explosions in the universe, is still not identified. Besides hyper-accreting black holes, rapidly spinning and highly magnetized neutron stars, known as millisecond magnetars, have been suggested to power both long and short GRBs. Indirect indications of a magnetar engine in these merger sources have been observed in the

form of plateau features present in the X-ray afterglow light curves of some short GRBs. Nevertheless, smoking gun evidence is still lacking for a magnetar engine in short GRBs. Here we present a comprehensive analysis of the broad-band prompt emission data of a peculiar, very bright GRB 230307A. Despite its apparently long duration, the prompt emission and host galaxy properties are consistent with a compact star merger origin, as suggested by its association with a kilonova. More intriguingly, an extended X-ray emission component shows up as the γ-ray emission dies out, signifying the emergence of a magnetar central engine.

Shear Particle Acceleration in Structured Gamma-Ray Burst Jets: the Physical Origin of the Band Function and its Applications

黄晓利 贵州师范大学

The radiation physics of gamma-ray bursts (GRBs) remains an open question. Based on the simulation analysis and recent observations, it was proposed that GRB jets are composed of a narrow ultra-relativistic core surrounded by a wide sub-relativistic cocoon. We show that emission from the synchrotron radiations and the synchrotron self-Compton (SSC) process of shear-accelerated electrons in the mixed jet-cocoon (MJC) region and internal-shock-accelerated electrons in the jet core is potentially explained the spectral characteristics of the prompt gamma-rays. Assuming an exponential-decay velocity profile, the shear flow in the MJC region can accelerate electrons up to $\gamma_{\rm e,\max} \sim 10^4$ for injected electrons with $\gamma_{\rm e,inject}=3 \times 10^2$, if its magnetic field strength ($B_{\rm cn}$) is 100 G and its inner-edge velocity ($\beta_{\rm cn, 0}$) is 0.9c. The cooling of these electrons is dominated by the SSC process, and the emission flux peaks at the keV band. In addition, the energy flux of synchrotron radiations of internal-shock-accelerated electrons ($\gamma_e=10^{4}\sim 10^{5}$) peaks at around the keV$-$MeV band, assuming a bulk Lorentz factor of 300, a magnetic field strength of $\sim 10^{6}$ G for the jet core. Adding the flux from both the jet core and the MJC region, the total spectral energy distribution (SED) illustrates an similar characteristics as the broadband observations of GRBs. The bimodal and Band-Cut spectra observed in GRBs 090926A, 131108A, and 160509A can be well fit with our model. The derived $B_{\rm cn}$ varies from 54 G to 450 G and $\beta_{\rm cn,0}=0.83\sim 0.91$c

Neutron Star Mergers as the Dominant Contributor to the Production of Heavy Elements

陈梦华 北京大学

heavy elements beyond iron through r-process nucleosysthesis in the universe. However, recent identifications of kilonovae following long-duration gamma-ray bursts, such as GRB 211211A and GRB 230307A, has sparked discussions about the potential of neutron star-white dwarf mergers to also produce neutron-rich ejecta and contribute to the production of heavy r-process elements.
In this work, we estimate the contribution of binary neutron star mergers to the total mass of r-process elements in the Milky Way and investigate the possibility of neutron star-white dwarf mergers as alternative astrophysical sites for r-process nucleosynthesis through an analysis of the total mass of the r-process elements in the Milky Way. Our results reveal that binary neutron star mergers can sufficiently account for the Galactic heavy r-process elements, suggesting that these events are the dominant contributor to the production of heavy r-process elements in the Milky Way. Considering the total mass of r-process elements in the Milky Way and the higher occurrence rate of neutron star-white dwarf mergers, it is unlikely that such mergers can produce a significant amount of neutron-rich ejecta, with the generated mass of r-process elements being lower than $0.005M_{\odot}$.

A bright electron-positron pair annihilation line in GRB 221009A

张镇 中国科学院高能物理研究所

Ultra-relativistic jets are believed to play important role in producing prompt emission and afterglow of gamma-ray burst (GRB), but the nature of the jet is poorly known owing to the lacking of decisive features observed in the prompt emission. A series of bright, narrow and regularly-evolving MeV emission line detected in the brightest-of-all-time GRB 221009A provide unprecedented opportunity to probe GRB jet physics. The time evolution of the central energy of the line with power-law index -1 is naturally explained by high-latitude curvature effect. Under the assumption that the line emission is generated in the prompt emission by $e^\pm$ pair production, cooling and annihilation in the jet, we can strictly constrain jet physics with observed line emission properties. We find the radius of the emission region is $r\sim10^{16}$cm. The narrow line width of 10% implies that pairs cool fast down to non-relativistic state within a time of tenth of the dynamical time. This

requires a magnetic-field energy density much larger than the prompt gamma-ray energy density in the jet, implying a magnetic field dominated jet. The temporal behavior of line flux suggests some angle dependence of line emission. We also discuss the difficulties of other scenarios to interpret the observed emission line.

A neutron capture explanation for the 10 MeV line in GRB 221009A

朱佳欢 清华大学

The brightest ever gamma-ray burst (GRB) 221009A displays a significant emission line around 10 MeV. We propose that the emission line could be explained with the 2.223 MeV gamma-rays followed by neutron capture with a proton in the rest frame. The measured line profile can be adequately fitted with a neutron capture model that involves thermal broadening and a bulk Doppler shift. The spectral fitting reveals a temporal evolution of the line emitting region: the Doppler factor varied from 5.1 to 2.1 with a temperature increase from 300 keV to about 900 keV. About 10^{-2} solar mass of deuteriums were produced in the process.We argue that the neutron capture can take place in the outer shell of a structure jet. Disk winds could be another possible site.

On the External Inverse Compton Scattering off the Prompt Emission in GRB 221009A

戴粹远 南京大学

The smooth temporal profile of the TeV emission in GRB 221009A suggests that it originates from a TeV afterglow driven by an external shock. The temporal overlap between the prompt MeV emission and the early TeV afterglow indicates that external inverse Compton scattering (EIC) between the prompt MeV photons and the afterglow electrons is inevitable. Since the energy density of the prompt emission is much higher than that of the afterglow during the early phase, the cooling of afterglow electrons is dominated by the EIC process. The EIC scattering rate is influenced by the anisotropy of the seed photon field, which depends on the radii of the internal dissipation ($R_{\rm dis}$) and the external shock ($R_{\rm ext}$). We investigate the EIC process with different $R_{\rm dis}$, as its value remains unclear. Our findings show that, for varying $R_{\rm dis}$, the EIC scattering rate can differ by

a factor of $\sim 0.3-0.6$. For GRB 221009A, the EIC emission dominates during the early rising phase of the TeV afterglow. This later transitions to a phase dominated by the synchrotron self-Compton (SSC) emission. Additionally, if $R_{\rm dis} \sim R_{\rm ext}$, the irradiation from the prompt emission could lead to $\gamma\gamma$ absorption of TeV photons. In this scenario, absorption by prompt MeV photons could account for the early rapid rise observed in the TeV afterglow light curve of GRB 221009A.

高能暂现源使用手册

高鹤　　北京师范大学

爱因斯坦探针卫星的长时标暂现源介绍

李东悦 国家天文台

爱因斯坦探针(Einstein Probe, EP)是一颗面向时域天文学的、发现型的 X 射线天文探测卫星，其于 2024 年 1 月 9 日成功发射。EP 卫星在发射之后完成了一系列的定标观测任务，并已于 2024 年 7 月底正式开始科学观测。截止目前，EP 已经发现约 60 例暂现源，其中有十多例长时标暂现源，包括 X 射线双星（XRB）和激变变星（CV）的耀发，潮汐瓦解事件（TDE）候选体等。还有一些特殊的长时标暂现源，其本质尚不明确。为了探测暗弱的长时标暂现源，我们将单次观测的数据进行叠加，提高探测灵敏度。在探测之后，我们将所有的暂现源和已有的天文数据库，以及多波段数据进行认证。在这个报告中，我们将介绍 EP 卫星探测到的长时标暂现源，尤其是其中的潮汐瓦解事件候选体。

SVOM/GRM 在轨运行

郑世界 中国科学院高能物理研究所

基于机器学习方法的费米伽马暴的分类

张富文 桂林理工大学

“风行天”空间 X 射线望远镜在轨观测

陈勇　　中国科学院高能物理研究所

爱因斯坦探针卫星是我国面向时域天文学研究的 X 射线天文卫星，于 2024 年初发射升空。 “风行天”是其上搭载的后随 X 射线天文望远镜，为中国主导的国际合作望远镜，由中国科学院高能物理研究所牵头，欧空局（ESA）和德国马普地外物理研究所和中国科学院理化技术研究所参加。风行天主要用于天体暂现源的后随观测，同时也可以对各类 X 射线天体进行图像、光变和能谱等观测。

“风行天”望远镜包含两台 Wolter-I 型聚焦望远镜，每台聚焦镜包含 54 层镍镀金材料的嵌套镜片，焦距为 1.6m，角分辨好于 25”。焦平面探测器采用 pnCCD，探测器采用氦脉冲管制冷机制冷，工作温度控制在-90℃以下，温度稳定度好于 0.5℃。探测器设置有全帧、开窗和时变等三种科学观测模式。“风行天”望远镜探测能段为 0.3-10 keV，有效面积达 600 cm2@1.5 keV，视场 1°×1°，定位精度好于 10”，在轨背景较低，使其拥有很强的包括暂现源在内的 X 射线天体源发现能力。风行天在轨已成功进行了多个暂现源的后随观测，发现高红移伽马暴余辉并精确定位，还新发现大量 X 射线天体源。

在轨测试表明，风行天各项性能指标都达到或超过了设计目标。

伽马射线暴特殊物理起源和数据分析工具

杨俊　　南京大学

It is generally believed that long-duration GRBs are associated with massive star core-collapse, whereas short-duration GRBs are associated with mergers of compact star binaries. However, growing observations have suggested that oddball GRBs do exist, and multiple criteria (prompt emission properties, supernova/kilonova associations, and host galaxy properties) rather than burst duration only are needed to classify GRBs physically. In this oral talk, I will introduce our recent works on GRBs with peculiar physical origins, including the peculiar short bursts GRB 200415A and GRB 231115A originating from magnetar giant flares, the peculiar short burst GRB 200826A originating from a core-collapse, and the peculiar long burst GRB 211211A originating from a compact star merger. These gamma-ray bursts with peculiar physical origins demonstrate the diversity of progenitor of gamma-ray bursts. Finally, I also want to introduce our self-developed GRB data analysis tools, which ara already public in github.

以伽玛暴长时标活动的信号探索中心引擎特征

郑天赐 紫金山天文台

The study of the central engine of gamma-ray bursts (GRBs) can offer specific insight into extreme conditions physics. However, it's uneasy to conclude the properties of a certain GRB. Finding clues of central engine activities in the prompt and afterglow emission is a popular method. By combining the X-ray flare and plateau in the afterglow phase, we suggest that some of the central engines have a magnetar-disc configuration. In this scenario, the magnetar's magnetosphere size and its re-magnetized process are studied. In the afterglow of GRB 050904, possible Quasi-Periodic Oscillation (QPO) signature throughout the internal plateau and the subsequent sharp decay (slope ~ -6). One can't be readily explained by a massive magnetar scenario but favors a Kerr black hole powered BZ jet scenario. Therefore, one potential clue for distinguishing between these two engines lies in whether QPO signature throughout the entire plateau and the subsequent sharp decay, as the magnetar scenario suggests a collapse at the end of the plateau.

The Progenitor and Central Engine of short-duration GRB 201006A associated with a coherent radio flash

田晓 广西大学

Recently, the detection of a coherent radio flash associated with short GRB 201006A, occurring 76.6 minutes after the burst, has attracted great attention. However, the physical origin of the coherent radio flash remains in debate. By reanalyzing its data observed by Fermi and Swift, we find that an early radio afterglow as the physical origin of the radio flash can be ruled out, but the coherent radio emission seems to be consistent with the hypothesis of a supramassive magnetar as the central engine collapsing into a black hole. Within this scenario, the derived magnetar surface magnetic field (Bp) and the initial spin period (P0) fall into a reasonable range, but require to prefer a low value of ηR = 10−7 or 10−6. Moreover, the calculated low-ε value and Eγ,iso −Ep correlation of GRB 201006A also support to the progenitor from merger of compact stars. No detected the kilonova emission associated with GRB 201006A to compare with the upper limits of optical observations is also discussed.

双峰千赫兹转周期振荡的辐射机制

史常圣 海南大学

低质量 X 射线双星中准周期振荡曾被认为起源于中子星中整个冕中等离子体物理参数的振荡。振荡可以由许多过程的微扰产生，也可以只在冕的局部区域产生，因此我们讨论研究了分为两层的冕来自磁流体动力学波的局部振荡。基于这个想法，整个冕和冕最外层的扰动被认为是双峰转周期振荡的起源。通过康普尼茨方程我们讨论了稳态辐射扰动时的结果。通过求解，得到了 29 个最佳源的参数。考虑到磁流体动力学波的模型和转周期振荡的辐射机制，准周期振荡可能是确定吸积盘最内半径的重要工具，是获得低质量 X 射线双星参数的重要研究对象，是检验广义相对论效应的重要武器。

黑洞 X 射线双星准周期信号研究

张鹏　　三峡大学

EP 卫星对 X 射线双星的研究：一例新发现的低质量 X 射线双星候选体 EP240904a

程华清 中国科学院国家天文台

爱因斯坦探针（EP）卫星是一颗面向时域天文学和 X 射线天文学的空间科学卫星。卫星于 2024 年 1 月 9 日成功发射，目前已顺利通过在轨测试和标定，进入正式科学运行阶段。其主要科学目标是探测宇宙中的 X 射线暂现天体，监测已知天体的 X 射线辐射。搜寻 X 射线双星并建立大规模样本是 EP 卫星的重要研究方向之一。在近期的观测数据中，我们发现了一例低质量 X 射线双星（LMXB）候选体 EP240904a，并对其开展了一系列多波段监测研究。在本报告中我们将展示对 EP240904a 的研究结果。

The delay optical emission in BHXRBs

杜迪湛 浙江大学

We investigate all publicly available observations of black hole binaries in the RXTE archive and search the optical and infrared(OIR) data during the corresponding epochs. It is widely observed that during the rising and decaying state, the Compton luminosity manifests as a flare through the process of model fitting and subsequent calculations of luminosity. We analyze the time lags between OIR and Compton luminosity by using the interpolated cross-correlation function(ICCF). We find in the rising state, the OIR flare is generally occurs before Compton luminosity for a few days. On the contrary, in the decaying state, the OIR flare always lags to Compton luminosity range from 6 days to 36 days. We conducted simulations to incorporate the time delay of GX 339-4 in its decaying states, and provided a reasonable explanation for the time delay during the rising hard states.

The delayed radio emission in the black hole X-ray binary MAXI J1348−630

杨帅康 武汉大学

Multi-wavelength observations are essential to understand the coupling between the accretion flow and the jet in black hole X-ray binary (BHXRB). We investigate the X-ray and radio emissions in MAXI J1348-630 during its 2019 outburst. For the first time, we find that the radio emission lags behind the X-ray Comptonization emission by about 3 days during the rising phase covering the rising hard state and the following soft state. Such a long radio delay indicates that, in this source, the Comptonization emission most likely originates from the advection-dominated accretion flow (ADAF) rather than the jet during the rising phase. Further, we study the correlation between the X-ray Comptonization and radio emissions in a broad X-ray energy band 0.1-100 keV. During the rising phase, considering the radio delay of ~ 3 days, we obtain a slope $\beta = 3.04 \pm 0.93$, which is much steeper than the previously reported $\beta = 0.6$ or 1.40 using the total luminosity in the limited band (e.g., 1-10 keV). During the mini-outburst, the radio-Compton correlation becomes shallow with the correlation slope $\beta = 1.11 \pm 0.15$. These indicate an intrinsic difference in the accretion-jet coupling physics between the main outburst and the mini-outburst.

黑洞吸积盘磁驱动外流的动力学过程及其应用

谢伟 贵州师范大学

该工作研究了黑洞吸积盘外流的磁加速过程，旨在探讨在不同黑洞吸积系统中由大尺度磁场驱动极端相对论外流（喷流）的可能及其条件。该工作基于广义相对论磁流体力学第一性原理，计算不同初始密度和温度的外流解。我们发现外流的最终速度和初始温度成正比，和初始密度成反比。在给定磁场下，能够形成外流的初始条件（比内能）受到限制，初始密度越高，则存在外流解的初始温度上限越低，最终的外流速度相对较低。反之，初始密度越低，存在外流解的初始温度上限越高，对应极端相对论外流（喷流）。高密高温以及低密低温两种初始条件不存在外流解。更进一步地，针对伽马射线暴、X 射线双星等典型的拥有极端相对论喷流的天体物理系统，我们验证了其相对论喷流由黑洞吸积盘大尺度磁场直接驱动产生的可行性。特别地是，它们都需要低密高温的外流初始条件，这暗示喷流产生可能与类盘冕结构的形成有关联，该结果与 X 射线双星喷流态的吸积模式为 ADAF 的普遍认识相符，同时对解决伽玛暴喷流的重子污染问题也有启发意义。

Study the inner Flow Geometry of Accreting X-ray Binaries: from the theory to observation

卜庆翠 华中师范大学

In an X-ray binary system, the central compact object, neutron star (NS) or black hole(BH), accretes matters from the companions. The matter orbits at very high velocities near the compact object, introducing a few milliseconds dynamical time-scales. X-ray emissions from this matter provides direct way to probe the strong gravity field near compact objects. In this talk, I will give a brief introduction to X-ray binary systems and the related spectral-timing studies involved in the new generation of X-ray observatories, and further how those results help us better understand the inner flow geometry of XRB systems.

Mass function of stellar black holes as revealed by the LIGO-Virgo-KAGRA observations

董小飞 南京大学

Ninety gravitational wave events have been detected by the LIGO-Virgo-KAGRA network and are released in the Gravitational-Wave Transient Catalog. Among these

events, 83 cases are definitely binary black hole mergers since the masses of all the objects involved significantly exceed the upper limit of neutron stars. The black holes in these merger events naturally form two interesting samples, a pre-merger sample that includes all the black holes before the mergers and a post-merger sample that consists of the black holes generated during the merging processes. The former represents black holes that once existed in the Universe, while the latter represents newly born black holes. Here we present a statistical analysis on these two samples. The non-parametric τ statistic method is adopted to correct for the observational selection effect. The Lynden-Bell's C^{-} method is further applied to derive the mass distribution and density function of black holes. It is found that the mass distributioncan be expressed as a broken power-law function. More interestingly, the power-law index in the high mass region is comparable for the two samples. The number density of black holesis found to depend on redshift as $\rho(z) \propto z^{-2.06}$ -- $z^{-2.12}$ based on the two samples. Implications of these findings on the origin of black holes are discussed.

引力波源前身星 IC 10 X-1 的演化通道

王贵余 南京大学

A physical model for radio and X-ray correlation in black hole X-ray binaries

江以恒 浙江大学

慧眼对热核暴的观测

陈玉鹏 中国科学院高能物理研究所

Fast Radio Bursts with Narrow Beaming Angles Can

Escape from Magnetar Magnetospheres

黄余晨 中国科学技术大学

Fast radio bursts (FRBs) are millisecond duration transients observed in the radio band, with their origin and radiation mechanism remaining unclear to date. Growing evidence indicates that at least some FRBs originate from magnetars and are likely generated within the magnetospheres of these highly magnetized neutron stars. However, a recent study suggested that FRBs originating from mag- netar magnetospheres would be scattered by magnetospheric electron–positron pair plasma, making it impossible for them to escape successfully. In this paper, we first demonstrate that the scattering effect can be greatly attenuated if the angle between the FRB propagation direction and the background magnetic field is ∼ 10^{−2} rad or smaller. When the angle is around 10^{−1} rad, the beaming effect of FRBs becomes significant in reducing scattering. Such FRBs have small transverse spatial sizes, which can help them instantly push the front plasma laterally out of the radiation region. This significantly mitigates the FRB-induced two-photon annihilation reaction, γ + γ → e− + e+, which was previously regarded as a key factor hindering the propagation of FRBs. A critical radiation cone half-opening angle between 10^{−3} − 10^{−2} rad is found for an FRB with isotropic luminosity Liso ∼ 10^{42} erg s−1 and emitted at a radius rem ≲ 10^9 cm in the magnetosphere of a magnetar. Smaller beaming angles and larger emission radii can be more advantageous for the propagation of FRBs in magnetospheres. Our result supports the scenario that FRBs could originate from magnetar magnetospheres.

磁星 SGR J1935+2154 在 2022 年爆发期间 X 射线持续辐射的 NICER 观测研究

付玉聪 北京师范大学

2022 年 10 月 12 日，磁星 SGR J1935+2154 进入了一个新的活跃期，期间探测到了多次 X 射线爆发，并且其持续辐射也有所增强。在该次爆发活跃期的末端还探测到了射电爆发，这揭示了 X 射线活动特性和射电辐射之间的联系。我们利用 NICER 的观测数据，对 SGR J1935+2154 爆发开始后近三个月的数据进行了分析。我们报告了此次爆发开始后 X 射线持续辐射的时变和能谱结果。在爆发衰减期间，光变曲线上出现了一个明显的耀发，导致流量增加一个数量级左右。在这个耀发的峰值之后，探测到了一个快速射电暴（FRB 221014）。我们发现 X 射线的单峰脉冲轮廓出现了相位跳跃，跳跃相位差为 0.16±0.03，这与磁星自转的周期跃变（glitch）有关。相位跳跃的时间略早于耀发的峰值。相位平均能谱结果表明，

幂律光子指数与流量和爆发率均表现出反相关关系。相位分解能谱结果进一步支持了相位跳跃的结论。这些结果揭示了 glitch、相位跳跃、爆发森林和射电爆发之间的联系，对于研究扭曲磁场的突变以及约束射电爆发的触发机制具有重要意义。

磁星 SGR 1935 爆发活动与 FRB 时期的关系

谢升伦 华中师范大学

Investigating off-pulse gamma-ray emission from millisecond pulsars

雷鸣宇 中国科学院紫金山天文台

Significant off-pulse emission has been detected in some millisecond pulsars (MSPs), and exploring their physical origin could greatly benefit the study of radiation mechanisms. Motivated by this, we report our analysis of 15 years of Fermi-LAT data for 35 MSPs, focusing particularly on the emission in the off-pulse phase. Twelve MSPs exhibit substantial off-pulse emission (TS ≥ 25), and eight of them show a significant cutoff (TScutoff ≥ 9) in their energy spectra, suggesting that the emission originates from the magnetosphere. The remaining four MSPs have power-law shaped energy spectra (TScutoff < 9) and point-like spatial distributions (TSext < 16). To investigate whether the emission originates from other radiation processes, such as ICS of electrons, we added an extra power-law component to the original model and refitted the data for these four MSPs. No significant ICS component was found for any of them, suggesting that the emission is also of magnetospheric origin. This approach provides a new way to discern the origin of pulsar radiation, and the detection of significant off-pulse emission from the magnetosphere can serve as a powerful discriminator for emission models. Moreover, we obtained the phase-resolved spectra of PSR J0614−3329, the brightest source in our samples, to provide another important diagnostic for model comparisons. Finally, we investigated high-energy emission above 25 GeV and found that only two MSPs, J0614−3329 and J1536−4948, exhibit high TS values.

An X-ray Shell Reveals the Supernova Explosion for

Galactic Microquasar SS 433

池奕恒 南京大学

How black holes are formed remains an open and fundamental question in Astrophysics. Despite theoretical predictions, it lacks observations to understand whether the black hole formation experiences a supernova explosion. Here we report the discovery of an X-ray shell north of the Galactic micro-quasar SS 433 harboring a stellar-mass black hole spatially associated with radio continuum and polarization emissions, and an HI cloud. Its spectrum can be reproduced by a 1-keV under-ionized plasma, from which the shell is inferred to have been created by a supernova explosion 20-30 kyr ago and its properties constitute evidence for canonical SN explosions to create some black holes. Our analysis precludes other possible origins including heated by jets or blown by disk winds. According to the lower mass limit of the compact object in SS 433, we roughly deduced that the progenitor should be more massive than 25 Ms. The existence of such a young remnant in SS 433 can also lead to new insights into the supercritical accretion in young microquasars and the γ-ray emission of this system. The fallback ejecta may provide accretion materials within tens of thousands of years while the shock of the supernova remnant may play a crucial role in the cosmic ray (re)acceleration.

On the dynamical evolution of the asteroid belt in a massive star-neutron star binary

邓晨 南京大学

Some fast radio bursts (FRBs) exhibit repetitive behaviors and their origins remain enigmatic. It has been argued that repeating FRBs could be produced by the interaction between a neutron star and an asteroid belt. Here we consider the systems in which an asteroid belt dwells around a massive star, while a neutron star, as a companion of the massive star, interacts with the belt through gravitational force. Various orbital configurations are assumed for the system. Direct N-body simulations are performed to investigate the dynamical evolution of the asteroids belt. It is found that a larger orbital eccentricity of the neutron star will destroy the belt more quickly, with a large number of asteroids being scattered out of the system. A low inclination not only suppresses the collisions but also inhibits the ejection rate at early stages. However, highly inclined systems may undergo strong oscillations, resulting in the Kozai--Lidov instabilities. Among the various configurations, a clear periodicity is observed in the collision events for the case with an orbital eccentricity of 0.7 and mutual inclination of 0. It is found that such a periodicity can be sustained for at least 8 neutron star orbital periods, supporting this mechanism as a possible explanation

for periodically repeating FRBs. Our studies also suggest that the active stage of these kinds of FRB sources should be limited, since the asteroid belt would finally be destroyed by the neutron star after multiple passages.

黑洞自旋测量

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自旋是描述天文黑洞的两大重要参量之一。自旋改变黑洞周围时空几何，影响黑洞和周围环境的作用方式，对理解众多黑洞物理有着重要作用。该报告介绍对 MAXI J1820+070、MAXI J1348-630 的自旋测量工作，给出自旋测量结果，并研究影响自旋测量的因素以及吸积几何的演化。Guan et al.（2021）研究 MAXI J1820+070 吸积盘内半径、硬度比、非热光度和反射比的演化现象，对冕的型态、冷却和辐射提出构想；同时研究吸积盘是否延伸到最内稳定轨道半径对自旋测量的影响，给出 MAXI J1820 自旋准确测量值 0.2（+0.2,-0.3）；MAXI J1820 低自旋得到 QPO 研究结果的支持，挑战了传统观念认为强喷流来自自旋驱动（BZ 效应）、支持磁化吸积盘供能（BP 效应）。在 MAXI J1348-630 的自旋测量中，研究了谱硬化因子对自旋测量的影响，发现正确的谱硬化因子能使得两种自旋测量方法的结果一致，给出 MAXI J1348-630 的自旋值为 0.79+-0.13。

随机非均匀等离子体中扭曲的射电波

张泽林 安徽科技学院

电磁波的偏振携带了关于其天体物理发射源和其穿过的介质的大量信息，在天文学的多个领域都显得至关重要。这里，我们展示了一个重要但长期被忽视的天体物理中的消偏振机制：当光的偏振矢量沿着非平面曲线传播时，会经历额外的旋转，尤其对射电波而言。这个过程会导致消偏振，我们称之为几何消偏振。在几何光学近似下，我们对随机非均匀等离子体中射电波传输的几何消偏振效应进行了简洁的理论分析。在日冕等离子体各向同性散射的情况下，我们发现几何消偏振机制对线偏振射电波通过湍动等离子体传播后的抵达角有显著影响。此效应可被推广到其他天体物理现象中，如快速射电暴和恒星射电暴等。我们的发现可能对天体物理中消偏振现象的分析产生深远影响。

利用快速射电暴的偏振测量寻找类轴子暗物质

王宝　　中国科学院紫金山天文台

类轴子粒子是暗物质候选粒子之一。寻找天体物理源发出的线偏振光的偏振角周期振荡特征是探测类轴子暗物质的一种常用方法。快速射电暴提供了一种在银河系外的距离尺度上探测类轴子的途径。我们首次利用 FAST 观测的活跃重复快速射电暴 FRB 20220912A 的偏振测量来寻找河外类轴子暗物质。给定 FRB 20220912A 宿主的 DM 密度分布，我们得到了类轴子-光子耦合常数的限制，g<(2.7 ×10^{-11}-1.0 × 10^{-9}) GeV^{-1}。使用 FAST 对偏振角进行持续观测将一步改善这一限制。

Gravitationally exciting a relativistic star

杨桓　　清华大学

In this talk we will describe the formalism of driving a relativistic neutron star under external tidal field. If time permits we will also show some numerical implementation in the fully relativistic regime.

Wolter I 型 X 射线聚焦镜

杨彦佶 中国科学院高能物理研究所

1952 年德国科学家 H.Wolter 提出了三种 X 射线聚焦的方式，其中 Wolter I 型使用的最为广泛，从最早的 HEAO 天文台到 Chandra 望远镜，使用的是微晶玻璃直接抛光的技术，这种聚焦镜角分辨好，但是重量大。之后由捷克科学家提出通过电铸复制的方法研制 Wolter I 型 X 射线聚焦镜，最早提出了环氧复制和镍电铸复制两种方案，通过 XMM 的研制，证明环氧复制的方案达不到高角分辨的要求，于是采用了镍电铸复制的方案，目前使用镍电铸复制技术研制的聚焦镜的 X 射线望远镜已超过 10 台，主要由美国 NASA 的 MSFC 和意大利的 MediaLario 公司提供。镍电铸复制生产 Wolter I 型 X 射线聚焦镜包括模具的粗车、化学镀镍磷、超精密车削、超光滑抛光、物理沉积反射膜、电铸镍、脱模获得 X 射线聚焦镜片，通过精密组装的方法获得高分辨的聚焦镜。高能所从 2018 年开始进行镍电铸复制 WolterI 型 X 射线聚焦镜的国产化研制，时至今日，我们研制的 Wolter I 型 X 射线聚焦镜片角分辨已达到 20"(HPD)以下，整套聚焦镜的角分辨已接近 30"，为 eXTP 项目提供了国产化的研制方案。同时在保持角分辨的要求下，进一步减薄镍基底的厚度，获得可与其它轻量化聚焦镜重量相近的解决方案，进一步提升了竞争力，并希望在 Catch 项目中发挥作用。

射电星系 Pictor A 的双成分伽马射线辐射和 X 射线偏振观测

张晋　北京理工大学

Pictor A 是一个伽马射线辐射射电星系，在其大尺度射电瓣上、离射电核约 4 角分的位置有个明亮的热点 WHS。我们详细分析了 Fermi-LAT 对 Pictor A 的 16 年观测数据，发现 Fermi-LAT 观测的平均能谱由两个成分组成表现为拐折幂律谱：光子谱指数在 2.5 GeV 处由 3.25±0.15 变硬为 1.81±0.07。Pictor A 的总伽马射线辐射有显著的光变特征，且在低能段（低于 2.5 GeV）有显著光变，而高能段（高于 2.5 GeV）没有光变。此外，我们发现高流量状态下的能谱可以用单一幂律谱很好地拟合，而低流量状态下的能谱仍然需要拐折幂律函数来解释。我们认为平均能谱双成分中低能成分由核区辐射主导，而高能成分主要由 WHS 贡献。核区和 WHS 的宽波段能谱均可以用一个简单的轻子模型很好地解释，其中伽马射线辐射都由同步自康普顿散射（SSC）过程产生。我们还分析了成像 x 射线偏振探测器(IXPE)对该源的首次观测数据，得到核区在 2—8 ke 能段的偏振度上限为 <8.9％，与 X 射线辐射来自 SSC 过程的解释一致。然而，较窄的 5—7 keV 能段在置信水平>99%上探测到偏振度为 23.5%±5.6%，不确认是否源于铁线的影响。

耀变体 OJ287 的 X 射线波段准周期光变及能谱特征研究

张丙开 阜阳师范大学

AGN 喷流中的 pp 相互作用

薛瑞　浙江师范大学

传统观点简单地认为 AGN 喷流中缺乏致密的冷质子场，从而忽略了质子-质子相互作用，但喷流中是否含有足够的冷质子还未有定论。我们近期工作用解析估算和数值模型均证明了，在不引入极端物理参数的情况下，喷流中的 pp 过程可以产生可探测的甚高能电磁辐射并对河外中微子背景有可观的贡献。

The broadband spectral energy distribution study of Fermi bright BL Lac objects

肖胡兵 上海师范大学

Understanding the phenomenological and intrinsic blazar sequence using a simple scaling model

万朱健 浙江师范大学

The blazar sequence, including negative correlations between radiative luminosity Lrad and synchrotron peak frequency ν, and between Compton dominance Y and ν, is widely adopted as a phenomenological description of spectral energy distributions (SEDs) of blazars, although its underlying cause is hotly debated. In particular, these correlations turn positive after correcting Doppler boosting effect. In this work, we revisit the phenomenological and intrinsic blazar sequence with three samples, which are historical sample (SEDs are built with historical data), quasi-simultaneous sample (SEDs are built with quasi-simultaneous data) and Doppler factor corrected sample (a sample with available Doppler factors), selected from literature. We find that phenomenological blazar sequence holds in historical sample, but does not exist in quasi-simultaneous sample, and intrinsic
correlation between Lrad and ν becomes positive in Doppler factor corrected sample. We also analyse if the blazar sequence still exists in subclasses of blazars, i.e. flat-spectrum radio quasars and BL Lacertae objects, with different values of Y. To interpret these correlations, we apply a simple scaling model, in which physical parameters of the dissipation region are connected to the location of the dissipation region. We find that the model generated results are highly sensitive to the chosen ranges and distributions of physical parameters. Therefore, we suggest that even though the simple scaling model can reproduce the blazar sequence under specific conditions that have been fine-tuned, such results may not have universal applicability. Further consideration of a more realistic emission model is expected.

低光度活动星系核 NGC 4278 的甚高能伽马射线辐射起源

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NGC 4278 是一个低光度活动星系核，通常被归类为低电离核发射线区（LINER）。最近，它被 LHAASO 合作组报道与甚高能辐射源 1LHAASO J1219+2915 空间成协。通过分析 Swift-XRT 对该源的 X 射线观测数据，我们发现 NGC 4278 在 MJD 59546 那天的 X 射线辐射处于流量高态，这个观测流量与 11.7 年前 Chandra 观测得到流量相比高出一个数量级。有趣的是，Swift-XRT 观测时间正巧处在

1LHAASO J1219+2915 的活跃阶段，因此，我们认为 LHAASO 探测到的甚高能伽马射线辐射可能源于 NGC 4278 中心处于活动期的核。我们采用单区轻子模型，常用于解释 BL Lacs 宽波段能谱的模型，拟合 NGC 4278 的宽波段能谱，发现与典型 TeV BL Lacs 相比需要更小的磁场强度。此外，NGC 4278 在射电和 TeV 波段的光度也明显低于典型的 TeV BL lac。在射电光度—爱丁顿比的关系图上，NGC 4278 的位置也更倾向与 Seyfert 星系和 LINER 成团，而不是 BL Lacs。相关成果：Lian et al. 2024, ApJ, in press

TeV 耀变体的 GeV 光变性质

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光变是耀变体的一个突出观测特征。这项工作使用 15 年的费米数据，对 78 个 TeV 耀变体样本的 GeV 光变特性开展了系统研究，给出了它们每年的平均光子流量和谱指数，讨论了流量分布、功率谱密度、谱指数与流量的关系；给出了 41 个亮源每个月的流量和谱指数，发现 14 个源有耀发，给出了它们的以 5 天为 bin 的光变曲线，研究了加速机制。

耀变体候选体 EP240709a 耀发的多波段研究

刘明君 中国科学院国家天文台

活动星系核（AGN）具有多波段光变的典型观测特征。我们介绍了耀变体候选体 EP240709a / 4FGLJ0031.5-5648 的特殊耀发。该源具有从射电到 GeV 的宽波段辐射。我们利用爱因斯坦探针卫星（EP）、Swift、NICER、Fermi、SALT、Magellan、ASAS-SN、Gaia 以及 RACS 等观测数据开展了对 EP240709a 的多波段研究。自 EP 于 2024 年 7 月 9 日监测到其变亮后，EP240709a 的软 X 射线流量于 7 月 13 日达到峰值，随后缓慢下降。在本次耀发期间，该源的软 X 射线流量较 2019-2020 年的历史探测增加了至少 30 倍，而射电、光学、紫外和 GeV 波段均无明显增亮。EP240709a 耀发前后的 X 射线能谱均为谱指数稍大于 2 的幂律谱，GeV 波段的谱指数在 2 左右。耀发早期无千秒量级以下的短时标光变。视差测量表明该源很可能是河外起源。其宽波段 SED 符合耀变体的特征。耀发期间的 X 射线能谱不符合 AGN 及潮汐瓦解事件中吸积盘的特征。我们计算了径移主导吸积流（ADAF）在几组典型参数下的光谱。计算结果表明，EP240709a 耀发期间的 SED 明显窄于 ADAF 的能谱，不支持耀发来自吸积流本身。此外，此次耀发相较于大多数超新星爆发衰减更慢。EP240709a 的耀发对喷流辐射起源给出了一定的限制。此前，仅少数 AGN 的耀发具有 X 射线活动而其它波段宁静的特征，如 PKS 2005–489。我们的工作证明了 EP 在搜寻 AGN 罕见耀发现象以及长期监测上的潜力。

Exploring variation of broad-line profile in strong variable AGNs

吴建成 华中科技大学

Stellar Black Holes Can “Stretch” Supermassive Black Hole Accretion Disks

周淑英 厦门大学

TDE 和 GRB 中双成份喷流

雷卫华 华中科技大学

潮汐瓦解事件和伽马暴都可以产生相对论性喷流，喷流的结构及其观测特征的研究对理解喷流物理和中心天体活动等具有重要参考。一些广泛研究的伽马暴如 GRB 221009A，被认为具有双成份喷流。一些具有喷流的 TDE，如 Sw J1644 和 AT2022cmc，也被认为产生了双成份喷流结构。报告将介绍多波段观测在研究喷流结构中的作用，并探讨双成份喷流产生的物理机制。报告还将研究在复杂的介质环境下，双成份喷流的观测特征。

An Explanation for Overrepresentation of Tidal Disruption Events in Post-starburst Galaxies

王梦叶 华中科技大学

Tidal disruption events (TDEs) provide a valuable probe in studying the dynamics of stars in the nuclear en- vironments of galaxies. Recent observations show that TDEs are strongly overrepresented in post-starburst or "green valley" galaxies, although the underlying physical mechanism remains unclear. Considering the pos- sible

interaction between stars and active galactic nucleus (AGN) disk, the TDE rates can be greatly changed compared to those in quiescent galactic nuclei. In this work, we revisit TDE rates by incorporating an evolving AGN disk within the framework of the "loss cone" theory. We numerically evolve the Fokker-Planck equations by considering the star-disk interactions, in-situ star formation in the unstable region of the outer AGN disk and the evolution of the accretion process for supermassive black holes (SMBHs). We find that the TDE rates are enhanced by about two orders of magnitude shortly after the AGN transitions into a non-active stage. During this phase, the accumulated stars are rapidly scattered into the loss cone due to the disappearance of the in- ner standard thin disk. Our results provide an explanation for the overrepresentation of TDEs in post-starburst galaxies.

Simulations on the collision between debris and torus: a possible channel for forming fast-rise and long-delayed radio outburst in TDE

雷享礼 华中科技大学

The geometrically thick dusty torus structure is believed to exist in the nuclear region of galaxies (especially in active galactic nuclei, AGNs). The debris stream from a tidal disruption event (TDE) will possibly collide with the dusty torus and produce a transient flare. We perform three-dimensional hydrodynamic simulations to model the dynamical evolution of the interaction between unbound debris and dusty torus. During the continuous interaction, the shocked material will be spilled out and form an outflow. We calculate the temporal evolution of the synchrotron emission by assuming a fraction of the electrons are accelerated into non-thermal distribution. We find that the radio emission from the debris-torus collision generates a steep rise and slow decline radio light curve due to the sharp edge and dense gas of dusty torus, where the radio outburst delays the main optical/X-ray outburst by several years or even several tens of years. We apply our model to a TDE that happened in a narrow-line Seyfert I (PS16dtm), where both the radio spectrum and the light curve can be roughly reproduced. Future high-sensitivity, wide-field-of-view radio surveys have the opportunity to detect more such radio flares.

TDE-AGN 候选体 2XMM J123103.2+110648 硬 X 射线辐射

研究

周敏华 上饶师范学院

潮汐瓦解事件（TDE）也可能发生在活动星系黑洞附近，并影响活动星系核（AGN）内区辐射，甚至与冕相互作用，表现有光学或 X 射线耀发现象。为研究 TDE-AGN 耀发前、后 X 射线辐射变化，我们重新对比研究了 TDE-AGN 候选体 2XMM J123103.2+110648 2003 至 2005 年耀发期间 XMM-牛顿观测数据。除了超软 X 射线辐射和软 X 射线准周期光变外，我们在 2003 年观测数据中还发现有一个弱的硬 X 射线辐射成分，而随后的其他数据均无显著硬 X 射线。该硬 X 射线成分有着一极端硬的光子指数 0.29（+0.43，-0.47）和与软 X 射线光变相当的光变周期。鉴于 2003 至 2005 年目标源软 X 射线变亮，且无显著光学光变，该源硬 X 射线辐射的消失可能在于 TDE 与 AGN 冕的相互作用。

搜寻活动星系核中的潮汐瓦解事件

孙静泊 中国科学院上海天文台

一般的，我们认为大部分星系中心普遍存在着超大质量黑洞。大多数的超大质量黑洞是“宁静“的，无法观测到明显的电磁辐射。而一小部分（约 5%-10%）活跃的超大质量黑洞则通过吸积气体，在多个波段发出明亮的电磁辐射，并伴随着随机的光变。我们把这些活跃的超大质量黑洞成为活动星系核（active galactic nuclei，简称 AGN）。通过对活动星系核的观测，我们可以去推断黑洞质量，黑洞吸积状态，黑洞周围物质分布的结构等重要信息。

而潮汐瓦解事件（tidal disruption event, 简称 TDE），则为我们研究那些宁静的黑洞提供了新的道路。TDE 是指当一颗恒星靠近超大质量黑洞时，如果恒星抵达超大质量黑洞的瓦解半径，就会被撕裂。撕裂的气体会回落向黑洞，发出明亮的耀发。得益于时域天文的到来，我们对 TDE 的认识正在飞速发展。目前在于宁静星系中已经证认了约一百个 TDE 的耀发，它们都展现出了相似的特征，如光变曲线的形状，极宽的发射线，滞后的 X 射线辐射，符合单温黑体谱的多波段辐射，以及保持恒定的黑体温度等。

TDE 也可以发生在 AGN 中。甚至根据理论预测，AGN 中的 TDE 应该更加频繁，但是可能展现出和宁静星系的 TDE 非常不同的观测特征，这也为观测上的搜寻带来困难。观测上，许多 AGN 的耀发已经有了实时的多波段观测，然而却没有一个 AGN 耀发与宁静星系的 TDE 相似。这也证明了，AGN 中的 TDE 的确会有着独特的，然而我们尚不清楚的一些特征。

AT2021aeuk 是一个窄线赛弗特 1 星系中的光学重复耀发。它的谱线演化，光变曲线形状，多波段的光谱能量分布与 AGN 明显不同，却更加类似于 TDE，使得它成为 AGN 中 TDE 的候选体。最关键的是，在第二次光学爆发中，我们观测到了 X 射线的快速衰减，随在耀发峰值后又快速变亮，呈现出与光学耀发极强的反相关趋势，这是在 AGN 中从未见过的现象，也很难用当前的 AGN 理论去解释。

而这种现象，和宁静星系中 TDE 的晚期 X 射线爆发有着一定的相似之处。有趣的是，其他 AGN 中 TDE 的候选体中，X 射线也展现出了这样不同寻常的演化。因此，我们在从多方面证认 AT2021aeuk 是一个 AGN 中 TDE 的候选体的同时，也提出，X 射线的演化可能是证认 AGN 中 TDE 的一项关键判据。

超新星爆发物理机制

彭秋和 南京大学

利用磁单极催化核子衰变作为能源。磁单极催化核子衰变的速率正比于核心区核子数密度的平方。当超新星核心坍缩,中心密度超过原子核密度时,由磁单极催化核子衰变产生的光度就会远远超过恒星稳定极限的爱丁顿光度，导致超新星爆发(包括 Gamma 暴)。

The AMS-02 cosmic ray deuteron flux is consistent with a secondary origin

袁强 紫金山天文台

一个解释银河系弥散伽马射线超出的新思路

方堃 中国科学院高能物理研究所

银河系 TeV 弥散伽马射线辐射（DGE）长期以来被认为是宇宙射线与星际介质之间强子相互作用的结果。然而，LHAASO 实验公布的 10-1000 TeV 的弥散伽马射线流量显著高于这一预期。此前有研究提出，这一超出可能来源于由电子辐射产生的未分辨大扩展伽马源，例如脉冲星风云或脉冲星晕（PWNe/halos）。本工作中，我们提出了一种解释 DGE 超出的新思路。LHAASO DGE 测量中使用的屏蔽区域可能未完全覆盖已知 PWNe/halos 的伽马信号，即部分大扩展信号可能泄漏到了屏蔽区以外。通过采用双区扩散模型描述电子在脉冲星附近的传播，我们发现在特定参数下，银盘大部分区域的 DGE 超出可以通过此信号泄漏模型很好地解释。我们认为，DGE 超出现象可能是已知源的信号泄漏和未知扩展源共同导致的结果。

超重极高能宇宙线

张兵　　中国科学院高能物理研究

We investigate the propagation of ultraheavy (UH) nuclei as ultrahigh-energy cosmic rays (UHECRs). We show that their energy loss lengths at less than ~300 EeV are significantly longer than those of protons and intermediate-mass nuclei and that the highest-energy cosmic rays with energies beyond ~EeV, including the Amaterasu particle, may originate from such UH-UHECRs. We derive constraints on the contribution of UH-UHECR sources and find that they are consistent with energy generation rate densities of UHECRs from collapsars and neutron star mergers.

银河系内年轻大质量星团的伽马射线与宇宙线起源的研究

孙晓娜 广西大学

伽马射线为研究宇宙线起源这一“世纪之谜”提供了一个重要探针。有观测证据表明大质量星团可能是银河系内一类重要的宇宙线源。我们基于最近的 GeV 伽马射线观测数据研究系列银河系内年轻大质量星团的伽马射线及其宇宙线起源。本报告将概括介绍关于 Carina Nebula Complex、RCW 38、W3 complex 等相关工作。

双黑洞并合引力波成协高能中微子和电磁辐射

王凯　　华中科技大学

Nuclear de-excitation lines as a probe of low-energy

cosmic rays

刘冰　　中国科学技术大学

Low-energy cosmic rays (LECRs) contribute substantially to the energy balance of the interstellar medium and play a significant role in the heating and chemistry of gas, which consequently impact the star formation process. Despite the current difficulties of studying LECRs directly, in the near future, next-generation MeV telescopes will provide us with unique opportunities for indirect research of LECRs through nuclear de-excitation lines that are produced via the interaction of LECRs and interstellar medium. Here we present results on the production of MeV de-excitation lines from different LECR sources combining the numerical treatment of nuclear reactions using the code TALYS. We estimated the possible MeV lines from the assumed CR point source and supernova remnant Cas A, and investigated the possible detectability of MeV line emission from Cas A against the newly measured diffuse Galactic background in the MeV band given the capability of the proposed MeV telescopes. Moreover, it was argued that the high ionization rate at the central molecular zone (CMZ) in the Galactic Center is mainly caused by LECRs. We considered two types of additional LECR components and found that only very soft anomalous CR components can explain such a high ionization rate. We also calculated the MeV line emission, discussed the detectability of next-generation MeV instruments, and found that future MeV observations can be used to pin down the origin of the high ionization rate in the CMZ.

Fermi-LAT Search for Pulsar Wind Nebula and Pulsar Halo

区子维 上海交通大学

通过月震探测中低频引力波

陈弦　　北京大学

目前引力波探测已经在高频（百赫兹）和甚低频（纳赫子）两个频段取得成功。此外，预计在 2035 年左右建成的多个太空激光干涉项目（如 LISA、太极、天琴等）有望在低频（毫赫兹）引力波探测方面取得突破。然而在分赫兹（0.1

赫兹）频段，尽管理论上可能存在中等质量黑洞、超新星、宇宙早期背景等多种重要的引力波源，但是目前尚没有成熟的计划在 2035 年前针对这一频段的引力波进行探测。

基于月震学测量的引力波探测方式于上世纪 60 年代被提出，在 70 年代美国阿波罗探月计划中进行了初步尝试，并在最近十年中随着欧美探月计划的制定而得到发展。本次报告中，我们将首先回顾这种引力波探测方法的理论发展过程，随后着重介绍近期我们在“月球对引力波的响应”方面进行的相关理论研究，并展示我们计算得到的中、低频段（分赫兹到毫赫兹）引力波探测灵敏度曲线。此外，我们将结合嫦娥七号探测器（预计于 2026 年前后发射）所搭载的月震仪，讨论我国的探月工程对宇宙早期引力波背景可能给出的科学限制。最后，我们将结合未来 10 年内各国计划的月震探测项目，展望联合探测可能实现的科学目标。

报告内容基于我们最新发表的论文 Yan, Chen, Zhang et al., 2024, PRD, 109, 064092 以及 Yan, Chen, Zhang et al., 2024, accepted by PRD, arXiv:2405.12640

Non-Gaussian statistics of nanohertz stochastic gravitational waves

潘震　　上海交大

Recent detection of nHz stochastic gravitational wave background (SGWB) by multiple pulsar timing arrays (PTAs) has stimulated intensive discussions about its origin. Either supermassive black hole binaries (SMBHBs) or processes in the early universe may be the sources. The key difference between the two lies in the statistics of GW amplitude. In particular, the often assumed Gaussian random SGWB does not accurately describe the col-
lective emission from SMBHBs. In this work, we semi-analytically study the non-Gaussian statistics of SGWB expected from SMBHBs. We find that interference between individual SMBHBs plays a vital role in shaping the non-Gaussian statistics. Implementing the non-Gaussian statistics developed in this work, we investigate the sensitivity of current and future PTA datasets in distinguishing the origin of the SGWB. Our findings indicate that, contrary to recent claims in the literature, the current PTA sensitivity is insufficient to constrain the population model parameters of SMBHBs. However, as PTA sensitivity improves and more independent frequency bins emerge from the noise background, this will become feasible.

基于 LIGO/Virgo/KAGRA 的并合双黑洞起源与演化研究

李银杰 中国科学院紫金山天文台

Stochastic Gravitational Wave Background from Cosmological Neutrino-dominated Accretion Flows

Yunfeng Wei 厦门大学

We investigate the stochastic gravitational wave background (SGWB) from neutrino-dominated accretion flows (NDAFs) based on the results of our fallback core-collapse supernova (CCSN) simulations. We find that the predicted SGWB is mainly determined by the typical CCSN initial explosion energy and progenitor metallicity.

For the optimistic cases in which the typical initial explosion energy is low, the SGWB from NDAFs without disk outflows might be detected by next-generation space-based interferometers such as DECi-hertz Interferometer Gravitational wave Observatory and Big Bang Observer. In the low-frequency regime ∼10^−3 –10^−1 Hz, this background is comparable to that expected from standard inflationary models. Therefore, the SGWB from NDAFs may become a foreground for research of the SGWB generated in the inflationary epoch. Combining the diffuse NDAF neutrino background and SGWB from NDAFs, one may constrain the properties of the CCSNe and NDAFs.

EP 卫星 WXT 载荷在轨工作情况

张臣 国家天文台

极高能宇宙线的低频射电探测（GRAND 项目）

马鹏雄 紫金山天文台

极高能宇宙线是来自宇宙的物质信使，这里指大约 0.1 EeV (1018 eV)以上的宇宙线，它的起源、加速和传播仍然存在诸多待研究的问题。本报告基于我们近几年建设的低频射电天线（阵列），介绍低频射电探测极高能宇宙线的原理、实验方法和阵列建设进展，并对该实验的预期进行讨论和展望。

模拟研究以菲涅尔透镜为基础的 HADAR 计划

刘美麟 西藏大学

高海拔天体辐射探测（High Altitude Detection of Astronomical Radiation，HADAR）计划提出使用折射式望远镜，用四台直径 5m 的水透镜呈正方形（100m×100m）排列，预估视场能达到 0.84sr。5m 水透镜具备视场大和阈能低的优点，但存在球冠透镜利用效率不高、易结冰、加工和维护成本高的问题。相比之下，菲涅尔透镜成像质量良好、制造和维护成本低、在高海拔低温下适应性强。本文利用 ZEMAX 软件模拟探究了菲涅尔透镜曲率半径、厚度、倾角和频率等参数对焦距、像斑的影响，模拟设计了四种菲涅尔透镜。为了提升菲涅尔透镜在视场上的性能，我们通过将像面优化成曲面这种方式对菲涅尔透镜进行优化。优化后的菲涅尔透镜成像可靠，在同入射角度下聚焦能力比水透镜强，接收度也高于水透镜，为未来的光学设计提供了理论依据和实践参考。

天格计划项目进展

王晨宇 清华大学

GRB 230812B, detected by the Gamma-Ray Integrated Detectors (GRID) mission, is an exceptionally bright gamma-ray burst (GRB) with a duration of only 3 seconds. Sitting near the traditional boundary (～ 2 s) between long and short GRBs, GRB 230812B is notably associated with a supernova (SN), indicating a massive star progenitor. This makes it a rare example of a short-duration GRB resulting from stellar collapse. Our analysis, using a time-evolving synchrotron model, reveals that the burst's spectral properties suggest a emission radius of approximately 10^14.5 cm. We propose that the short duration of GRB 230812B is due to the combined effects of the central engine's activity time and the time required for the jet to break through the stellar envelope. Our findings provide another case that challenges the conventional view that short-duration GRBs originate exclusively from compact object mergers, demonstrating that a broader range of durations exists for GRBs arising from the collapse of massive stars.

EP-FXT 科学数据中心介绍

贾淑梅 中国科学院高能物理研究所

The Multiband Emission of the two-component Gamma-Ray Burst jet influenced by progenitor winds within the Accretion Disk of Active Galactic Nuclei

原浩瑜 华中科技大学

Gamma-ray bursts (GRBs), both from merger of binary compact objects (short GRBs) and collapse of massive stars (long GRBs), are expected to occur in the dense environments, e.g., the accretion disk of active galactic nuclei (AGN). The propagating of GRB jets in such dense environment will result in multiband transients. Investigating the properties of these transients plays important roles in their identification, understanding the jet structure and constraining population of the star and compact object in AGN disks. In this work, we intend to study the propagation and emission of a two-component GRB jet (a fast narrow component and wide slow one) in the AGN disk. We consider the influence of wind from the short and long GRB progenitors, which would reconstruct the surrounding density distribution and form a cavity in the AGN disk. We find that the long GRB jets will be chocked, the dynamcis and the emission are resemble to the case without cavity. The narrow and wide cocoon breakout emission can be detected by EP and HXMT, respectively. For short GRBs, we expect a non-thermal afterglow emission from the wide jet and a cocoon breakout emission from the chocked narrow jet, which can be monitored by EP and HXMT, respectively. Therefore, the joint observations by EP and HXMT might be helpful to distinguish the type of GRBs in the AGN disk and the jet components.

Event rates of short gamma-ray bursts originated from compact binary mergers in the era of multiple missions

杜秀云 曲阜师范大学

There have been many studies on the event rate of long GRBs, but due to the lack of SGRBs event, there is no systematic comparison between the event rate of SGRBs and the star formation rate. SGRBs are generally thought to be the result of merger events and more complex than the process of stellar collapse. The purpose of this

paper is to present a comparative analysis of event rate based on the reported SGRBs combined with delayed star formation rate. For the classification of SGRBs by different detectors, we apply three delay time models to analyse the event rate of these merger events using the traditional parametric approach without considering redshift evolution and luminosity evolution. We finally find that the event rate of SGRBs at low redshift (z <1) is beyond any delayed SFR. We think that the event rate of SGRBs reflects the current evolution of the universe.

黑洞 X 射线双星特殊爆发和吸积环境研究

彭景强 中国科学院高能物理研究所

黑洞 X 射线双星一般可以分为持续源和暂现源，对于大部分暂现源，其爆发会经历不同的谱态，在爆发上升阶段，源由硬态，经过中间态，向软态转换（硬-软转换）；在下降阶段，源由软态，经过中间态，回到硬态（软-硬转换）。然而，有些源的爆发表现出了不同的特性。部分源在上升期仅达到低硬态或中间态，或者低硬态时间很长，而有些则没有被观测到上升期的低硬态。这些特殊的爆发揭示了 X 射线源的独特性质及其吸积环境的特殊性。相对于黑洞 X 射线双星，中子星 X 射线双星存在硬表面，同时拥有较强的磁场。吸积到中子星表面的 H/He 产生的不稳定的核燃烧会产生一型 X 射线暴。与时标长达几十上百天左右的爆发相比，X 射线暴拥有更加短的时标，所以我们可以用 X 射线暴作为更加精细的探针研究吸积环境。

A Most-Energetic-Ever-Detected X-ray Stellar Flare Discovered by Lobster Eye Imager for Astronomy

毛选 国家天文台

LEIA (Lobster Eye Imager for Astronomy) detected a new X-ray transient on November 7, 2022, identified as a superflare event occurring on a nearby RS CVn-type binary HD 251108. The flux increase was also detected in follow-up observations at X-ray, UV and optical wavelengths. The flare lasted for about forty days in soft X-ray observations, reaching a peak luminosity of ~1.1×10^34 erg/s in 0.5--4.0 keV, which is roughly 60 times the quiescent luminosity. Optical brightening was observed for only one night. The X-ray light curve is well described by a double

“FRED” (fast rise and exponential decay) model, attributed to the cooling process of a loop arcade structure formed subsequent to the initial large loop with a half-length of ~1.8 R*. Time-resolved X-ray spectra were fitted with a two-temperature apec model, showing significant evolution of plasma temperature, emission measure, and metal abundance over time. The estimated energy released in the LEIA band is ~3×10^39 erg, suggesting this is likely the most energetic X-ray stellar flare detected to date.

Bridging the Gap: GRB 230812B — A Three-Second Supernova-Associated Burst Detected by GRID CubeSat Mission

王晨宇 清华大学

GRB 230812B, detected by the Gamma-Ray Integrated Detectors (GRID) mission, is an exceptionally bright gamma-ray burst (GRB) with a duration of only 3 seconds. Sitting near the traditional boundary (～ 2 s) between long and short GRBs, GRB 230812B is notably associated with a supernova (SN), indicating a massive star progenitor. This makes it a rare example of a short-duration GRB resulting from stellar collapse. Our analysis, using a time-evolving synchrotron model, reveals that the burst's spectral properties suggest a emission radius of approximately 10^14.5 cm. We propose that the short duration of GRB 230812B is due to the combined effects of the central engine's activity time and the time required for the jet to break through the stellar envelope. Our findings provide another case that challenges the conventional view that short-duration GRBs originate exclusively from compact object mergers, demonstrating that a broader range of durations exists for GRBs arising from the collapse of massive stars.

利用 GRB 的尘埃环研究宇宙的曲率

沈君义 华中科技大学

我们研究了使用 GRB 221009A 的尘埃散射环来测量宇宙曲率的方法。我们推导了在非平坦宇宙中散射角与时间延迟之间的关系，并通过将理论预测与观测数据进行拟合来尝试限制宇宙学参数。结果表明，由于观测几何尺度较小，这种方法的有效性受到限制。虽然未能提供显著的约束，但这项研究引入了一种使用

GRB 散射环进行宇宙学测量的新方法。我们讨论了该方法的局限性及其在大规模观测中的潜在未来应用。

一个新的致密星并合伽马暴子类

王晨巍 中国科学院高能物理研究所

Fermi-4LAC 低峰频蝎虎型天体的物理性质

胡海滨

Previous studies on the fitting of spectral energy distributions (SEDs) often apply the external-Compton process to interpret the high-energy peak of low-synchrotron-peaked (LSP) BL Lac objects (LBLs), despite the lack of strong broad emission lines observed for LBLs. In this work, we collect quasi-simultaneous multiwavelength data of 15 LBLs from the Fermi fourth LAT AGN catalogue (4LAC). We propose an analytical method to assess the necessity of external photon fields in the framework of one-zone scenario. Following derived analytical results, we fit the SEDs of these LBLs with the conventional one-zone leptonic model and study their jet physical properties. Our main results can be summarized as follows. (1) We find that most LBLs cannot be fitted by the one-zone synchrotron-self-Compton (SSC) model. This indicates that external photons play a crucial role in the high-energy emission of LBLs, therefore we suggest that LBLs are masquerading BL Lacs. (2) We suggest that the γ -ray emitting regions of LBLs are located outside the broad-line region and within the dusty torus. (3) By extending the analytical method to all types of LSPs in Fermi-4LAC (using historical data), we find that the high-energy peaks of some flat spectrum radio quasars and blazar candidates of unknown types can be attributed to the SSC emission, implying that the importance of external photons could be minor. We suggest that the variability time-scale may help distinguish the origin of the high-energy peak.

回顾耀变体 TXS 0506+056 与高能中微子 IC 170922A 的成协：排除单辐射区起源

李伟健浙江师范大学

The Study of Jet Formation Mechanism in Fermi Blazars

谢尚春

The origin of jet launching mainly comes from two mechanisms: the Blandford-Znajek mechanism and the Blandford-Payne mechanism.However, it is in debate which one is dominating in blazars.In this work, we used a sample of 937 \textit{Fermi} blazars to study the jet formation mechanism. We studied the correlation between the jet power and the accretion rate, as well as the comparison between jet power estimated by SED fitting and that estimated by theoretical formula and radio flux density. Our results suggest that there is no correlation between jet power estimated by SED fitting and the accretion rate for BL Lacs, while a positive and weak correlation exists for FSRQs.Meanwhile, to confirm whether BP and BZ mechanism is sufficient to launch the jet for FSRQs and BL Lacs, we compare the theoretical jet power with that estimated by SED fitting, as well as that by radio emission. We found that the jet power for most of the two subclasses estimated by SED fitting cannot be explained by either the BP or BZ mechanism.While the jet power for most FSRQs estimated by radio flux density can be explained by the BP mechanism, and most BL Lacs can be explained by the BZ mechanism.We also found that FSRQs have higher accretion rates than BL Lacs, implying different accretion disks around their central black holes: FSRQs typically have standard disks, while BL Lacs usually have ADAF disks.

高峰频耀变体的 X 射线偏振观测特征

胡新珂

耀变体 (Blazar) 是一类特殊的活动星系核 (AGN)，其典型特征是多波段剧烈光变。耀变体的宽波段能谱呈现双峰结构，低能峰起源于相对论电子的同步辐射，高能峰的起源仍有争议，但普遍被认为是低能光子与相对论电子的逆康普顿散射过程。根据同步辐射峰的峰值频率耀变体可被分为低峰频、中峰频和高峰频耀变体三个子类。耀变体是成像 X 射线偏振探测器 (imaging X-ray polarimetry explorer, IXPE) 的一类主要观测目标源。目前 IXPE 只对 Mrk 501、Mrk 421、PG 1553+113、1ES 0229+200、1ES 1959+650、PKS 2155-304 和 H 1426+428 这些高峰频耀变体进行了观测，它们已经呈现出略有不同的观测特征。总体而言，高峰频耀变体在 X 射线波段呈现显著偏振，一般 X 射线波段偏振度高于光学、再高于射电波段。有

的耀变体在 X 射线波段呈现出快速的偏振角旋转特征，但在光学和射电波段却没有观测到类似现象。我们利用 IXPE 的观测数据、以及同时和准同时的多波段数据研究了三个高峰频耀变体的 X 射线偏振特征。发现：(1) 在 PKS 2155-304 中呈现出 IXPE 探测的所有耀变体中最高的偏振度，在 IXPE 的 2-8 keV 全能段为 21.9%±1.9%，而在较窄的能段 3-4 keV 更是高达 28.6%±2.7%；(2) 1ES 1959+650 在 4 次 IXPE 观测中呈现出不同的偏振特征，偏振角的变化可能表征螺旋磁场结构的存在；(3) Mrk 501 的偏振度在宽波段（X 射线、光学和射电）上呈现出随能量增大而增大的趋势，而偏振角在三个波段较为一致。近期，我们又分析了 IXPE 对高峰频耀变体 H 1426+428 的观测结果，其也有显著偏振。这些观测结果支持高峰频耀变体的 X 射线辐射起源于同步辐射。

探索活动星系核 X 射线的掩食事件：基于 Swift/XRT 观测数据的系统研究

连恬颖 国家天文台

AGN 的核心周围可能被众多各种物理状态下的云团环绕，其中一些块状的气体云（吸收体）可能会在视线方向上随机遮挡中心的 X 射线源，导致掩食事件。最近的研究表明，在 AGN 中，这种掩食事件很可能是常见的。然而，完整的掩食事件很少被发现，因为它们需要跨越数年的大量 X 射线监测。在这项研究中，我们对 40 个 AGN 进行了系统性的掩食事件搜索，研究样本总共包含了 11486 次 Swift-XRT 的观测数据。我们基于 X 射线流量和硬度比的异常变化，在 3 个源中发现了 3 次掩食事件，5 个源中发现了 7 次候选的掩食事件，所有事件均发生在 I 型 AGN 中。与以往的研究结果相比，我们的样本新发现了 5 个掩食事件。通过拟合掩食期间内的平均光谱，我们得出吸收体的电离度范围从-0.547 到 2.443，柱密度范围为 0.16-31.15x10^{22} cm^{-2}。这些掩食事件的时间跨度从几天到几年不等，对应的吸收体距中心黑洞的距离约为 0.31-107.79x10^{4} Rg(引力半径)。10 个掩食事件中有 6 个吸收体位于尘埃升华区(DSZ)内，而 2 个事件对应的吸收体位于 DSZ 之外，剩下的 2 个位于宽线区（BLR）内。爱因斯坦探针（EP）对 X 射线全天监测可能对临近宇宙的掩食事件发生率提供更强的约束。

X-ray study of the IC1262 group of galaxies with C handra

王诚敬 上海工程技术大学

We analyze the Chandra observation data of galaxy group IC1262, and find that the brightness discontinuity, located about 17 kpc east of the X-ray peak, is a cold front with a Mach number of M=0.7. Furthermore, the line-of-sight velocity distribution of the member galaxies supports two subgroups, with the lower subgroup having an average velocity of 9 280+<80>_<170> and a dispersion velocity of 320+<80>_<120> , and the higher subgroup with an average velocity of 9 960+<30>_<20> and a dispersion velocity of 110+<20>_<30>. This indicates the IC1262 galaxy group is undergoing a major merger with a merger mass ration of approximately 3:1. It should to be noted that the higher subgroup includes IC 1262, the brightest galaxy of the group, and other three galaxies. All of them are very close in terms of both visual velocity and sky plane. This supports that the cold front is likely associated with this merger, rather than AGN activity in the center of galaxy IC1262 with jet directions almost parallel to the edge of the cold front.

The Fundamental Planes of Black Hole Activity for Blazars

龙青琛 贵州师范大学

黑洞双星中的吸积盘退行现象

徐赛恩 武汉大学

Effects from Dark Matter Halos on X-ray Pulsar Pulse Profiles

刘宇堃 北京大学

关于孤立中子星回落盘的时标研究

许坤　青岛理工大学

新磁星 Swift 1555.2-5402 的爆发特性

李清心 北京师范大学

Mapping Anisotropies in the Stochastic Gravitational-Wave Background with TianQin

李知圆 中山大学

In the milli-Hertz frequency band, stochastic gravitational-wave background can be composed of both astronomical and cosmological sources, both can be anisotropic.
Numerically depicting these anisotropies can be critical in revealing the underlying properties of their origins.
For the first time, we perform a theoretical analysis of the constraining ability of TianQin on multiple moments of the stochastic background.
First, we find that with a one-year operation, for a background with a signal-to-noise ratio of 16, TianQin can recover the multiple moments up to $l=4$.
We also identified a unique feature of the stochastic background skymap, which is the mirror symmetry along the fixed orbital plane of TianQin.
Thirdly, we explain the difference in anisotropy recovering ability between TianQin and LISA, by employing the criteria of the singularity of the covariance matrix (which is the condition number).
Finally, we find that since the different data channel combinations correspond to different singularities, certain combinations might have an advantage in stochastic background map-making.
We believe that the findings of this work can provide an important reference to future stochastic background analysis pipelines.
It can also serve as a guideline for designing better gravitational-wave detectors aiming to decipher anisotropies in the stochastic background.

Space-based Gravitational Wave Observatories Will Be

Able to Use Eccentricity to Unveil Stellar-mass Binary Black Hole Formation

王晗　中山大学

Since the first gravitational-wave detection of stellar-mass binary black holes, their formation mechanism has puzzled the scientific community. Measuring the eccentricity of these systems offers the possibility of distinguishing between the various possible formation channels and solving this mystery. However, measuring eccentricity in ground-based observatories is difficult because eccentricity will have decayed before the source is visible to such observatories. Space-based observatories will observe stellar-mass black holes at lower frequencies where eccentricity may remain measurable. Observing stellar-mass black holes in space-based observatories is potentially a very computationally challenging task, but this can be resolved by relying on ground-based observatories to find these systems and then looking back in data from space-based observatories to find the same source - so-called "archival searches". In this work, we construct the first template bank for an archival search that includes eccentricity. We demonstrate that even though including eccentricity enlarges the bank size by 5 orders of magnitude, such searches are still feasible given expected computational power and will provide significantly tighter constraints on the source eccentricity than is possible from only using ground-based observatories.

天体物理环境影响下极端质量比旋近系统引力波形的一般形式

江野　中国科学院上海天文台

超大质量黑洞周围天体物理环境的探测和广义相对论的检验是极端质量比旋近系统（EMRIs）的重要应用领域。而有效地描述旋近过程中各种效应的影响仍然是一个挑战，例如暗物质、气体、偶极子辐射和电磁相互作用。本文研究并发现了非齐次 Teukolsky 方程渐近解的线性性。基于这一性质，我们完全解耦了波形中能量动量张量的摄动和 Kerr 背景时空。利用这种解耦形式，可以方便地计算 Kerr 时空中非测地线运动的 EMRIs 的波形。这将有助于分辨超大质量黑洞周围的环境(包括气体、场、暗物质、电磁相互作用)，并检验广义相对论。

利用空间探测器绘制随机引力波背景天图

李知圆 中山大学

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We believe that the findings of this work can provide an important reference to future stochastic background analysis pipelines.
It can also serve as a guideline for designing better gravitational-wave detectors aiming to decipher anisotropies in the stochastic background.

Constraining gravitational wave velocities using gravitational and electromagnetic wave observations of white dwarf binaries

曹天涌 中科院高能物理研究所

引力波证认层级三星合并与检验修改引力

高博 紫金山天文台

Discover the turning point of the Black Hole transient Swift J1727.8-1613 in fractional rms based on Insight-HXMT

韦敏　　云南大学

We analyze the new black hole transient Swift J1727.8-1613 outburst in 2023 base on Insight-HXMT, and investigate the timing characteristics of type-C QPO in the flare state.

By investigating the relationship between the fractional rms and frequency in Swift J1727.8-1613, we find that the fractional rms has a strong inverse correlation with frequency below 10 keV, and a weak inverse correlation also appears at 50-100 keV. This is the first time we have detected the inverse correlation at high energy, and it is consistent with the energy range of the hard tail component.

Subsequently, we find that the fractional rms of 2-4 keV and 50-100 keV have turning points around 4 Hz respectively, and correspond to different piecewise-linear functions.

We do not yet understand the corresponding physical mechanism of these turning points, and will continue to investigate.

中微子天体物理学

郭刚　　中国地质大学（武汉）

中微子是构成物理世界中的一类十分神奇的基本粒子，它不带电，与普通物质仅发生十分微弱的相互作用。在宇宙大爆炸、恒星演化和爆炸等各类剧烈的天体活动中，不同能量的中微子被大量产生并深刻影响宇宙的演化和各类天体过程。太阳中微子和超新星 1987a 中微子的发现开启了中微子天体物理学研究的新篇章。本报告将简要介绍在大质量恒星演化、塌缩型超新星爆发和伽马射线暴等天体过程的中微子过程以及探测中微子信号的意义。

Search for the Hawking radiation of primordial black holes: prospective sensitivity of LHAASO

杨晨　　东北大学理学院

Primordial black holes (PBHs) with initial mass ∼ 5 × 10^14 g are evaporating due to Hawking radiation, leading to bursts of very-high-energy gamma rays. In this work, we investigate the prospective sensitivity of the Large High Altitude Air Shower Observatory (LHAASO) to measure the local burst rate density of PBHs. Our findings reveal that LHAASO is capable of searching for the PBH bursts within a distance ∼ 0.1 pc from the sun and thereby measure the local burst rate density ∼ 1164 (or 699) pc^−3 yr^−1 at 99% confidence level during a 3 (or 5) year observing run. This stands for a sensitivity that is one order of magnitude stronger than the strongest observational constraint from the High Altitude Water Cherenkov Observatory (HAWC). In addition, we further suggest an observing strategy to search for the PBH bursts during upcoming observing runs of LHAASO.

EP 和 LEIA 的暂现源搜寻

张文杰 中国科学院国家天文台

Eintein Probe (EP) is a space X-ray observatory to monitor the soft X-ray sky with X-ray follow-up capability, and was lauched on January 9, 2024. It carried out a series of performance verification and calibration observation after launch and had begun scienfic observations since late July. By now, EP has detected more than 30 fast X-ray transients, and long-term transients of different origin. Of which, some are very puzzling transients and their nature are still under investigation. In this talk, we will introduce the strategy we adopt to search for the transeints. For short term transients, like GRBs and stellar flares, that show high amplitude varibility during one single exposure, the Bayesian block algotithm is adopted to search for the variabile signal. While for long-term, and relatively fainter transients, like TDEs, data stacking is used to increase the detection sensitivity. All these sources have been carefully identified following a series of cross-matches with astronomical data bases and multiwavelength catalogues, and also follow-up observations. In this talk, we will give a brief introduction to the search and multi-wavelength identification for the EP transients.

EP 和 LEIA 的科学运行

刘禾阳 中国科学院国家天文台

作为中科院先导二期项目的正选星，爱因斯坦探针（Einstein Probe，简称 EP）是一颗面向时域天文学和高能天体物理的 X 射线天文探测卫星，旨在开展高灵敏度、高采样频率的巡天监测，预期将发现一批宇宙 X 射线暂现源。EP 卫星已于 2024 年 1 月 9 日成功发射，目前已完成在轨测试，处于正式科学运行阶段。龙虾眼天文成像仪（ Lobster Eye Imager for Astronomy，简称 LEIA）是 EP 卫星的探路者，主要目标为通过对真实天空 X 射线源的成像观测，验证 EP 采用的龙虾眼成像技术和 CMOS 探测器的在轨表现；先期研究、测试、优化和演练 EP 卫星在轨标定方案、EP 数据处理算法和软件及整个地面系统流程。LEIA 于 2022 年 7 月 22 日发射，目前已在轨运行 2 年多。本报告将介绍 EP 和 LEIA 的科学运行情况，包括运行流程、观测模式、科学用户支持和数据政策等。

Wolter-I 型 X 射线聚焦镜精密装调技术研究

于可　长春理工大学

增强型时变偏振天文台（enhanced X-ray Timing and Polarimetry, eXTP）作为一项科学空间任务，目标聚焦于探索物质在极端密度、重力和磁性条件下的状态。该任务将部署 6 组能谱测量 X 射线聚焦望远镜阵列（Spectroscopic Focusing Array, SFA）与 3 组偏振测量 X 射线聚焦望远镜阵列（Polarimetry Focusing Array, PFA）。Wolter-I 型结构是目前应用最为广泛的 X 射线聚焦镜结构，eXTP 搭载的 SFA 和 PFA 聚焦镜均选用了该结构，采用电铸镍复制工艺制造，通过 45 层不同口径镜片的嵌套增加有效面积。具体而言，SFA 的焦距设定为 5250mm，镜身长 600mm，口径 480mm，反射层使用金材料；PFA 的口径为 500mm，焦距和镜身与 PFA 一致，反射层采用镍材料。聚焦镜性能上，角分辨和有效面积是两项重要指标，eXTP 聚焦镜载荷角分辨目标优于 30″。实现这一性能指标，不仅依赖于单层镜片的卓越性能，更需多层镜片能够实现高精度同轴共焦精密装配成为聚焦镜组。
本文基于 eXTP 聚焦镜的研制，介绍了复制电铸镍工艺 Wolter-I 型聚焦镜的精密装配技术。通过分解指标精度、针对性指定装调与检测方案，将聚焦镜精密对准装配分为装调系统构建与基准、镜片性能检测与预测，以及镜片装配与固化三个核心环节展开介绍。同时，展示了 eXTP 2 号试验样机的装配与测试结果，证实该装配技术能够满足 eXTP 任务的性能指标要求。

EP-WXT 和 LEIA 的已知源长期监测

胡静维 中国科学院国家天文台

爱因斯坦探针(Einstein Probe, EP)是一颗面向时域天文学的、发现型的 X 射线

天文探测卫星。EP 卫星于 2024 年 1 月 9 日在西昌卫星发射中心成功发射升空，顺利进入预定轨道。目前已成功完成在轨测试和标定，进入正式科学运行阶段。宽视场 X 射线望远镜(Wide-field X-ray Telescope, WXT)是 EP 的两个主要科学载荷之一，可以实现大视场的 X 射线聚焦成像，主要用于监测 X 射线天空并具备星载触发能力。2022 年 7 月发射的 EP-WXT 探路者 LEIA(Lobster-Eye Imager for Astronomy)也验证了 WXT 的一些性能。在本次报告中，我们将展示 EP-WXT 和 LEIA 对已知 X 射线源的长期监测情况，包括已探测到的已知源全天分布、分类统计等。

The pile-up fraction of EP/FXT based on observation simulation

张娟　中国科学院高能物理研究所

A simulation study on the sub-threshold joint gravitational wave-electromagnetic wave observation on binary neutron star mergers

杜云飞

The maximum-likelihood estimation method for X-ray spectra with low counts

徐歆鹏中国科学院国家天文台

For X-ray spectra with low counts, traditional statistics such as chi2 statistic and Poisson (C) statistic cannot well enough evaluate the goodness-of-fit during model fitting, because the binning process is usually arbitrary and would result in the loss of channel information. The maximum-likelihood estimation method is an ideal alternative method that does not require any binning procedures. We establish the maximum-likelihood estimation method and test it with fake spectra with low counts.

We also test other methods such as XSPEC fitting, MCMC method and BXA method for comparison, and we found that the results obtained by the maximum-likelihood estimation method are better than those obtained by XSPEC fitting. Both the maximum-likelihood estimation method and MCMC method can obtain pretty good results, however, the running time of MCMC can be much longer than that of the maximum-likelihood estimator. Besides, we also look into the effect that the parameter values have on the results.
We further apply the method to the LEIA observational data and attain some satisfactory results. In a word, we have established the unbinned aximum-likelihood estimation method especially for low-count data and proved its practicability by applying to the real data.

The Evolution of the X-ray Spectra in Tidal Disruption Events

陈维国家天文台

The evolution of the energy spectrum during black hole tidal disruption events (TDEs) is an important approach to studying their physical processes. Many observational sources exhibit a soft X-ray spectrum during the peak of outbursts, which gradually becomes harder over the course of several years. We have developed a model for the coexistence of the disk and corona in an super-Eddington accretion state, explaining the observed radiation of hard X-rays in late-stage TDEs through the inverse Compton scattering of low-energy particles in the corona. In our model, we replace the standard disk in the region dominated by radiation pressure with a slim disk, while the outer region dominated by gas pressure continues to use the standard disk plus strong corona model. As the accretion rate decreases, the corona gradually moves inward, resulting in the observed transition of the X-ray spectrum from soft to hard in TDEs. This behavior is compared with data from sources such as ASASSN-14li, showing good agreement with observations.

Signatures of the Self-organized Criticality Phenomenon in Precursors of Gamma-Ray Bursts

李秀娟曲阜师范大学

Precursors provide important clues to the nature of gamma-ray burst (GRB) central

engines and can be used to contain GRB physical processes. In this Letter, we study the self-organized criticality in precursors of long GRBs in the third Swift/Burst Alert Telescope catalog. We investigate the differential and cumulative size distributions of 100 precursors, including peak flux, duration, rise time, decay time, and quiescent time with the Markov Chain Monte Carlo technique. It is found that all of the distributions can be well described by power-law models and understood within the physical framework of a self-organized criticality system. In addition, we inspect the cumulative distribution functions of the size differences with a q-Gaussian function. The scale-invariance structures of precursors further strengthen our findings. Particularly, similar analyses are made in 127 main bursts. The results show that both precursors and main bursts can be attributed to a self-organized criticality system with the spatial dimension S = 3 and driven by a similar magnetically dominated process.

The Black-Hole Entropy within Tsallis Non-Extensive Statistics

申可明东华理工大学理学院

The non-extensive statistical entropy of black holes is obtained within the Tsallis non-extensive quantum statistics in the generalized brick-wall model without introducing any cut-offs, which further gives out the frequency-temperature relation. By considering the reaction of a black hole radiation in the space-time background, the non-extensive energy of radiation is also calculated with respect to temperature. The non-extensive connection is discussed together with possible consequences for the fate of black holes in the whole stages of evaporation.
All calculations are performed in both Bose-Einstein and Fermi-Dirac fields, whose results show that the standard relation between them is no longer satisfied in the non-extensive approach.

Systematic Analysis of Changing-look AGN Variability Using Optical Light Curve

王惠美

Changing-look active galactic nuclei (CLAGNs) are a unique population of AGNs that exhibit the appearance (turn-on) or disappearance (turn-off) of broad emission lines. This study aims to explore the intrinsic mechanisms of CLAGNs by investigating their photometric variability using data from the Zwicky Transient Facility (ZTF), which has

provided high-cadence observations over the past five years. We visually inspect and construct a sample of 90 CLAGNs from the literature, all of which show spectral transitions with corresponding ZTF light curves. We also create control samples of type 1 AGNs, type 2 AGNs, and extremely variable quasars (EVQs), matched in redshift and supermassive black hole mass. We compare color variability, structure function (SF), and the variability metric σ_{QSO}, which quantifies how closely the light curves resemble a damped random walk (DRW) model, between CLAGNs and the control samples. We find that CLAGNs and EVQs share a similar distribution and fall within a critical region between type 1 and type 2 AGNs. Our results support the hypothesis that while CLAGNs and EVQs exhibit similar variability behaviors, they differ from typical type 1 and type 2 AGNs in bolometric luminosity, Eddington ratio, and other variability properties.

射电星系 NGC 6251 大尺度射电瓣上的伽马射线辐射

喻雨薇 北京理工大学

目前约有 45 个射电星系被证认是伽马射线辐射源，但是受限于探测器角分辨率能力，对射电星系的伽马射线辐射起源一直存有争议。近期，我们发现射电星系 NGC 6251 的大尺度射电瓣上有可探测的 GeV 辐射。我们用一个射电结构（包括核区、西北射电瓣、东南射电瓣三部分）的延展源模型去拟合这个源 Fermi/LAT 近 15 年的观测数据，通过最大似然检验，发现射电结构的延展源模型比点源模型能更好的拟合观测数据，置信水平高出 8.1σ。利用射电结构模型拟合 Fermi/LAT 观测数据，我们还得到了射电核区、两个射电瓣的流量和能谱。射电瓣的能谱与射电核区的能谱显著不同，而射电瓣的辐射流量贡献了源总流量的 50%以上。射电核与射电瓣的长时标光变曲线都没有表现出显著的伽马射线流量变化，其中核区的伽马射线辐射源于同步自康普顿散射过程，而射电瓣的伽马射线辐射由宇宙微波背景光的逆康普顿散射贡献。NGC 6251 是除了 Cen A 和 Fornax A 之外第三个从观测上证实活动星系核大尺度喷流存在可探测伽马射线辐射的源，表明活动星系核大尺度喷流存在伽马射线辐射可能并非特例。附上相关成果链接：https://ui.adsabs.harvard.edu/abs/2024ApJ...965..163Y/abstract

致密对称源的高能辐射性质

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致密对称源 (Compact Symmetric Object , CSO) 是射电结构对称且紧凑 (投影线尺度小于 1 kpc) 的一类活动星系核 (AGN)。CSO 被认为处在 AGN 演化的早期阶段，部分 CSOs 将会演化成典型的射电星系。但也有学者认为其致密结构是源于受周围致密环境阻碍的喷流，或者是源于中心引擎间歇式的爆发，不足以驱

动大尺度喷流形成。目前，有 5 个 CSOs 被证认为是伽马射线辐射源。通过对这 5 个源长达十几年的 Fermi/LAT 观测数据的系统分析，我们发现 CTD 135 和 PKS 1413+135 具有高的伽马射线光度、显著的能谱演化和类似耀变体的剧烈光变，并且能谱需要带曲率的对数抛物线模型拟合。然而，另外 3 个致密对称源的伽马射线辐射光度偏低且没有显著的光变，能谱只需要用简单的幂律函数来拟合。在谱指数和光度关系图上，CTD 135 和 PKS 1413+135 落在耀变体分布的区域，而另外 3 个 CSOs 在射电星系分布的区域。基于这些结果，我们认为致密对称源的伽马射线辐射来源不同，分为核主导和瓣主导两类。对于核主导的 2 个源，它们中心引擎的活动是间歇性的，射电对称结构可能源于之前一次爆发的喷流活动，而探测到的伽马射线辐射则起源于最新爆发的喷流活动。近期，通过详细分析一个 CSO 样本的 Chandra 和 XMM-Newton 观测数据，我们发现 CSO 的致密射电结构不太可能是源于受阻原因。通过对比其它类型 AGN 的光子谱指数分布，以及这些 CSO 的 X 射线光度与多频率射电光度的相关分析，我们认为这些 CSO 的 X 射线辐射应该是喷流辐射主导，而不是盘-冕系统主导。 (相关论文：Gan et al. 2021; 2022; 2024; 2024, submitted)

高能天体爆发现象中的自组织临界特性研究

张文龙 曲阜师范大学

In natural phenomena, self-organized criticality is often observed, such as in earthquakes, solar flares, SGR, and GRB. In previous studies, we investigated the behavior of X-ray flares from supergiant fast X-ray bursts and X-ray bursts from SGR J1935+2154, analyzing the cumulative distributions of their characteristic parameters (including time, energy, and luminosity). The results showed that both the X-ray flares from supergiant fast X-ray bursts and the X-ray bursts from SGR J1935+2154 exhibited self-organized critical characteristics during the active period in April 2020. In recent work, based on previous research on the TeV radiation of GRB221009A, we found evidence of transient radiation participation. We suggest that each TeV photon may originate from the activities associated with the production of keV-MeV radiation. Therefore, studying the behavior of TeV photons can provide insights into the underlying dynamics that are difficult to observe directly. Our findings indicate that the distribution of waiting times of TeV photons exhibits partial self-organized critical features.

探究黑洞 X 射线双星中的准周期振荡：希尔伯特-黄变换的应用与新发现

税擎苍 中国科学院高能物理研究所

黑洞 X 射线双星包含一颗正处于吸积状态的恒星级黑洞。伴星的物质在强大引力场的作用下向黑洞掉落，在这个过程中，吸积物质在黑洞周围形成吸积盘并产生明亮的 X 射线辐射。单个黑洞 X 射线双星的吸积环境会在天到月量级的时间尺度上发生状态变化，人们可以通过 X 射线探测卫星对这些状态的变化进行完整的监测。这些特点使得黑洞 X 射线双星成为研究吸积物理、强引力场下的磁流体力学以及喷流等诸多基本天体物理过程的理想实验室。过去的研究表明，该类天体的 X 射线辐射也会在秒量级的短时标内发生变化（快速光变）。在功率谱上，这些快速光变表现为宽频带的红噪声以及叠加在其上的具有一定宽度的结构峰——准周期振荡（QPO）。一般认为这些快速光变产生于吸积盘的最内区部分，是研究吸积盘内区性质的理想探针。虽然 QPO 是黑洞 X 射线双星中普遍存在的观测现象，且自上个世纪 80 年代第一次发现这种现象到现在已经过去了几十年，但是它们的起源依然存在很大的争议。为了打破这一局面，人们迫切地需要引入新的分析方法来结合多方面的观测信息，以提供多维度的观测特征，从而约束现有的理论模型。我们在最近的工作中引入了希尔伯特-黄变换（Hilbert-Huang transform, HHT）来研究 QPO 的性质。HHT 能够提供非稳定周期信号的相位信息，非常适合用于研究 QPO 的性质。通过这一新方法，我们利用 Insight-HXMT、NICER 以及 NuSTAR 等多个卫星的数据首次在多个源中得到了能谱随 QPO 相位的调制。利用最近 IXPE 的观测，我们首次给出了偏振信息的 QPO 相位调制。基于 HHT，我们还开发了搜寻高能 QPO 信号的新方法，该方法大大提高了传统傅里叶方法探测到的 QPO 能量极限，为更高能量（>150 keV）QPO 性质的研究打开了窗口。本报告将介绍我们基于希尔伯特-黄变换方法在多个源中得到的观测结果，并讨论其反映的物理图像。

X-ray spectral and timing evolution during the outburst of BHXRB -- a case study of MAXI J1820+070

李亚星 中国科学院上海天文台

MAXI J1820+070, a black hole X-ray binary (BHXRB), was first discovered during its 2018 outburst. Its exceptional brightness across nearly all wavelengths prompted extensive observational campaigns, ranging from radio to gamma rays. The wealth of observational phenomena yielded significant results, advancing our understanding of black hole accretion physics. Insight-HXMT, China's first X-ray satellite, has closely monitored the 2018 outburst of MAXI J1820+070. These high-cadence observations with large photon counts, offered an excellent opportunity to study the X-ray spectral and timing properties across various X-ray spectral states. Here, we present a comprehensive analysis of the X-ray spectral and timing evolution during the 2018 outburst, encompassing the evolution of X-ray spectral parameters, characteristical fast variabilities and their interrelationships.

银河系 erosita 气泡的研究

张瑞玉 河南师范大学

本报告主要介绍报告人及合作者近期对银河系 eRosita 气泡研究取得的一些进展。我们提出了一个新的模型来解释 eRosita 气泡的起源，通过流体模拟计算 eRosita 气泡的演化过程，并将模拟结果与 X 射线波段的观测数据进行对比。我们的结果能够同时复现 eRosita 气泡与费米气泡在不同波段的观测特征，并给出有力的证据证明 eRosita 气泡是一个星系尺度的结构而非太阳系附近的超新星遗迹。

天琴计划中大质量双黑洞引力波的解析信噪比

陈洪昱 中山大学

大质量双黑洞是天琴计划的重要观测源之一。我们的研究表明，对于天琴计划来说，在大质量双黑洞的旋近阶段，信噪比的平方与观测时间与并合前剩余时间的比值呈直接比例关系。这一发现显著提高了对大质量双黑洞探测能力的估计。在本工作中，我们在全天平均和非全天平均条件下解析计算了这种关系。后者仅引入了一个额外的项，我们称之为响应因子。尽管这个项不容易通过解析方法计算，但我们提供了一种简单的估算方法，误差范围在 2%以内。

Hot gas condensation in black hole X-ray binaries

王裔龙 中国科学院国家天文台

Conventional models for the spectral state transition in black hole X-ray binaries (BHXBs) predict the truncation of the accretion disc in the low/hard state (LHS) with the innermost region of the accretion flow replaced by the advection dominated accretion flow (ADAF). However, in the LHS of several BHXBs, relativistically blurred Fe K α lines are observed, which is a direct evidence for the existence of inner discs located near the innermost stable circular orbit (ISCO) and is therefore against the truncated disc models. As an alternative we propose that the condensation of hot gas provides a potential route for understanding this phenomenon. Assuming the accretion flow in the LHS is in the form of an ADAF at around 100 Schwarzschild radii, which is supplied by either the stellar wind of a massive companion star (the case in

high-mass X-ray binaries) or the evaporation of the accretion disc fed by Roche lobe overflow (the case in low-mass X-ray binaries), we study the possible condensation of the hot gas during its accretion towards the black hole. It is found that, as a result of efficient radiative cooling, a small fraction of the ADAF condenses into a cold disc and thus a disc-corona configuration is formed near the ISCO, which takes place for low accretion rates with luminosities ranging from ~ 10^{-3} to a few per cent of the Eddington luminosity. The coexistence of a weak inner disc and a dominant hot corona/ADAF provides a natural explanation to the observed Fe K α lines in the LHS. Moreover, detailed computations demonstrate that such accretion flows produce an X-ray spectrum with a negative correlation between the 2-10 keV photon index and the Eddington ratio, which is in good agreement with the observed correlation of a sample of BHXBs in the LHS. As an example, we apply the condensation model to Cygnus X-1, a typical wind-fed high-mass X-ray binary, and find that the predicted spectrum can also well explain the observed LHS spectrum. Finally, in order to apply the model to higher accretion rates and thus explain the more luminous states of accreting systems, we generalize the model by adopting a boundary condition with both hot and cold gas supplies. Preliminary results show that, apart from the accretion rate, the initial form of the accreted gas also plays an important role in the determination of the accretion geometry and hence the observed spectral characteristics of the accreting system, which shows the potential of explaining the various spectral states of BHXBs.

英仙座分子云的 GeV 伽马射线辐射研究

江檬　　广西大学

有迹象表明一些分子云中的年轻大质量星团能有效的加速宇宙线，宇宙线在传播过程中会和周围的介质相互作用产生伽马射线辐射，通过分析伽马射线可以间接研究宇宙线。

这项工作基于 Fermi-LAT 观测数据，对大质量恒星形成区英仙座分子云的伽马射线辐射进行分析研究，并讨论宇宙线在其内部的传播和加速效应。我们对该区域的气体和尘埃进行分析，并且推导了当地暗气体的分布情况，利用分析结果对背景模型进行重建，并使用 PSmap 进行比较，发现重建后的背景模型明显优于 fermi 提供的标准模型。我们将三个核区 IC348、NGC1333、B1 的能谱与当地预测宇宙线能谱相比较，发现 IC348 在高能处谱变硬现象，认为其可能源于恒星团中加速质子与环境气体的相互作用；NGC1333 在低能处有抑制现象，可能是由慢扩散效应引起的，但是我们也不能排除氢原子数量估算误差所带来的影响。

7、星系、宇宙学分会场报告日程

宇宙学与基础物理

李惕碚 清华大学

CMB 观测结果、基本粒子的全同性及长程势场的洛伦茨规范条件，都要求宇宙真空由非零能量密度的中性介质构成。中性真空的动力过程遵从热力学而非机械力学。成熟星系和标准模型中的宇宙年龄都约为 140 亿年；韦布望远镜观测到一批红移 z~10 的成熟星系，它们在标准模型中的年龄≲10 亿年，严重挑战了大爆炸宇宙学。而热力学相变模型的宇宙年龄约 280 亿年，与早期星系的观测结果相容。在 CMB 温度图上，我们发现了一批相变模型所预期的 z~10 时期宇宙早期相变产生的张角 θ~10^0 的特征冷/热斑结构。中性宇宙真空相变模型还可以自然地解释哈勃常数疑难和 CMB 大尺度反常问题。

原始宇宙真空或膨胀宇宙的共动真空是实物运动的绝对静止参照物。经典物理和近代物理都错误地将相对性原理作为基本原理，忽视了真空介质及其与实物运动的关联。电子相对于静止真空的匀速平动带动真空介质随动，随动的电中性流产生涡旋磁场，运动电子的速度场由电磁场和随动的真空介质构成：

电子运动的“相对论效应”(光速不变，尺缩钟慢)是速度场的物理效应,並非相对论的“时空效应”。电子的双缝干涉现象也是速度场波包的效应。速度场並非任何力作用的产物，而是真空通过随动中性介质向电子输入惯性（但不增加动能和势能）的结果。洛伦兹协变性只适用于运动学；将无外力的运动粒子视为孤立系统的相对论动力学存在重大缺陷。例如，麦克斯韦方程导出的运动电子质量 m=4⁄3 γm_0 = γm_0+1⁄3 γm_0，其中多余的 1⁄3 γm_0 项就是将匀速运动电子视为孤立的机械力学系统的后果。

相对论没有清晰区分力荷、质量、惯性等概念，严重地滥用了“质量”一词，将力荷与种种所谓的“质量”混为一谈，导致物理理论出现种种无穷大困难。在中性真空-实物关联的物理图景中，不存在规范场的自作用，不需要用重整化消除无穷大。中性真空中的引力作用可以如电磁作用一样地线性化，量子化，和热能化。膨胀宇宙真空中的热声子同实物粒子的相互作用，可以用来统一地处理粒子标准模型中的电子和缪子反常磁矩、W 玻色子质量、奇特强子态等疑难问题。

鸿蒙月球轨道天文台与超长波天文学

陈学雷 中国科学院国家天文台

Hubble tension from local perspective

王少江 中国科学院理论物理研究所

The standard model of modern cosmology might be cracked by the recent persistent hot debate on the Hubble-constant (H0) tension, which manifests itself as the sound-horizon (rs) tension or absolute-magnitude (MB) tension if deeming the origin of the Hubble tension from modifying the early or late Universe, respectively. In this talk, I will introduce another two tensions that might be related to the Hubble tension. One is the intercept (aB) tension of the magnitude-redshift relation of SNe between our local Univerese and late-time Universe. The other is the slop (K) tension of sample variance of the Hubble-constant measurements from the local Universe of SN-host environment. These two tensions have suggested that, even without the Hubble tension, our LCDM model might still call for new physics at local scales.

基于对数密度场的多尺度极值限制晚期宇宙的原初非高斯性

王云 吉林大学

为更有效地从宇宙大尺度结构中限制原初非高斯性（PNG）参数 f_NL，本报告提出了两种新型统计方法：（1）尺度依赖的峰值函数（scale-depndent peak height function, scale-PKHF），（2）尺度依赖的谷值函数（scale-dependent valley depth function, scale-VLYDF）。借助 Quijote 和 Quijote-PNG 这两组数以万计的 N-体模拟，通过 Fisher 信息矩阵，作者评估了这两种统计方法对 PNG 参数和标准宇宙学参数的约束能力，并与功率谱和双谱进行了比较。发现 scale-PKHF 和 scale-VLYDF 可以有效地捕捉宇宙大尺度结构中的原初信息，特别是对标量谱指数 n_s 的约束比传统功率谱和双谱更为严格。将这两种统计量结合后，对 PNG 参数的约束能力超过了功率谱和双谱组合。特别地，正交形状的 PNG 参数 f_NL^ortho 的约束提升了 1.4 倍。当功率谱被纳入统计量组合后，所有参数的约束都更加紧致，相比功率谱和双谱组合提升了 1.1 到 2.9 倍。总而言之，本报告提出的 scale-PKHF 和 scale-VLYDF 在约束 PNG 方面表现出显著优势，并且与功率谱结合后，可以更有效地提取大尺度结构中的宇宙学信息。因此，scale-PKHF 和 scale-VLYDF 可以被推广应用于未来的巡天观测数据，以进一步提高对原初非高斯性参数和其他宇宙学参数的约束能力。

Constraints on interacting dark energy models from the DESI BAO and DES supernovae data

李天诺 东北大学

The recent results from the first year baryon acoustic oscillations (BAO) data released by the Dark Energy Spectroscopic Instrument (DESI), combined with cosmic microwave background (CMB) and type Ia supernova (SN) data, have shown a detection of significant deviation from a cosmological constant for dark energy. In this work, we utilize the latest DESI BAO data in combination with the
SN data from the full five-year observations of the Dark Energy Survey and the CMB data from the Planck satellite to explore potential interactions between dark energy and dark matter. We consider four typical forms of the interaction term Q. Our findings suggest that interacting dark energy (IDE) models with $Q \propto \rho de$ support the presence of an interaction where dark energy decays into dark matter. Specifically, the deviation from ΛCDM for the IDE model with $Q = \beta H0\rho de$ reaches
the 3σ level. These models yield a lower value of Akaike information criterion than the ΛCDM model, indicating a preference for these IDE models based on the current observational data. For IDE models with $Q \propto \rho c$, the existence of interaction depends on the form of the proportionality coefficient Γ. The IDE model with $Q = \beta H\rho c$ yields $\beta = 0.0003 \pm 0.0011$, which essentially does
not support the presence of the interaction. In general, whether the observational data support the existence of interaction is closely related to the model. Our analysis helps to elucidate which type of IDE model can better explain the currrent observational data.

高分辨率中红外空间天文台-觅音计划

周济林 南京大学

围绕目前天文学重大科学问题，下一代空间光学/红外望远镜将以看得更暗、分辨率更高为目标。为此我们提出下一代中红外空间天文台概念--觅音。该计划将由 4 台 3.5 米望远镜和一台合束器在日地 L2 组阵开展光干涉，每台望远镜可以单独或者合光使用（集光面积等效约 7 米）。该望远镜可以开展系外宜居行星搜寻和证认、太阳系天体探测、黑洞搜寻等国际天文学的重大课题研究。本报告将介绍觅音概念，欢迎国内外学者参与并予以指导。

DESI2024 数据的重分析

胡彬　　北京师范大学

DESI 是第四代光谱巡天的旗舰级项目，首批数据获得了近 5 百万条星系和类星体的光谱。2024 年 4 月 5 日，DESI 合作组发布首批重子声学震荡测量结果和宇宙学结果。出人意料地，DESI 合作组首次发现了动力学暗能量的证据，置

信度在 2-4 个标准差的范围内。本次报告，我将介绍 DESI 的星系成团性分析以及重子声学震荡效应的角直径距离的测量方法。此外，我还将介绍我们我们最近对于 DESI 数据的重新分析结果。我们发现：位于红移 0.71 处的亮红星系样本，由其各向同性的成团性分析所推断出的宇宙学明显地倾向与普朗克宇宙微波背景辐射不同的宇宙学。

CSST 宇宙学分析仿真器进展

余瑜　　上海交通大学

我们构造了面向 CSST 宇宙学巡天中星系成团性分析和弱引力透镜分析的仿真器。利用八维宇宙学参数空间中的均匀取样并运行 129 组高精度宇宙学模拟，我们能够对多种大尺度结构的统计量进行高精度的理论预测。报告将介绍仿真器的整体构架、实现和预测精度检验。仿真器成果已在 GitHub 发布并将不断更新，并应用于 CSST 的宇宙学分析中。

Enhancing Morphological Measurements of Cosmic Web with Delaunay Tessellation Field Estimation

刘雨　　清华大学

True-z distribution estimation by clustering methods

陈坤全 中山大学

Characterization of the true-redshift (true-z) distribution of a photo-z sample is crucial in cosmological analyses in imaging surveys. Clustering-based methods, which can be catagorized into clustering-z (CZ) and self calibration (SC) method, provide a valuable means to do so. In this work we study the joint inference of the true-z distribution by combining SC and CZ. We derive simple multiplicative update rules to perform the joint inference. Our method includes proper error weighting and additional weighting function, and is found to significantly improve over the previous algorithm. We test our algorithm using the DES Y3 mock catalogs. The true-z estimation is generally more accurate relative to using SC or CZ alone. We assign different weight to the SC and CZ contribution to account for their different constraining power. There are optimal weights minimizing the error with the precise values of the weights depending on the relative constraining power of the SC and CZ data. We show that the combination of SC and CZ can effectively extend the validity of the clustering methods to higher redshifts.

Studies on nonlinear cosmological perturbations

王博　　中国科学技术大学

With the improvement of cosmological observation precision, nonlinear perturbations have become necessary to understand the cosmological phenomenons. In the framework of general relativity, we analytically study the perturbations of the metric and of the scalar field for a power-law inflation, of the density, pressure and velocity of a relativistic fluid model during the radiation-dominated stage, of the density of a dust model during the matter-dominated stage, in synchronous coordinates. We analyze the structure of the 1st- and 2nd-order perturbed Einstein equations and give the 1st- and 2nd-order solutions. The 2nd-order perturbed Einstein equations are similar in structure to the 1st-order ones, but various products of the 1st-order perturbations occur as the effective source. We perform the residual gauge transformations between synchronous coordinates up to the 2nd-order, and present the gauge modes of 1st- and 2nd-order perturbations. During inflation both the scalar metric perturbation and the perturbed scalar field are waves propagating at the speed of light, analogous to the tensor perturbation, and different from those in the dust and relativistic fluid models in which only tensor perturbation propagates at the speed of light and is regarded as gravitational waves but scalars and vectors do not. The 1st-order vector perturbation during inflation is not a wave and decreases with expansion, but the 2nd order vector perturbation is a wave since it consists of products of the 1st-order scalar perturbations. This causes the 1st-order vector modes to vanish as the universe evolves but the 2nd-order vector modes present inevitably. For the inflation stage, we investigate four gauge invariant scalar perturbations and use the zero-point energy of the scalar field in the vacuum to determine the initial conditions and yield corresponding primordial spectra. For the raditation- and matter-dominated stages, we keep the integration constants in the 2nd-order solutions which shall be used to connect with the inflation stage solutions and to achieve a whole evolution picture of the 2nd order in our future plan.

The impact of baryonic compression on our understanding of dark matter

李鹏飞 南京大学

Astrophysics constrains the nature of dark matter by studying its distribution, i.e. the structure of dark matter halos. The well-known cusp-core problem has once cast doubt on the presumed cold dark matter, but it is then believed to be caused by baryonic feedback, which generates outflows and flattens the central dark matter density. However, baryonic matter that has been accreted into a dark matter halo

would also make the halo to adiabatically contract. In this talk, I will show that the adiabatic contraction due to baryonic compression significantly changes the inner structure of dark matter halos for mass galaxies. It causes the original cuspy halos to be super cuspy, in conflict to the rotation curves of massive disk galaxies. This leads to a cusp-core problem in massive galaxies. Two possible solutions are again: baryonic feedback or modifying the nature of dark matter. As it is well known, stellar feedback does not work in massive galaxies, but even AGN feedback may not work efficiently, as TNG simulations showed similar super cuspy halos, the latter implemented AGN feedback. Our results also suggest that modifying the nature of dark matter can effectively remove the super cusp caused by baryonic compression.

Dark matter production and evolution from primordial black holes in the early Universe

贾拿云 东北大学

Rotating black holes can efficiently transfer energy to their surroundings through the superradiance mechanism, particularly when a particle's Compton wavelength matches the black hole's gravitational radius, leading to an exponential amplification in the particle's occupation number. We investigate the impact of superradiant instabilities of primordial black holes on the gravitational production of heavy bosonic dark matter, as well as its interaction with Hawking radiation. Our findings suggest that, although superradiance can significantly enhance the production of superradiant dark matter particles, the resulting dark matter cloud is rapidly dissipated by gravitational wave emission. Consequently, in contrast to previous studies, the parameter space that can account for the present-day dark matter relic density is more constrained.

透镜类星体的系统性研究

何紫朝 中国科学院紫金山天文台

星系群尺度强透镜系统的建模与源重构

丁恒凯 中国科学院国家天文台

广义相对论告诉我们，质量会使时空弯曲，当光线从遥远的背景天体穿过一个大质量前景天体时，引力透镜效应就会发生。若前景天体质量足够大，背景天体会形成多重像或弧形结构，称为强引力透镜。根据前景天体的尺度和质量，强透镜可划分为星系、星系群和星系团尺度。

相比其他尺度，星系群尺度的强透镜观测样本较少，精细建模更是稀缺。然而，这种研究非常关键：

1.星系尺度强透镜的总质量密度对数斜率接近等温分布，而星系团的则更平缓，暗示了重子物质与暗物质之间可能存在未知的相互作用。星系群尺度透镜作为中间尺度，有助于揭示不同尺度上质量分布的变化规律。

2.强透镜效应的观测可以用于测量暗晕的 mass-concentration-relation 但可能受限于样本选择效应。星系群尺度透镜的研究能够减少这种选择效应的影响。

3.星系群尺度透镜通常具有较高的放大率，可以展示背景源的更多细节，有助于研究背景星系的内部结构和恒星形成过程，从而帮助我们理解星系形成与演化。

因此，扩展星系群尺度透镜样本的建模至关重要。新一代巡天观测为此提供了机会，需要设计有效的建模流程。本研究通过个例分析切入，探索高效精细的建模方法及其科学应用。

Advancing the halo model: Coupling the Einasto profile with the depletion radius

周义丰 上海交通大学

The halo model is a powerful tool for understanding the non-linear evolution of the Universe. Conventionally, a dark matter halo is defined as a virialized object according to the virial radius. However, this definition does not completely partition all mass into halos, as the halo is much more extended beyond the virial radius and grows continuously. Consequently, there is a well-known limitation of the classical halo model in the transition region between the halo edge and the large-scale environment (for about 0.1<k<1 hMpc^-1). A more accurate and explicit halo model requires a better understanding of the dark matter halo and its boundary.

In this talk, I will present an improved halo model that accounts for the unresolved mass component (arXiv: 2303.10886). Based on a new characterization of the halo boundary called depletion radius, we find the model ingredient (halo mass function, halo profile, and halo-halo correlation) can be expressed simply and naturally. I will also show how to solve for the matching halo profiles to completely decompose the matter field for any given halo catalogue (arXiv: 2407.08381). Our results show that the matching profile of the depletion-radius-based halo catalogue can be well described by the Einasto profile. Coupling the Einasto profile with the depletion-radius-based catalogue, our model accurately predicts the multiple statistics of the halo and matter field without any ad hoc fix. Finally, I will compare our model to other existing halo models, and highlight the advantages of our model in terms of clarity, interpretability, and versatility.

利用伽马暴高能光子的吸收测量河外背景光

张勇　四川大学

河外背景光（Extragalactic background light, EBL）由星光和尘埃反光组成，对高能伽马射线有强烈的吸收。通过伽马暴中高能光子的衰减测量了大红移时的 EBL 光深；基于贝叶斯统计方法，提高了较低红移时 EBL 光深的精度。

Probing the baryons in comic filaments with localized Fast Radio Bursts

莫俭锋 中山大学

百万类星体源表的构建及其应用

吴学兵 北京大学

将介绍我们基于光学和红外大型多色测光巡天数据和最新机器学习方法生成的 CatNorth 类星体候选源表，包括 150 多万个类星体候选体，并给出了其测光红移。经观测检验，其可靠性超过 80%，且测光红移精度比 Gaia 和 Quaia 两种类星体候选源表高出很多。这一百万类星体候选体源表将成为未来 LAOMST、CSST 等类星体光谱巡天的输入星表，并将应用于特殊类星体搜寻、宇宙学研究和天体测量参考架研究等课题。

The role of nuclear star cluster in SMBH accretion: the case of M31

李志远 南京大学

Evolution of the quasar population using SDSS and DESI

尹高成 北京大学

The observational test of AGN variability characteristic timescales

任国伟 厦门大学

The characteristic timescale at which the variability of active galactic nuclei (AGNs) turns from red noise to white noise can probe the accretion physics around supermassive black holes (SMBHs). A number of works have studied the characteristic timescale of quasars and obtained quite different scaling relations between the timescale and quasar physical properties. One possible reason for the discrepancies is that the characteristic timescale can be easily underestimated if the light curves are not long enough. In this work, we construct well-defined AGN samples to observationally test the relationships between the characteristic timescale and AGN properties obtained by previous works. Our samples eliminate the effects of insufficient light-curve lengths. We confirm that the timescale predictions (Zhou et al. 2024) of the Corona Heated Accretion disk Reprocessing model are consistent with our timescale measurements. The timescale predictions by empirically relations (Kelly et al. 2009) are systematically smaller than our measured ones. Our results provide further evidence that AGN variability is driven by thermal fluctuations in SMBH accretion disks. Future flagship time-domain surveys can critically test our conclusions and reveal the physical nature of AGN variability.

恒星与黑洞吸积盘相互作用：银心恒星轨道分布

范霄　　武汉大学

双活动星系核的 VLBI 观测研究

许万成 中国科学院新疆天文台

双活动星系核（dual-AGN）是星系并合的重要阶段，研究它们的辐射性质有助于理解星系和黑洞的演化。我们利用甚长基线干涉阵（VLBA）在多相位中心和相位参考模式下观测了四个位于 Stripe 82 天区的已证认的双 AGN，旨在研究其毫弧秒尺度的射电辐射性质。我们探测到两个 pc 尺度的射电核，分别对应于 J0051+0020B 和 J2300-0005A，其射电辐射性质与一般的喷流主导的 AGN 类

似；其余六个成分在高分辨率射电成像中被完全分解。对目标源的多波段分析表明在双 AGN 中可能存在系统性的 X 射线缺陷，由于样本数量较小，这些结论仍有待验证。为了进一步扩大双 AGN 的研究样本，我们提出了对基于天体测量和 JWST 深度成像筛选出的高红移双 AGN 候选体开展射电干涉证认的观测申请，这些观测的结果将有助于揭示宇宙早期并合系统中 AGN 的辐射性质。

双黑洞系统进动与高阶模式对引力波暗汽笛信号的影响

恽倩芸 中国科学院杭州高等研究院

双黑洞并合产生的引力波信号可以作为标准汽笛用于宇宙学常数的推断。然而，由于双黑洞轨道角动量与观测者视线夹角与光度距离之间的简并关系，限制了光度距离的精确测量。我们研究了双黑洞系统的进动和高阶模式对第三代引力波探测器距离估计的影响。研究结果表明，考虑进动和高阶模式均能显著提高光度距离的推断精度，较无进动和单一模式的情况分别提升了一个数量级。更准确的距离测量有助于加强对宿主星系的约束，从而提高哈勃常数的测量精度。这些结果表明，进动和高阶模式对第三代地面引力波探测器的距离估计具有重要影响，并为宇宙学研究提供了更精确的探测工具。改研究的相关论文已发表，doi = "10.1093/mnrasl/slad119" ； https://doi.org/10.1093/mnras/stae1730。

Changing-look Active Galactic Nuclei in the Dark Energy Spectroscopic Instrument

郭威坚 中国科学技术大学

Changing-look active galactic nuclei (AGN), which transition between quasar-like and quiescent states, have become a critical focus in astrophysical research. The Dark Energy Spectroscopic Instrument (DESI) offers an unprecedented opportunity to detect and study these phenomena on a large scale. Utilizing DESI's high-precision spectroscopic data, we have recently identified and analyzed several hundred changing-look AGNs, offering new insights into their frequency, underlying mechanisms, and connections to their host galaxy environments. I will present the latest findings from DESI on changing-look AGN and outlines the ongoing follow-up research plans aimed at further understanding these dynamic processes and their broader implications for AGN evolution.

黑洞准周期震荡与参数限制

郭明宇 上海工程技术大学

准周期震荡简称 QPO，是来自微类星体吸积盘的噪声连续 X 射线数据进行傅里叶分析发现的功率谱中的天体物理现象。首次在低质量 x 射线双星(LMXB)系统的 x 射线通量功率谱分析中被发现,中子星和恒星质量黑洞的 X 射线功率谱中能观测到有一定宽度的频率峰，这接近于黑洞最内稳定圆轨道的频率。

QPO 的频率与测试粒子的特征轨道频率直接相关，而特征轨道频率仅由背景度规确定，与吸积的复杂天体物理过程无关。因此，黑洞周围带电测试粒子的动力学可以基于它们在径向和角方向上的(准)谐波振荡来解释 QPOs 的存在。且有人提出，QPO 与恒星的表面磁场及其自转周期密切相关。

最近，通过观测可以得到一些星体的 QPO 数据，它们很好地符合相对论进动模型，QPOs 可能会成为探测候选黑洞周围时空几何的一个非常强大的工具。我们以一个特殊的磁化黑洞为模型，根据几个星体的赤道圆轨道的轨道频率、径向周转频率和垂直周转频率，建立以轨道半径 r、黑洞质量 M、黑洞自旋参数 a 和参数 g 为变量的卡方分布，使用马尔可夫链蒙特卡罗法寻找最小值点附近的几个变量的取值范围从而对参数进行限制。

Dissecting the Baryon Cycle and ISM Properties with JWST NIRISS and NIRSpec Spectroscopy

王鑫 University of Chinese Academy of Science

Using state-of-the-art reduction methods, we analyze the new JWST data acquired by the NIRISS wide-field slitless spectroscopy (WFSS) and NIRSpec multi-object spectroscopy (MOS). The cross calibration of these two complementary modes opens up key window on unbiased investigation of star formation, feedback, and ISM properties in and beyond the cosmic noon epoch. We bring forth the first spatially resolved analysis of high-redshift galaxies with JWST WFSS and measure the first gas-phase metallicity radial gradient with sub-kpc resolution at $z\geq3$. Using the NIRSpec MOS in high-resolution gratings, we compile a large sample of 35 galaxies at z~1-9 whose [O II]λλ3726,3729 and [S II]λλ6718,6732 line doublets are well resolved to shed light upon their ISM electron density and ionization properties. The exquisite sensitivity and wavelength coverage of the NIRSpec MOS in prism mode gives us an excellent chance to identify unique spectral features in galaxies in the epoch of reionization. We discover one of the highest redshift galaxies, spectroscopically confirmed at z=8.16, with PopIII-like stellar populations. This galaxy candidate hosting the first generation stars opens up new key frontiers on galaxy evolution and stellar physics in the early Universe.

On the Biases and Uncertainties in Quantifying Galaxy Morphology using JWST Observations

余思悦 The Kavli Institute for the Physics and Mathematics of the Universe

Observations of high-redshift galaxies with unprecedented detail have now been rendered possible with the James Webb Space Telescope (JWST). However, accurately quantifying their morphology remains uncertain due to potential biases and uncertainties caused by observational effects. To address this issue, I used a sample of 1816 nearby DESI galaxies to compute artificial JWST NIRCam images of galaxies at high redshifts. I analyzed the effects of cosmological redshift on the measurements of size, Asymmetry, Concentration, axis ratio, Sersic index, and bar properties. Our results show that galaxy size calculated using non-parametric methods, are slightly overestimated due to PSF smoothing, while those obtained through fitting a Sersic model does not exhibit significant biases. By incorporating a more accurate noise effect removal procedure, we improve the computation of Asymmetry over existing methods. Due to PSF Asymmetry, there is a minor overestimation of Asymmetry for intrinsically symmetric galaxies. However, for intrinsically asymmetric galaxies, PSF smoothing dominates and results in an underestimation of Asymmetry. Moreover, PSF smoothing also leads to an underestimation of Concentration. We developed functions for correcting these biases and the associated statistical uncertainties. Our correction functions can be applied to other surveys, offering valuable tools for future studies.
I also analyzed a set of simulated JWST images and took into account observational effects and plausible galaxy (and bar-size) evolution models. I show that a significant (and misleading) reduction in the detected bar fraction with increasing redshift would apparently result even if the true bar fraction remained constant. Our results underscore the importance of disentangling the true bar fraction evolution from resolution effects and bar size growth.

FEASTS: Mapping of the Circumgalactic Medium in H I Emission in Seven Edge-on Galaxies

杨冬 北京大学

Exploring the Relative Elemental Abundances in Different Regions of the Circumgalactic Medium: Insights from the DESI Spectroscopic Survey

陈泽宇**中国科学技术大学**

The metal abundance and its evolution are studied for quasar absorption line systems from their weak, unsaturated spectral lines using stacked spectra from the archived data of DESI. We associate these systems with the CGM of foreground galaxies to obtain the metal abundance at different locations within the CGM of a specific type of

galaxy. We measure a weak but statistically significant equivalent width (including Lyα, Si II, C IV, Al II, Al III, Fe II, and Mg II) and attempt to relate the equivalent width of the absorption line to the elemental abundance by using Voigt profile analysis and Photoionization models.

A statistical survey on star forming driven galactic outflow

于浩然 中国科学技术大学

Galactic winds are thought to be crucial in establishing galaxy evolution models. Based on DESI EDR data, we employed spectra stacking analysis on a sample of over 260000 emission line galaxies and studied the correlations between outflow properties (mass outflow rate, mass loading factor) and host galaxy properties (stellar mass, star formation rate and galaxy size). We find that star formation rate tightly correlates with outflow properties, which is in support of a star formation driven origin of galactic outflows. We propose a simple model with a star forming disk of finite size and two expanding sheets of outflowing material, in order to properly account for the effect of different galaxy size in determining outflow rates. We further discovered that the mass loading factor well correlates with gravity potential, which could reveal the nature of galaxy mass loading.

Metal enrichment and its complex environment

邹思蔚 国家天文台

I will introduce the metal enrichment and its connection to the complex environments revealed by JWST, MUSE, and ALMA. From multi-wavelength observations, we find that heavy metals reside in overdense regions from cosmic noon to the reionization epoch. In particular, the cold and neutral gas is kinematically disturbed with the surrounding optically thin gas in and around galaxies. The inclination and morphology of galaxies are also tentatively key factors influencing the metal distribution in the circumgalactic medium. We need mall-scale, fine-tuned simulations and models to interpret these relevant observations.

Discovery of local analogs to JWST's Little Red Dots

林如秋 中国科学院上海天文台

低红移致密强发射线星系，也就是绿豌豆星系，普遍具有质量低、金属丰度低、恒星形成活跃等性质，通常被认为是高红移恒星形成星系的类似体；是研究

矮星系中星爆活动的最佳实验室，也有助于加深对高红移恒星形成星系的认识。基于 LAMOST 绿豌豆星系证认项目以及 SDSS 巡天补充样本，我们获得了最大的有光谱证认的绿豌豆星系样本。我们通过对发射线轮廓的拟合分析，搜寻特殊样本，包括双活动星系核候选源和大质量黑洞候选源。这些特殊样本能够加深我们对活动星系核并合、大质量黑洞与致密矮星系共同演化等科学课题的认识。（论文：2023MNRAS.524.2224L、2024SCPMA..6709811L）

Six spiral galaxies lacking dark matter

陈振予 中央大学

Dark matter is believed to be the essential building blocks of galaxy formation. While instances of galaxies lacking dark matter have been observed, these occurrences are typically linked to specific formation mechanisms, making them stand out as unique cases. In spiral galaxies, the presence of flat rotation curves is a common observation, indicating the need for dark matter to support these
dynamics. However, the galaxies displaying minimal or no dark matter are likely not exceptional cases. We report several spiral galaxies where the flat rotation areas exhibit an average dynamical to baryonic mass ratio value of 1.09 . The low dynamical to baryonic mass ratios indicate that the kinematics of these galaxies can be supported by their baryonic mass only. The existence of spiral galaxies devoid of dark matter suggests that, in specific scenarios, the influence of dark matter on galaxy formation may not be as universally essential as previously believed.

莱曼连续谱星系中的吸收

符晓丹 中国科学院上海天文台

宇宙的再电离一直是人们非常感兴趣的话题，而莱曼连续谱星系作为宇宙再电离过程可能的驱动者，可以为其提供所需的能量。我们从莱曼连续谱星系的吸收线出发，探究了其吸收线中的外流性质，通过分析其吸收体的形态分布，来探究其中的莱曼连续谱光子的逃逸过程。

Combining Deep Images with Spatially Resolved Spectra to Uncover the Assembly of Stellar Halo in Massive Galaxies

张筱雅 Department of Astronomy， Tsinghua University

The two-stage formation scenario provides a simple yet insightful picture of today's

massive galaxies. In this picture, the assembly of the hosting dark matter halos drove the growth of the massive galaxies and created a complex history of mergers that accumulated their extended stellar halos. Recent work suggests that, at similar stellar masses, there is an intriguing connection between the stellar mass distributions of low-redshift massive galaxies' outer envelope and their dark matter halos. This result reflects the complex entanglement of the dark & bright sides of massive galaxies that could leave evidence in the stellar population properties of their stellar halos. In this work, we utilize the deep optical images from the LegacySurvey and the spatially resolved spectroscopic data from the MaNGA survey to search for such evidence. In a representative sample of massive galaxies (M* > 10^11.2 Msun) at z<0.05, we investigate the radial trends of stellar metallicity & alpha-elements abundance out to 1.5 Re in sub-samples with different shapes of stellar halo profiles out to 50 kpc. With the help of the empirical spectral indices for key absorption features and the full-spectrum fitting method, we recover subtle yet interesting relations between the assembly of the stellar halo and its chemical compositions & star-formation efficiency. While the depth of the images and the radial coverage & sensitivity of the IFU data restrict us from exploring further away, our work is a proof-of-concept that demonstrates the potential of combining deep images and state-of-the-art IFU data

基础司天巡天的 AGN 光变研究

胡绍明 山东大学

星系中心黑洞质量是其重要的物理参数，中心黑洞质量的测量具有重要科学意义。几台司天原型机将很快安装调试后逐步进入观测，巡天将有大量多波段时域测光数据产生。利用司天测光的多波段测光数据，采用宽波段测光反响映射方法、光变的功率谱方法可以测量其中中心黑洞质量。同时结合 X、Gamma 多波段观测数据，可对 AGN 的多波段光变开展深入研究。

Inferring the ex-situ Stellar Fraction of Galaxies from Photometric Observations: Importance of the inner and outer Stellar Halo

蔡润生 中国科学院上海天文台

Galaxy structures are expected to provide valuable insight into its merger history. In this paper, we search for the best parameters defined from photometric images to quantify the ex-situ stellar mass fraction of galaxies.

We created mock SDSS-like and HSC-like images using galaxies in the cosmological hydrodynamical simulations Illustris TNG100 and EAGLE at redshift z=0. All galaxies are projected as edge-on, and we define a series of parameters

describing their structures, including: the absolute magnitude in r and g bands (M_r, M_g), the half-light and 90%-light radius (r50, r90), the concentration (C), the luminosity fractions of inner and outer halos (finnerhalo, fouterhalo) and the single-aperture velocity dispersion sigma and Kurtosis from Gaussian-Hermit fitting (h_4).

In particular, the inner and outer halo of a galaxy are defined by sectors ranging from 45-135 degrees from the disk major axis, and with radii ranging from 3.5-10 kpc and 10-30 kpc, respectively; avoiding the contamination of disk and bugle.

We find that finnerhalo and fouterhalo are strongly correlated with the ex situ stellar mass fraction (fexsitu), the correlations are almost identical in TNG100 and EAGLE. Furthermore, we utilize the Random Forest method to create a model that predicts fexsitu by including all morphological parameters, the model predicts fexsitu well with a scatter smaller than 0.1 compared to the ground truth in all mass ranges, and the model can be transferred between TNG100 and EAGLE. The analysis using Random Forest reveals that finnerhalo and fouterhalo are the two most influential parameters in prediction of fexsitu, underscoring their significance in uncovering the merging history of galaxies. We further analysed how the quality of images will affect the results by using SDSS-like and HSC-like images for galaxies at different distances. Our results can be used to indicate ex-situ stellar mass fractions for large sample of galaxies from photometric surveys.

利用积分场光谱研究冲压剥离星系的气体运动学特性

罗荣欣 贵州师范大学

冲压剥离（Ram Pressure Stripping）被认为是高密度环境下影响星系演化的重要机制，特别在近邻的大质量星系团中发挥着关键作用。同时，那些被剥离出星系的气体会与周围的星系团内介质相互混合，这为研究多相气体介质的能量平衡和传递提供了重要实验室。近期我们利用 MUSE 积分场光谱数据研究了星系 ESO 137-001 中电离气体的运动学特性。我们的观测完整地覆盖了该系统中的星系区域和被剥离的延展气体，发现其中存在着速度梯度的递减和速度弥散的递增，表明这些气体在远离星系的过程中湍流度不断增加。结合 ALMA 数据，我们还比较了被剥离气体中分子气体和电离气体的速度与速度弥散，发现两种成分在运动学特性上的存在着一定的联系。我们的研究为冲压剥离星系的数值模拟提供了重要的观测依据，同时也证明了宽场积分场光谱在探测被剥离气体运动学特性方面的巨大潜力。

Dynamics of nuclear and globular clusters, black holes, gravitational waves

Rainer Spurzem　中国科学院国家天文台

Nuclear and globular star clusters (NSC and GC) are spectacular self-gravitating stellar systems in our Galaxy and across the Universe - in many respects. The evolution of star clusters is not only governed by the aging of their stellar populations and simple Newtonian dynamics. For increasing particle number, unique gravitational effects of collisional many-body systems begin to dominate the early cluster evolution. For example we find that intermediate mass black holes form in initially dense clusters, through mergers of massive stars, binary induced interactions with black holes, and several generations of relativistic black hole coalescences. GC models of the DRAGON and DRAGON-II simulations provide reasonable predictions e.g. on rates of coalescences observable with current gravitational wave instruments.

Formation of dense filaments induced by runaway supermassive black holes

Go Ogiya　浙江大学

A narrow linear object extending ~60 kpc from the centre of a galaxy at redshift z ~ 1 has recently been discovered and interpreted as shocked gas filament forming stars. The host galaxy presents an irregular morphology, implying recent merger events. Supposing that each of the progenitor galaxies has a central supermassive black hole (SMBH) and the SMBHs are accumulated at the centre of the merger remnant, a fraction of them can be ejected from the galaxy with a high velocity due to interactions between SMBHs. When such a runaway SMBH (RSMBH) passes through the circumgalactic medium (CGM), converging flows are induced along the RSMBH path, and star formation could eventually be ignited. We show that the CGM temperature prior to the RSMBH perturbation should be below the peak temperature in the cooling function to trigger filament formation. While the gas is temporarily heated due to compression, the cooling efficiency increases, and gas accumulation becomes allowed along the path. When the CGM density is sufficiently high, the gas can cool down and develop a dense filament by z = 1. The mass and velocity of the RSMBH determine the scale of filament formation. Hydrodynamical simulations validate the analytical expectations. Therefore, we conclude that the perturbation by RSMBHs is a viable channel to form the observed linear object. Using the analytical model validated by simulations, we show that the CGM around the linear object to be warm and dense.

大质量星系晕中光致电离冷气体的演化

徐迎中 浙江大学

The mass and redshift dependence of halo star clustering

谭镇林 上海交通大学

We adopt the two point correlation function (2PCF) as a statistical tool to quantify the spatial clustering of halo stars, for galaxy systems spanning a wide range in host halo virial mass ($11.25<\log_{10}M_{200c}/\msun<15$) and redshifts ($0<z<1.5$) from the IllustrisTNG suites of simulations. Consistent with a previous study \cite[][Paper I]{2024ApJ...961..223Z}, we identify clear correlations between the strength of the 2PCF signals and galaxy formation redshifts, but over a much wider mass range. We find that such correlations are slightly stronger at higher redshifts, and get weakened with the increase of host halo mass. The spatial clustering of halo stars is affected by two factors: 1) the clustering gets gradually weakened as time passes; 2) newly accreted stars at more recent times would increase the clustering. For more massive galaxy systems, despite the fact that they assemble late, the accreted stars are stripped and disrupted more efficiently due to the stronger tidal effects and the more radial infalling of surrounding satellite galaxies, which contributes to the formation of accreted halo stars. This results in a stronger effect of factor 1) than 2), hence explaining the weaker correlations between the 2PCF signals and the galaxy formation redshifts, as halo stars in more massive systems lose their initial clustering more efficiently.

Mock Observation: Morphological investigation of galaxies in the IllustrisTNG simulation

龚俊宇 中山大学

Galaxy Quenching From the High Redshift to Local Universe

谢利智 天津师范大学

Challenges in Cosmological Simulations: Unraveling the

Black Hole, Star Formation, and Dark Matter Connection in Nearby Galaxies

Hassen Yesuf 上海天文台

Environmental factors and supermassive black hole (SMBH) feedback are key drivers of galaxy evolution. In this presentation, I will provide a detailed comparative analysis of observed and simulated galaxies, focusing on stellar mass, star formation rate, halo mass, multiscale environments, and SMBH properties. This study draws on multiwavelength data from nearby galaxies in the SDSS and GAMA surveys. I will present new measurements and highlight significant results, particularly addressing discrepancies between approximately 40,000 nearby active galactic nuclei (AGNs: Seyferts and quasars) identified in Sloan data and their counterparts in the TNG, EAGLE, and SIMBA cosmological simulations. Although both simulations and observations qualitatively suggest that strongly accreting SMBHs are prevalent in gas-rich, star-forming galaxies within low-density environments, we find substantial quantitative differences. These include variations in the distribution (number density) of stellar mass, star formation rates, black hole masses, and accretion luminosities. Additionally, simulations consistently overpredict the quenched fraction by more than 30% in low-mass galaxies within high-density environments or massive halos, while offering inconsistent predictions for high-stellar-mass galaxies. These findings provide valuable insights for improving future models of galaxy evolution.

NIHAO-RiNG: A Comparison of Simulated Disc Galaxies from GASOLINE and GIZMO

陈厚尊 浙江大学

We utilize the public GIZMO code to re-simulate 12 galaxies selected from the NIHAO simulation suite which were run with the GASOLINE code, then compare their properties. We find that while both codes with the same initial conditions and large-scale environments can successfully produce similar galactic discs in Milky Way-mass systems, yet significant differences are still seen in many aspects, particularly the circum-galactic medium (CGM) environment they reside in. Specifically, the thermal feedback recipe used in GASOLINE results in ubiquitous long-term large-scale outflows, primarily driven by high-density hot inter-stellar medium (ISM) from the galaxy center, preventing the inter-galactic medium (IGM) from falling efficiently. Recycled gas and inflows in CGM appear at 10^4~10^5 K, playing a crucial role in the formation of cold discs in the NIHAO simulations. In contrast, disc galaxies simulated by GIZMO do not exhibit prominent outflows at low redshifts, but instead display quasi-virialized hot gas halos that arise from the interaction between inflows and feedback-driven outflows. Therefore, the origins of mass and angular momentum of the cold disc in the two simulations are quite

different, even though the final morphology of corresponding galaxies is similar at z~0. The differences in the distribution of CGM gas are mainly due to different feedback models implemented in the two codes, future observations of CGM could provide valuable insight into the physics governing baryon cycle in galaxies.

Low-redshift Galaxy Quenching Process During Infall: Impact of Mass and Environment

窦浩然 北京师范大学

The quenching of star formation is an important aspect of galaxy evolution.
We investigate the evolution, particularly the quenching process, of galaxies in regular clusters at low redshift, based on the SDSS DR18 data.
To investigate the effects of the environment on the quenching process, we employ the Blooming Tree Algorithm to identify substructures in the field of clusters, and distinguish galaxies belonging to clusters and groups from isolated ones.
Instead of radial projection distances, we adopt the phase space distance, Δd, in the $R-v$ diagram to quantify the infall extent and trace the quenching process.
We find a general trend that galaxies being gradually quenched as they infall into clusters.
This trend is also influenced by stellar mass and environment, with more massive galaxies and cluster galaxies containing less star forming galaxies than low-mass galaxies and group/field galaxies, respectively.
We also consider the morphological transformation, which is found to occur prior to quenching during the infall process.

Galactic wind in M82 revisted I: simulating the recent starburt and the launch of outflow

汪天睿 中山大学

Stellar feedback in the starburst dwarf galaxy plays a key role in driving turbulence, launching galactic wind, and, on a larger scale, manipulating dwarf galaxy formation. Developing a more accurate, next-generation cosmological simulation requires a better understanding of feedback of dwarf galaxies. Most modern-day cosmological numerical simulations like the Illustris TNG project still use empirical feedback models. In this work, we revisit the starburst and the launch of galactic outflow in M82 by performing high-resolution hydrodynamics simulation to the starburst area with Athena++. The M82 cigar galaxy is a nearby starburst dwarf galaxy with most of its properties (i.e. star formation history, outflow velocity, spectrum of multiple bands and different positions) well constrained by observations. Having experienced its most recent starburst event just a few million years ago, the M82 galaxy serves as an

excellent testbed and calibration source for stellar feedback models, as well as for dwarf galaxy feedback models under extreme conditions. We present the detailed implementation and discuss the effect of our star formation recipe, together with several renewed feedback processes including a self-shielding radiation cooling and heating scheme, a variable stellar wind and a supernovae model. By comparing our results to observation data, we find that our simulation can reproduce a starburst event similar to the one observed and launch a significant outflow with key observables that are comparable to observations. We found supernovae feedback to be the key driving process to the launch of galactic winds. Additionally, though incapable of driving a significant outflow, radiation pressure, photoelectric heating, and stellar wind together play an important role in manipulating star formation.

Nucleus and Star Formation Activities in Nearby Galaxies: Roles of Gas Supply and AGN feedback

Le Nguyen Huynh Anh 中国科学技术大学

We analyzed a large sample of ~112,000 galaxies ($z < 0.3$), divided into star-forming (SF), composite, Seyfert, and LINER types, to explore the relationships between UV-to-optical colors (u-r), star formation rates (SFRs), specific star formation rates (sSFRs) and Eddington ratios. Our findings show that SF galaxies predominantly feature young, blue stars along the main-sequence (MS) line, while composite, Seyfert, and LINER galaxies deviate from this line, displaying progressively older stellar populations and lower SFRs. Eddington ratios are highest in Seyfert galaxies, moderate in composite galaxies, and lowest in LINERs, with higher ratios associated with bluer colors, indicating a younger stellar population and stronger Active Galactic Nucleus (AGN) activity. These trends suggest a strong correlation between sSFRs and Eddington ratios, highlighting a close connection between AGN and star formation activities. The data may imply an evolutionary sequence where galaxies transition from blue SF galaxies to red LINERs, passing through composite and Seyfert phases, driven primarily by gas supply, with AGN feedback playing a secondary role. Additionally, while both radio luminosity (L_{1.4GHz}) and Eddington ratios correlate with SFRs, their trends differ on the SFRs and stellar mass (M_{*}) plane, with radio luminosity increasing with stellar mass along the MS line, and no direct connection between radio luminosity and Eddington ratios. These findings may provide new insights into the interplay between star formation, AGN activity, and radio emissions in galaxies, shedding light on their evolutionary pathways.

运动学小尺度涨落随星系面密度变化的研究

钟泽昊 中国科学院大学天文与空间科学学院

星系动力学质量的测量，对了解星系的物质分布，衡量星系中的暗物质含量都具有非常重要的意义。通常利用星系动力学模型拟合星系内气体或恒星的运动可以测量星系的动力学质量，而当前的主流星系动力学模型都具有一定的对称性假设，相应从模型得到的二维投影恒星运动学都是中心对称的。观测表明，大质量星系的恒星运动学对称性相对较好，因此动力学模型的拟合结果一般都很好；然而低质量星系的恒星运动学通常包含大量的小尺度块状结构，导致其恒星运动速度场既不平滑也远远偏离对称，我们称之为运动学小尺度涨落。在观测上，运动学涨落很容易被误认为是测量不确定性导致的，目前没有被很好地研究过。另一方面，运动学涨落的存在导致从任意主流动力学模型得到的恒星运动都无法匹配低质量星系的观测值，因此对低质量星系来说，需要研究对称性模型是否会引入动力学质量测量的偏差。

针对以上两个问题我们进行了相应研究。我们用 180°旋转自减法定义了不对称参数 η 来定量描述运动学涨落。我们详细讨论了观测不确定性带来的影响，计算了 SAMI 巡天星系样本和 TNG 数值模拟伪巡天中星系的不对称参数并进行比较，结果表明观测与数值模拟符合地很好，这证明除开观测不确定性，运动学小尺度涨落是真实存在的。我们首次发现运动学涨落程度和恒星质量面密度具有非常好的逆对数线性关系。我们的样本星系不处于相互作用或并合阶段，表明星系的恒星运动具有固有的小尺度不对称，其程度与星系本身的性质密切相关，不受外部环境影响。

我们也研究了运动学涨落对星系质量测量的影响。我们用 TNG 数值模拟建立了一个已知总质量的伪巡天星系大样本，结合标量位力定理拟合相应的位力质量估算公式。我们发现在对称性假设下，距离样本伪星系中心三维有效半径内动力学质量的总体平均估算精度约为 0.1 dex。我们研究了样本伪星系位力质量估算的局部偏差，发现不同涨落分组之间最大的局部偏差约为 0.16 dex，我们认为这来源于不同种类星系之间的最大系统差。我们发现正确地考虑局部偏差之后，涨落程度与内禀质量估算偏差之间没有明显相关性。这表明即使对于低质量星系来说，运动学小尺度涨落也不影响其动力学质量的测量。

利用深度学习与数据声音化进行星系形态分类与并合特征识别

曹晨 山东大学

利用深度学习方法对 Galaxy Zoo 2 星系样本进行了自动形态分类研究，侧重于并合星系分类及星系的并合特征识别；同时，尝试利用数据声音化方法对近邻主并合相互作用星系对样本 H-KPAIRs 进行了声音转化和声音形态分类，比较了其与传统目视分类结果。以上研究可为我国 CSST 望远镜星系研究和星系公众科学研究等积累经验资料。

基于深度学习的星系团成员星系识别与质量估算

王子成 上海师范大学

We developed a Long Short-Term Memory (LSTM)-based network for identifying members of galaxy clusters within a fixed $4h^{-1}\text{Mpc}$ field of view from the center, utilizing the phase distribution of galaxies' line-of-sight velocities, projected radii, and rest-frame magnitudes. The LSTM network accurately calibrates membership probabilities; by setting a threshold of 0.5, nearly 68\% of clusters achieve a high completeness (f_m) of 1.0 within r_{200}. The variability in predicted membership probabilities also reflects the structural profiles of the clusters. Subsequently, we employ Bayesian Neural Networks (BNNs) to estimate the mass of these clusters and to quantify uncertainties. Our results demonstrate that incorporating both magnitude or the LSTM-predicted membership probability as input features significantly enhances the BNNs' predictive performance, reduce the logarithmic residual scatter from 0.157 dex to 0.122 dex and 0.129 dex respectively, and achieving better convergence. The networks were trained and evaluated using semi-analytic galaxy catalogs derived from the JiuTian-1G simulation. Moreover, in applying the networks to observations, we find that miscentering and incomplete galaxy information within r_{200} notably impact the accuracy of the BNN predictions.

How Long Will the Quasar UV/Optical Flickering Be Damped?

周淑英 厦门大学

Supernova Remnants in Star-Forming Galaxies

区子维 上海交通大学

Extragalactic radio continuum surveys: the impact on studying galaxy formation and evolution

安芳霞 紫金山天文台

In recent years, the high-sensitivity and wide-field extragalactic radio continuum surveys were conducted using the most powerful radio interferometric facilities, including the Karl ,G. ,Jansky Very Large Array (VLA), the Low Frequency Array (LOFAR), Giant Metrewave Radio Telescope (GMRT), Murchison Widefield Array (MWA), Australian Square Kilometre Array (SKA) Pathfinder (ASKAP), MeerKAT (SKA precursor at South Africa), etc., have provided us with unprecedented insights in a wide range of astronomical fields, including the formation and evolution of galaxies. In this talk, I will introduce some very successful extragalactic radio continuum surveys and our recently completed projects on studying the radio spectral properties of star-forming galaxies based on these surveys. I will also discuss how the high-quality radio surveys at both low and high frequencies from the SKA and its precursors will shed light on galaxy formation and evolution through the radio window.

Investigation of the variability of LRDs using JWST data

张子键 北京大学

James Webb Space Telescope (JWST) has revealed a population of compact and extremely red galaxies at $z \gtrsim 6$ known as ``Little Red Dots" (LRDs), which likely host active galactic nuclei (AGNs). We present a comprehensive analysis of the variability of a large sample of 314 LRDs with multi-epoch JWST/NIRCAM observations in five JWST deep fields, including UDS, GOODS-S, GOODS-N, Abell 2744, and COSMOS. Our analysis use all public available NIRCAM data in these five fields, and for the first time, incorporates multi-epoch JWST/MIRI data. With careful correction of systematic photometric offsets and calibration of photometric uncertainties, we evaluate the variability of LRD statistically. Our results indicate a general lack of significant variability among the LRDs, which holds even for LRDs that show broad Hα/Hβ emission line. These results challenge the assumption that most of these objects are AGNs. Nevertheless, we also find eight variable LRD candidates that show signal-to-noise ratio of larger than 3, with maximum
variability amplitudes of around 0.24--0.82 mag. We suggest that the rest-frame optical SED of these variable LRDs should have significant AGN contribution.

Magnetically arrested discs in FR I radio galaxies

何晗　　武汉大学

A sample of 17 Fanaroff–Riley type I (FR I) radio galaxies constructed from the 3CR catalogue, which is characterized by edge-darkened radio structures, is studied. The optical core luminosities derived from Hubble Space Telescope observation are used

to estimate the Eddington ratios which are found to be below 10−3.4 for this sample. This is supported by the BaldwinPhillips–Terlevich optical diagnostic diagrams derived with the spectroscopic observation of Telescopio Nazionale Galileo, suggesting that these sources are of low-ionization nuclear emission-line regions. It implies that the accretion in these FR I sources can be modelled as advection-dominated accretion flows (ADAFs). Given the low accretion rate, the predicted jet power with a fast-spinning black hole (BH) a = 0.95 in the Blandford–Znajek mechanics is lower than the estimated one for almost all the sources in our sample. Such powerful jets indicate the presence of magnetically arrested discs (MAD) in the inner region of the ADAF, in the sense that the magnetic fields in the inner accretion zone are strong. Moreover, we show that, even in the MAD scenario, the BH spins in the sample are most likely moderate and/or fast with a ≥ 0.5.

两个天文观测发现的重要意义

彭秋和 南京大学

银河系中心高速云的形成机制与反馈活动

张孟飞 浙江大学

银河系中心的高速气体（high-velocity clouds, HVCs）在多年前已被观测到，其成因可解释为银心超大质量黑洞或者星爆活动对原子气体的加速。然而最近观测到的高速分子气体（high-velocity molecular clouds ，HVMCs）更加致密，温度更低，很难在被加速到高银纬的同时依然保持自身的完整。其可能的形成机制，以及与银河系反馈过程的联系可以帮助理解银河系的演化过程。以星爆模型为基础的一系列磁流体模拟结果显示，中心分子区（central molecular zone ，CMZ）的连续超新星随机爆发可以将分子气体云不断加速到距离银盘 1 kpc 的高度，并且保持分子气体云不被完全破坏，这些 HVCs/HVMCs 的位置分布、视向速度分布、柱密度等都与观测相吻合。而且，这一过程产生的外流会不断注入更大尺度的结构，为诸如费米气泡、eROSITA 泡的存在维持提供能量，也表明恒星活动对银河系的反馈过程有着不可忽视忽视的影响。

Beaming effect in TeV Blazars

钱妍君 广州大学

Blazars, as the prominent sub-classes of active galactic nuclei (AGNs), are known for

emitting relativistic jets that are directed towards us. The multiwavelength emissions are expected to be dominated by their jets, thus showing a strong beaming effect. Up to now, 84 blazars have been identified as tera-electronvolts (TeV) emissions emitting sources. In this work, we study the beaming effect within these TeV blazars via emission-core-dominance parameters, Doppler factors, viewing angles between line-of-sight and jets, and other beaming indicators. These physical parameters not only facilitate our understanding of the beaming effect but also help us uncover the properties of TeV jets in blazars. Principally, we obtain the following conclusions:
(i) We compiled the core-dominance parameters in the radio, X-ray, GeV and TeV bands from our previous study, respectively. We find they are all tightly correlative, indicating that the multiwavelength emissions in TeV blazars are strongly beamed;
(ii) Adopting the correlation between the spectral indices (photon indices) and core-dominance parameters from the radio band to TeV emission, we find the total spectral indices are believed to be coming from two components, namely the core and extended ones, which demonstrating the emission-two-components model can be truly applied in the TeV blazars;
(iii) We estimate the Doppler boosting factors in X-ray, Gamma-ray and TeV emission in consideration of the bulk Lorentz factors within jets are identical in multiwavelength bands.

Plasma lensing interpretation of FRB 20201124A bursts at the end of September 2021

陈雪纯 北京师范大学

Investigating Primordial Black Holes as Dark Matter through X-ray and Soft Gamma-ray Emission

谭秀慧 中国科学院理论物理研究所

在小行星质量范围内，原始黑洞（PBHs）一直是暗物质的可信候选者。我们的研究包括通过比较分析宇宙 X 射线背景（CXB）及其霍金蒸发产生的辐射，重新评估对原始黑洞的限制。我们在对应的能量区间中发现了以前被忽视的辐射过程，包括霍金辐射的直接辐射、飞行中湮灭、辐射的最终状态以及正电子湮灭。我们对所有这些过程及其各自的辐射分支比都进行了详尽的考虑，然后精确计算了针对高纬度观测的 D 因子。此外，我们还整合了银河系外来源的通量，这两个来源都对测量到的各向同性通量都有贡献。通过对之前利用活动星系核双幂律模型进行的 CXB 观测数据对比分析的方法，我们为 PBHs 建立了最严格的限制结果，从而排除了 PBHs 在 2.5×10^17 - 3×10^17 克范围内构成整个暗物质质量的可能性。

Angular correlation and deformed Hellings-Downs curve from spin-2 ultralight dark matter

张云龙 中国科学院国家天文台

The pulsar timings are sensitive to both the nanohertz gravitational-wave background and the oscillation of ultralight dark matter. The Hellings-Downs angular correlation curve provides a criterion to search for stochastic gravitational-wave backgrounds at nanohertz via pulsar timing arrays. We study the angular correlation of the timing residuals induced by the spin-2 ultralight dark matter, which is different from the usual Hellings-Downs correlation. At a typical frequency, we show that the spin-2 ultralight dark matter can give rise to the deformation of the Hellings-Downs correlation curve induced by the stochastic gravitational wave background.[https://doi.org/10.1103/PhysRevD.110.044052]

Science Opportunities of Wet Extreme Mass-Ratio Inspirals

吕振伟 大连理工大学

In our previous work, we forecast that the formation of wet extreme mass ratio inspirals (EMRIs) assisted by the accretion flow around accreting galactic-center massive black holes (MBHs) will contribute a significant, possibly even dominant, fraction of all detectable EMRIs using spaceborne gravitational wave detectors. In this study, we explore various multi-messenger science opportunities that arise from detecting a population of these systems.

First Large Absorption Survey in HI (FLASH)巡天及最新进展

苏仁智 之江实验室

中性氢对星系的演化非常重要。它是恒星形成的最原始材料，也能充当超大质量黑洞与寄主星系共同演化的介质。所以对中性氢分布的探测及含量的测量能给星系及宇宙的演化提供至关重要的线索。First Large Absorption Survey in HI (FALSH)是利用平方公里阵探路者望远镜 ASKAP 进行中性氢吸收线巡天的项目。巡天的红移区间是 0.4 到 1.0。目前该巡天已经经历两次试巡天，正式的巡天正在开展中。在该报告里，我将介绍 FLASH 的基本情况，包括基本参数、科学目标等。另外，我将介绍 FLASH 目前已经取得的科学成就及最近进展。

极环星系的形成与演化机制

余捻坤 国家天文台

极环星系是由中央 S0 成分和垂直于 S0 成分的由气体、恒星和尘埃组成的外环组成，早期光学图像的证认显示有 0.5%的邻近 S0 星系有极环，而近期 WALLABY 的巡天数据显示近邻星系中可能 2%的星系具有延展的中性氢环状结构。我们利用 FAST 的高灵敏度观测进一步研究了极环星系的塔里费舍尔关系及其气体吸积过程，从而进一步研究极环星系的形成与演化机制。

Varstrometry 选的双超大质量黑洞候选体的射电观测研究

汪昊辰 中国科学技术大学天文学系

Dual super massive black holes at sub-kpc to kpc scales are the products of galaxy mergers and the progenitors of eventually coalescing binary SMBHs. Dual AGNs or off-nucleus AGNs may be witnessed if both or one of the dual SMBHs are accreting. Despite its rarity, such systems are essential for learning the dynamical evolution of binary SMBHs as well as the process of galaxy merging. Recently a novel and highly efficient astrometry-based method named varstrometry has been put forward to search for dual SMBHs at high redshift. This method shows that the unsynchronized flux variability of off-nucleus and dual AGNs will cause astrometric jitter detectable by Gaia without spatially resolving them. Based on varstrometry we select a rare sample of five high redshift radio quasars with clear Gaia astrometric jitters, and with e-MERLIN observations a single compact radio source is revealed for each of them. Clear Gaia-radio offsets of ~ 7 -- 40 mas are deteced in all but one targets. The observed Gaia jitters appear consistent with the expected values. These detected Gaia-radio offsets suggest these candidate dual SMBHs may have projected separations as small as ~ 0.01 - 0.1 arcsec (~ 0.1 kpc, depending on the optical flux ratio of two SMBHs). We will also report preliminary results from our new EVN observations which have even higher spatial resolution than e-MERLIN.

The Mass-Metallicity Relation in the Overdense Environments at Cosmic Noon

杨翼铭 国家天文台

We present a measurement of the mass-metallicity relation (MZR) in the overdense regions at cosmic noon. Using the MAMMOTH–Grism observations in the fields of three protoclus- ters: BOSS1244, BOSS1441 and BOSS1542, we secure a sample of

66 protocluster member galaxies at z = 2–3, showing strong nebular emission lines ([OIII], H?_beta?, and [OII]) in their G141 spectra. This allows us to derive their gas-phase metallicity and star formation rates from these spectra. We also perform SED fitting on these sources using broadband deep imaging from HST and ground-based telescopes to estimate their stellar masses. To minimize interference from factors other than stellar mass, we stack our sample spectra into five mass bins, allowing us to derive stacked gas-phase metallicities and star formation rates. We find the MZR in the overdense regions at cosmic noon has a slope of 0.143 ± 0.029, which is shallower than that of field galaxies. This shallower slope is most likely caused by cold-mode gas accretion and the efficient recycling of feedback-driven winds in overdense regions, consistent with the results of our previous work.

The ISM distribution, gas kinematics and system dynamics of the FIR luminous quasar SDSS J2310+1855 at z=6

邵亚莉 北京航空航天大学

Quasars are the most luminous non-transient sources in the epoch of reionization (z>~6) powered by accreting black holes. They are the most powerful tracer of the cosmic reionization in which the Universe is in a very extreme condition. These quasars provide a unique opportunity to study the key issues, for example, the typical ISM conditions in the quasar host galaxies, and the formation of the young luminous quasars and the evolving impact on their host galaxies, during the epoch at which the intergalactic medium was being reionized by the first luminous sources. However, most previous works are based on low-resolution and low sensitivity ISM observations. High resolution ALMA observations of the ISM in these quasar host galaxies at z~6 can provide important insight into issues, for example, the spacial distribution of different ISM tracers as well as the star formation activity, the gas kinematics and overall dynamics probed by bright ISM tracers in the SMBH-host system at the earliest epoch. In this talk, the speaker will introduce a case study toward the ISM of the FIR luminous quasar SDSS J2310+1855 at z = 6.0 with high resolution ALMA observations.

A recent rejuvenated star-forming galaxy with PAH detection in the Abell 2744 cluster

胡慧杰 UCAS

哈勃参量数据测量进展

焦康　郑州大学

Baryon Acoustic Oscillations Analyses with Density Split Statistics

许腾鹏 中国科学院国家天文台

Accurate modeling for the evolution of the Baryon Acoustic Oscillations (BAO) is essential for using it as a standard ruler to probe cosmology. We explore the non-linearity of the BAO in different environments using the density-split statistics and compare them to the case of the conventional two-point correlation function (2PCF). We detect density-dependent shifts for the position of the BAO with respect to its linear version using halos from N-body simulations. Around low/high-densities, the scale of the BAO expands/contracts due to non-linear peculiar velocities. As the simulation evolves from redshift 1 to 0, the difference in the magnitude of the shifts between high- and low-density regions increases from the sub-percent to the percent level. In contrast, the scale of the BAO does not evolve in the total 2PCF in the same redshift range. The width of the BAO around high density regions increases as the universe evolves, similar to the known broadening of the BAO in the 2PCF due to non-linear evolution. In contrast, the width is smaller and stable for low density regions. We discuss possible implications for the reconstructions of the BAO in light of our results.

Can early dark energy be probed by the high-redshift galaxy abundance?

刘威扬 中国科学院国家天文台

The analysis of the Cosmic Microwave Background (CMB) data acquired by the Atacama Cosmology Telescope (ACT) and the large-scale (l<=1300) Planck Telescope show a preference for the Early Dark Energy (EDE) theory, which was set to alleviate the Hubble tension of the Λ Cold Dark Matter (ΛCDM) model by decreasing the sound horizon r_s, and gives H_0~72 km s^-1 Mpc^-1. However, the EDE model is commonly questioned for exacerbating the σ_8 tension on top of the ΛCDM model, and its lack of preference from the late-time matter power spectrum observations, e.g., Baryon Oscillation Spectroscopic Survey (BOSS). In light of the current obscurities, we inspect if the high redshift galaxy abundance, i.e., Stellar Mass Function/Density (SMF/SMD) and Luminosity Function (LF), can independently probe the EDE model. Our result shows that, compared to ΛCDM, the EDE model

prediction at z>10 displays better consistency with the unexpectedly high results observed by the James Webb Space Telescope (JWST). At lower redshift, the EDE model only fits the most luminous/massive end, with the majority of the data presenting better consistency with ΛCDM, implying that adding an extra luminosity/mass-sensitive suppression mechanism of the galaxy formation is required for EDE to explain all data around z~7-10.

Near real-time gravitational wave data analysis of the massive black hole binary with TianQin

胡一鸣 中山大学

空间引力波探测器可以探测到大质量黑洞的并合。并合前引力波事件的预警和定位可用于预警电磁望远镜、并进行多信使观测。然而，这一能力依赖于实时的数据传输和分析能力。天琴作为地心轨道的空间引力波探测器，有能力实现实时数据传输。在本研究中，我们讨论了天琴在常规和实时数据传输模式下的大质量双黑洞的搜索和定位流程。研究表明，通过实时数据传输，我们可以在大质量双黑洞并合过程中将其精确定位。随着并合的临近，每次分析仅需 40 分钟即可完成。对于距离 1 Gpc 的系统，假设每小时接收一次数据，则可以在并合前的最后一天将其空间方位精确定位到 1 平方度以内。

Properties of classical bulge and pseudo-bulge galaxies at low- and mid-redshift

胡佳 中国科学院国家天文台

大部分盘星系中心均存在核球结构，它们聚集了星系大部分的光和恒星。根据性质不同，通常可以将核球分为像椭球星系一样弥散主导的经典核球，和像盘星系一样旋转主导并有很多子结构的伪核球。在低红移星系中，经典核球通常更红，恒星形成更缓慢，中心速度弥散更大。一般认为经典核球通过星系并合这样暴力的过程形成，而伪核球通过星系缓慢演化形成，但仍没有定论。

为进一步研究不同类型核球的形成与演化，我们分别对低红移和中红移的两类核球星系性质进行了详细地比较：

1. 基于 MaNGA 空间分辨数据，我们研究了近邻星系中不同类型核球性质，并发现，在固定星系质量时，经典核球比伪核球更年老，恒星形成更缓慢，旋转更慢，可能包含更少的 HI 气体。更重要的，我们发现两类核球星系盘之间在这些性质上的差异要比核球本身更大。这可能指向盘星系中核球和盘的协同演化。

2. 基于 CANDELS 数据，我们研究了中红移（0.5<z<1）星系中不同类型核球性质，发现，与低红移星系相同，中红移两类核球星系盘之间的差异也比核球之间的差异更大，再次证明了核球和盘可能存在协同演化。另外，与低红移星系相比，中红移两类核球之间的差异是更小的，这可能反映了两类核球是在演化过程中逐渐分化为两个极端的。

Kinematic morphology of low-mass galaxies in IllustrisTNG

曾广权 中国科学院国家天文台

用机器学习修正红移畸变效应

陈鸿翔 中国科学院国家天文台

metallicity gradient of galaxy pairs in JWST PASSAGE

李思佳

Reconstructing redshift distributions with photometric galaxy

彭辉 上海交通大学

The accurate determination of the true redshift distributions in tomographic bins is critical for cosmological constraints from photometric surveys. The proposed redshift self-calibration method, which utilizes the photometric galaxy clustering alone, is highly convenient and avoids the challenges from incomplete or unrepresentative spectroscopic samples in external calibration. However, the imperfection of the theoretical approximation on broad bins as well as the flaw of the algorithm in previous work risk the accuracy and application of the method. In this talk, we propose the improved self-calibration algorithm that incorporates novel update rules, which effectively accounts for heteroskedastic weights and noisy data with negative values. The improved algorithm greatly expands the application range of self-calibration method and accurately reconstructs the redshift distributions for various mock data. Using the luminous red galaxy (LRG) sample of the Dark Energy Spectroscopic Instrument (DESI) survey, we find that the reconstructed results are comparable to the state-of-the-art external calibration. This suggests the exciting prospect of using photometric galaxy clustering to reconstruct redshift distributions in the cosmological analysis of survey data.

TBD

陈钊　上海交通大学

Modeling the light curve of rebrightening tidal disruption event

钟诗言 云南大学

近年来，大规模巡天观测得到的大质量黑洞潮汐瓦解恒星事件（TDE）数量稳步增加。这些 TDE 大多表现为一过性的单次耀发，利用已有的光变曲线拟合软件，人们已经测量了一大批 TDE 的物理参数，特别是其宿主黑洞的质量。但是随着巡天数据的积累，一类具有特殊光变的 TDE 开始进入人们的视野：其在光度下降阶段会再次变亮产生第二个峰，两个峰之间的间隔仅几百天，且第二个峰既可能高于也可能低于第一个峰。文献里对此现象有多种解释，其中一种认为这是同一恒星经历了两次部分瓦解（partial TDE）。如果简单地把已有的拟合软件直接应用于此类光变曲线，会遇到以下问题：（1）需要分别拟合两个峰，且无法处理第一个峰的下降阶段对第二个峰的贡献；（2）恒星处在抛物线轨道上，即便它没有被完全摧毁也不会发生第二次 TDE。我们针对这两个问题进行改进，构建了新的光变曲线模型，并开发了相应的光变曲线拟合代码。该代码已应用于一批有再次变亮特征的 TDE。最后，我们会简单介绍该模型的其它应用。

TBD

孙磊　中国科学院大学

We present a new measurement of the rest-frame UV luminosity function (LF) at z < 1 to very low luminosities Muv < -13. We use deep near-UV F225W imaging from HST WFC3/UVIS of the Hubble Frontier Field survey Abell 2744 field. Combining deep UV imaging and high magnification from strong gravitational lensing of the foreground Abell 2744 cluster, we use photometric redshifts to identify ~ 200 faint galaxies with Muv < -13 AB mag at z < 1. We report the preliminary results on the best fit Schechter LF parameters. A possible turn over at the faint end of the UV LF at z < 1 is observed, through inclusion of a curvature paremeter.

类星体的形成及其本质特征

钟萃相

类星体的发现是 20 世纪 60 年代天文学四大发现之一。虽然类星体的发现大大促进了人们对宇宙演化的了解，但仍有许多问题让天文学家感到困惑不解：类星体是恒星还是星系？为什么类星体每秒钟释放的能量比体型大其几十万甚至千万倍的普通星系每秒钟释放的能量还大上千倍?为什么观察到的类星体都是遥远的星体？类星体的红移是否是哈勃红移？为什么有些蓝星体的光学性质和类星电波源相似，却没有辐射无线电波。这些问题长期困扰着人们，悬而未决，莫衷一是。幸而，作者近来研究和提出了星系的形成与演进新理论，可用来揭示类星体的形成与实质，很容易地解决上述问题。

利用统计方法推断引力波源的形成通道并促进对宇宙学的限制

朱良贵 北京大学

引力波探测可以直接推断引力波源的光度距离而不需要其他观测的校准，因此引力波被称为标准汽笛，有希望为澄清哈勃常数危机和探索暗能量的本质等重大问题提供独立的精确宇宙学测量。空间引力探测器对宇宙膨胀历史的探测能力预期主要由极端质量比旋进旋进(EMRI)和大质量双黑洞(MBHB)两类候选引力波源贡献，但目前我们对 EMRI 和 MBHB 的形成机制、形成环境和族群性质的认识都非常地不确定。在利用他们推断宇宙膨胀历史时，因为预期没有可观测的电磁对应体，庞大数量的候选宿主星系制约着 EMRI 和 MBHB 的潜力。一种可以有效提升他们对宇宙膨胀历史限制能力的方法是给候选宿主星系合理分配权重，但权重的分配依赖于引力波源和宿主星系的天体物理关联。本报告将介绍一种通过检验引力波源和特殊天体如 AGN 的相关关系的方法，并介绍统计检验这种引力波源-AGN 的相关关系对推断宇宙膨胀历史的促进作用。

Estimating Photometric Redshifts in Mid-Infrared Galaxies Using Local Templates: Insights into Dusty Star Formation from JWST

卢艳

本研究基于詹姆斯·韦伯太空望远镜（JWST）对 GOODS-South 天区的全波段观测数据，构建了一个基于 F1800W 流量选取的星系样本。研究首先使用从近邻星系真实观测数据插值得到的光谱能量分布（SED）模板，对星系的测光点进行拟合，以估计测光红移。拟合涵盖从 HST/F435W 到 MIRI/F2550W 的广泛波段，利用 JWST 覆盖的长波长范围，这些测光点能够详细描述星系不同成分的 SED

谱型，如 1.6um stellar bump 和恒星形成区 PAH 发射特征。通过使用卡方最小化方法选择最佳匹配模板，本研究对 F1800W 星系样本进行了分类，探讨了 F1800W 选的星系样本中不同类型星系的组成，并深入分析了各类型星系的 SED 特点。测光红移结果表明，对于恒星形成星系和宁静星系，我们获得了准确的测光红移，模板与星系测光数据的匹配非常成功，能够精确描绘出星系的 PAH 特征。然而，对于以 AGN 热尘埃辐射为主的 power-law 星系，测光红移的失败率较高。这一测光红移方法不仅验证并补充了传统侧重于光学 Balmer 断裂和 Lyman 断裂等特征的测光红移研究，同时也为利用近邻星系研究高红移星系的 SED 提供了新的机会。在样本中，我们还发现了一些与近邻星系谱型差异显著的极红星系，这将是 JWST 时代研究的热点之一。

Neutral Universe Machine: Predictions of HI gas in Different Theoretical Models

温凌坤 中国科学院上海天文台

This study investigates the characteristics of HI gas in different models, including hydrodynamical models (SIMBA, TNG100), a semi-analytical model (GAEA) and an empirical model (NUM). The main objective is to explore the factors that contribute to the disparities observed among these models. The analysis demonstrates that the HI mass functions (HIMF) are primarily influenced by central and star-forming galaxies in small halos ($M_{\rm vir} < 10^{12}\msun$). However, as the halo mass increases, the number of satellite galaxies increases significantly, resulting in them containing the majority of the HI mass in massive halos ($M_{\rm vir} > 10^{12}\msun$). This highlights the importance of considering satellite estimates for HI mass properties. Furthermore, the impact of AGN feedback on the distribution of HI mass is found to be substantial. The study also examines the evolution of HI and the galaxy/halo mass with redshifts and observes that each model performs differently at high redshifts, and we anticipate for future observational data that will provide further constraints.

Environmental Effects on Low Surface Brightness Galaxies in the IllustrisTNG Simulation

Luis Enrique Pérez Montaño 浙江大学

Understanding the nature of dark matter is possible due to its interconnectedness with galaxy’s structure and formation history. The variations in the size of galaxies, and consequently, the formation of Low Surface Brighntess Galaxies (LSBGs) could be followed from one of two different effects: variations in the spin parameter of the halo (λ) or variations in the density of dark matter halos (McGaugh 2021). We test both scenarios by employing a simulated sample of galaxies drawn from the TNG100 run of the IllustrisTNG project. We find no significant differences in the halo

concentration index between LSBGs and their High Surface Brightness (HSBGs) counterparts, with LSBGs residing in halos with higher λ than HSBGs, suggesting that variations in galaxy sizes are followed by the effect of variating λ, rather than the density of dark matter halos, specially at z~2. Extending our analysis to larger scales, we found that the relative abundance of LSBGs within groups and clusters displays a central deficit, hinting at potential destruction upon reaching these core regions. A detailed observation of the two-point correlation function ξ(r) shows a preference for rotation-dominated LSBGs to reside in low-density environments, while dispersion-dominated LSBGs thrive in high-density regions where galaxy interactions govern their evolution. Our examination of the cosmic web reveals no significant differences in the distance to the closest large-scale structure, barring a few exceptions suggesting a limited impact of large-scale spatial distribution on mechanisms driving LSBG evolution. All together, we conclude that the halo vicinity and local environment at the scale of galaxy clusters, where mechanisms such as galaxy mergers and tidal stripping, as well as stellar and gas accretion take place, is the most likely environment that favour the emergence of LSBGs with different morphologies, mostly driven by the presence or absence of important local interaction phenomena.

Measuring galaxy properties from SED fitting with a physical prior

高泽宇 北京大学

The spectral energy distribution (SED) of galaxies is essential for deriving fundamental properties like stellar mass and star formation history (SFH). However, conventional methods, including both parametric and non-parametric approaches, often fail to accurately recover the observed cosmic star formation rate (SFR) density due to oversimplified or unrealistic assumptions about SFH and their inability to account for the complex SFH variations across different galaxy populations. To address this issue, we introduce a novel approach that improves galaxy broad-band SED analysis by incorporating physical priors derived from hydrodynamical simulations. Tests using IllustrisTNG simulations demonstrate that our method can reliably determine galaxy physical properties from broad-band photometry, including stellar mass within 0.05 dex, current SFR within 0.3 dex, and fractional stellar formation time within 0.2 dex, with a negligible fraction of catastrophic failures. When applied to the SDSS main photometric galaxy sample with spectroscopic redshift, our estimates of stellar mass and SFR are consistent with the widely-used MPA-JHU and GSWLC catalogs. Notably, using the derived SFHs of individual SDSS galaxies, we estimate the cosmic SFR density and stellar mass density with remarkable consistency to direct observations up to $z \sim 6$. This marks the first time SFHs derived from SEDs can accurately match observations. Consequently, our method can reliably recover observed spectral indices such as $\rm D_{\rm n}(4000)$ and $\rm H\delta_{\rm A}$ by synthesizing the full spectra of galaxies

using the estimated SFHs and metal enrichment histories, relying solely on broad-band photometry as input. Furthermore, this method is extremely computationally efficient compared to conventional approaches.

Dark-halo and Environmental Conditions for Forming Thin Disks at High-z Universe

梁晋宁 北京大学

Big Bulgeless Disks (BBDs, also known as Super Spirals) are common in the nearby Universe but are believed to be rare for high redshift since modern theoretical pictures for high-z disk formation require a young stellar bulge to prelude and stablize disk formation, until recent JWST observations reveal their existence at an epoch as early as z~3. Their large sizes, extreme bulgeless morphology, formation mechanisms, and fates remain open questions. In this talk, I will present our new morphological decomposition method for identifying galaxies of particular morphological types in cosmological simulations. Our method incorporates and improves upon existing algorithms with a simple yet physical approach, which enables robust separation of thin and thick galactic discs without assuming constant but arbitrary circularity threshold. Next, I apply this new method to BBDs and explore their baryonic properties, halo conditions, assembly histories, and environments, comparing them to normal galaxies of similar mass. I will show their mock images and related measurements. The results reveals that BBDs are richer in cold gas, more metal-poor, clumpier, younger, and more actively star-forming. They are hosted by more virialized, cored-ish halos; experience fewer but gas-rich mergers; and tend to reside in knots or filaments, though with local densities slightly lower than those of the normal galaxies. Our method is public and highly modular, easily adaptable for analyzing any cosmological hydro simulations for detailed morphological and galaxy-halo analyses.

Testing the Line of Sight Effect in Strong Lensing Systems from N-body Simulation

蔺是杰 北京师范大学

Determine H0 cosmological-model-independently using Time-Delay Lensing

李晓雷 河北师范大学

Local perspective of Hubble tension

黄路　　中国科学院理论物理所

The recently found intercept aB tension of Supernovae (SNe) magnitude-redshift relation between local ($z < 0.0233$) and late-time ($z > 0.0233$) Universes hints for either the local-scale new physics or systematics. Classifying the PantheonPlus SNe scrupulously and comparing the aB of different SNe groups, we find the SNe in the third-rung distance ladder maintains a very stable aB over a wide redshift range $z \in [0.003, 2.3]$ while the Cepheid-hosted SNe in the second-rung ladder presents a significant aB deviation leading to the aB tension. We analyze the potential systematics and look into what enlightenment it will give to Hubble tension.

AGN outflows in the triple AGN candidate SDSS J0849+1114

许啸宇 南京大学

星系的并合会触发星系中的恒星形成与核活动。星系的核活动理论上可以产生显著的外流或者喷流，加热、破坏或者压缩星系中的气体，使星系的恒星形成活动被抑制或者增强。基于 VLT/MUSE 的数据，我们在一个三重 AGN 的候选体 SDSS J0849+1114 中，发现了来自不同 AGN 的电离气体外流，并且外流与射电喷流在空间上一致。

星系角动量与宇宙原初密度扰动

盛明捷 厦门大学

星系的角动量可以通过旋涡星系在天球的投影椭圆和旋臂手性及多普勒效应等观测到，提供了位置与速度分布之外额外的宇宙学信息，使我们能够推测宇宙的原初扰动，从而限制宇宙学模型和参数。已有的研究表示，星系角动量很好的示踪了其所在暗物质晕的角动量，且与宇宙学拉格朗日坐标的原初暗物质晕的角动量有密切的相关性，从而反映了宇宙原初扰动的性质。我们利用 N 体数值模拟、星系演化流体数值模拟，研究了暗物质晕与可观测的星系重子组分角动量受到非线性演化、星系形成过程的影响以及与宇宙原初扰动之间的相关，并进一步通过角动量重构方法从初始条件中预测低红移星系角动量。我们的研究验证了利用可观测的星系角动量重构与原初扰动有关的参数和模型的可能性。

搜寻和研究密近类星体

吉祥　　上海天文台

密近类星体，包括双活动星系核以及透镜类星体，是天体物理学中极具吸引力的研究对象。对密近类星体的研究在天体物理学上具有重要意义。例如，双活动星系核是我们研究星系并合和演化的重要载体。而透镜类星体则为研究暗物质的分布和测量宇宙学参数提供了独特的机会。尽管在寻找双活动星系核和透镜类星体方面取得了显著进展，但迄今为止报告的案例数量仍相对有限，目前已记录的每种类型的实例仅有数百个。在我们的研究中，我们专注于使用天体测量学、光谱学和时域巡天的数据来寻找、识别以及研究密近类星体的相关科学。

MSA-3D: Metallicity Gradients in Galaxies at z ∼ 1 with JWST/NIRSpec Slit-stepping Spectroscopy

居梦婷 中国科学院大学

The radial gradient of gas-phase metallicity is a powerful probe of the chemical and structural evolution of star-forming galaxies, closely tied to disk formation and gas kinematics in the early universe. We present spatially resolved chemical and dynamical properties for a sample of 26 galaxies at $0.5 \lesssim z \lesssim 1.7$ from the MSA-3D survey. These innovative observations provide 3D spectroscopy of galaxies at a spatial resolution approaching JWST's diffraction limit and a high spectral resolution of $R \simeq 2700$. The metallicity gradients measured in our galaxy sample range from −0.05 to 0.02 dex kpc−1. Most galaxies exhibit negative or flat radial gradients, indicating lower metallicity in the outskirts or uniform metallicity throughout the entire galaxy. We confirm a tight relationship between stellar mass and metallicity gradient at $z \sim 1$ with small intrinsic scatter of 0.02 dex kpc−1. Our results indicate that metallicity gradients become increasingly negative as stellar mass increases, likely because the more massive galaxies tend to be more "disky". This relationship is consistent with the predictions from cosmological hydrodynamic zoom-in simulations with strong stellar feedback. This work presents the effort to harness the multiplexing capability of JWST NIRSpec/MSA in slit-stepping mode to map the chemical and kinematic profiles of high-redshift galaxies in large samples and at high spatial and spectral resolution.

暗物質的可能探測途徑

Chan Iat neng Physics Olympiad Center of Macao

目前暗物質難以探測，原因是對暗物質的特性未能定論。作者綜合對宇宙探測的數目，基於初步計算和符合邏輯的推論及假設，提出新的暗物質性質，藉此引導及解釋一些宇宙問題和建議相關的可能測量及驗證。

探究混合星系对中的恒星形成机制

石彩璐 河北师范大学

星系并合是星系形成和演化的关键环节，而研究星系并合的主要途径是分析星系对的观测性质。根据成员星系类型组成，星系对可以分为三类，其中混合星系对（漩涡星系与椭圆星系的组合）占比最多。近年来的研究表明，混合星系对具有非常特殊的恒星形成性质，对于理解星系并合具有重要意义。在本工作中，我们利用 SDSS-IV MaNGA 的积分视场光谱数据，分别研究了混合星系对中成员星系的恒星形成性质。我们发现当伴星系是大质量椭圆星系时，漩涡星系在 1.5 倍的有效半径内均出现恒星形成抑制现象，中心区域更加明显，同时金属丰度则呈现出整体升高的现象。这可能是椭圆星系周围热的环星系介质切断了伴星系冷气体的供给的结果。我们还发现混合星系对中椭圆星系的恒星形成存在增强现象，这可能是椭圆星系从伴星系吸积冷气体造成的。本工作的研究表明，星系并合过程中成员星系之间存在非常紧密的物质交流进而改变了各自的观测性质。

The physical origin of positive metallicity radial gradients in high-redshift galaxies: insights from the FIRE-2 cosmological hydrodynamic simulations

孙训达 中国科学院大学

Using the FIRE-2 cosmological zoom-in simulations, we investigate the temporal evolution of gas-phase metallicity radial gradients of Milky Way-mass progenitors in the redshift range of $0.4<z<3$. We pay special attention to the occurrence of positive (i.e. inverted) metallicity gradients --- where metallicity increases with galactocentric radius. This trend, contrary to the more commonly observed negative radial gradients, has been frequently seen in recent spatially resolved grism observations. The occurrence rate of positive gradients in FIRE-2 is about ~10% for $0.4<z<3$, and ~16% at higher redshifts ($1.5<z<3$), broadly consistent with observations. Moreover, we investigate the correlations among galaxy metallicity gradient, stellar mass, star formation rate (SFR), and degree of rotational support. Our results show that galaxies with lower mass, higher specific SFR (sSFR), and more turbulent disks are more likely to exhibit positive metallicity gradients. The FIRE-2 simulations show evidence for positive gradients that occur both before and/or after major episodes of star

formation, manifesting as sharp rises in a galaxy's star-formation history. Positive gradients occurring before major star-formation episodes are likely caused by metal-poor gas inflows, whereas those appearing afterwards often result from metal-enriched gas outflows, driven by strong stellar feedback. Our results support the important role of stellar feedback in governing the chemo-structural evolution and disk formation of Milky Way-mass galaxies at the cosmic noon epoch.

Probing the Mechanisms of the ISM in Massive Galaxy Protoclusters

周航　中国科学院大学

Using the deep spectroscopy acquired by Keck MOSFIRE and HST grisms, we compile a sample of 43 galaxies at $z\sim2$ with full suites of rest-frame optical emission lines residing in massive protocluster cores at the cosmic noon. This unique galaxy sample provides critical information about galaxy evolution in overdense environments at high redshifts. By analyzing key diagnostics such as electron density, BPT diagrams, and the O$_{32}$ vs. R$_{23}$ excitation diagram, we identify a distinct offset in the emission-line properties of these high-redshift galaxies in overdense environments compared to local star-forming galaxies observed in SDSS. In stacked spectra of our sample galaxies, we measure a median electron density of approximately 275 cm^{-3}. When dividing the sample into different mass bins, we observe that galaxy stacks with higher mass tend to have lower electron density. Importantly, we find that the [O$_{\mathrm{\,I}}$]$\lambda6300$ emission line fluxes are significantly enhanced in these high redshift samples, which deviates from the behavior observed in local galaxies. By incorporating detailed photoionization models that combine contributions from H$_{\mathrm{II}}$ region ionization and shock excitation, we propose that the observed offsets, including the [N$_{\mathrm{\,II}}$]$\lambda6584$/Hα BPT diagram, electron density, and especially the strong [O$_{\mathrm{\,I}}$]$\lambda6300$ emission line, can be attributed to the influence of shock waves. This discovery sheds light on the complex ISM mechanisms in overdense environments in the early universe.

恒星形成星系的局域金属丰度

赵倩文 上海天文台

星系的金属丰度和其他物理性质的相关性是理解星系的形成和演化的重要途径。我们利用星系的化学演化模型，研究星系局域的气相和恒星金属丰度与质量面密度的关系。我们在 MaNGA 的 IFU 数据中发现，在同一星系质量下，随

着质量面密度增大，局域的气相和恒星金属丰度也增大；在同一质量面密度下，星系质量越大，局域的气相和恒星金属丰度也越大。为了解释观测到的这一相关性，我们建立了化学演化模型，模型包括了气体内流、恒星形成和气体外流过程。通过气相金属丰度和 Dn4000 对模型参数的约束，我们发现，星系的内流时标随质量面密度的增大而减小；外流比例也随着质量面密度的增大而减小，在同一面密度下，质量越小的星系拥有更多的外流。在我们的样本中，质量面密度在星系中心时最大，随着半径增大而减小，模型中内流时标由中心向外增大，符合由内到外的恒星形成模式。外流参数随质量和面密度的变化，也反映了星系整体和局域性质对局域金属丰度的共同影响。另外，对小质量星系，需要降低恒星形成效率来得到与观测相符的恒星金属丰度，这不会影响内流和外流参数随面密度的变化。

用 CSST 和 FRB 测量宇宙增长率

王诗源 北京师范大学

The cosmic growth rate, which is related to peculiar velocity and is a primary scientific objective of galaxy spectroscopic surveys, can be inferred from the Redshift Space Distortion effect and the kinetic Sunyaev-Zel'dovich (kSZ) effect. However, the reconstruction noise power spectrum of the radial velocity field in kSZ is significantly dependent on the measurement of the small-scale galaxy-electron power spectrum P_{ge}. In this study, we thoroughly discuss the enhancement of cosmic growth rate measurements facilitated by Fast Radio Bursts (FRBs), which probe the electron density of the universe along their propagation paths to provide crucial additional information on P_{ge}. Subsequently, we utilize future spectroscopic surveys from the Chinese Space Station Telescope and the CMB-S4 experiment, combined with FRB dispersion measures, to achieve precise measurements of the cosmic growth rate at redshifts zg = 0.15,0.45,0.75. Employing Fisher matrix forecasting analysis, we anticipate that constraints on fsigma8 will reach a precision of 0.1% with a sample size of 10^6 FRBs. Furthermore, we perform a global analysis using Markov Chain Monte Carlo methods to constrain key parameters of three distinct dark energy models based on cosmic growth rate measurements. The results demonstrate that these refined fsigma8 measurements considerably enhance the constraints on relevant cosmological parameters compared to those obtained from Planck CMB data. As the number of observed FRBs increases, alongside more precise galaxy surveys and next-generation CMB observations, new opportunities will arise for constraining cosmological models using the kSZ effect and for developing novel cosmological applications of FRBs.

基于等值宽度的不依赖先验减光曲线的星族合成算法及尘埃减光曲线的性质

卢家风 浙江大学

我们提出了一种基于等值宽度的线性星族合成方法。这种方法不需要先验减光曲线假设和校准偏差假设，而是将其作为拟合信息输出。基于这个方法，我们探究了星系减光曲线的演化性质和背后的物理图像。

恒星系统的双星比例

张奉辉 云南天文台

绿豌豆星系中的气体成分和可能的 X-ray 辐射来源

刘思琦 北京大学

冷气体是星系中恒星形成的重要燃料来源，然而，对于低金属丰度、低质量且具有高恒星形成率的星系，其冷气体成分与演化过程和辐射来源仍缺乏充分了解。绿豌豆星系作为该类星系的代表，为研究这些问题提供了关键的数据支持。通过对绿豌豆星系的 HI 21cm 谱线观测，我们发现其原子气体质量比例低于颜色标度关系的预测值。此外，我们通过分子谱线观测，成功测量了绿豌豆星系中的分子气体质量，并对低金属丰度环境下的 CO-H2 转换因子进行了约束分析。值得注意的是，部分绿豌豆星系表现出强烈的 X 射线辐射。通过比较其 LX-SFR 和 LX-SFR-metallicity 关系，我们推测该辐射源可能是活动星系核（AGN）与高质量 X 射线双星（HMXB）共同作用的结果。本研究为揭示早期宇宙和再电离时期星系中冷气体的成分、演化过程以及可能的 X 射线辐射来源提供了新的洞见。

Evolution of subhalo mass function through tidal stripping and disruption

何飞鸿 上海交通大学

Understanding the properties and distribution of subhaloes is essential for linking galaxies to dark matter and for probing the nature of dark matter. In this talk, I will

show how tidal stripping and disruption transform the unevolved subhalo mass function into the final subhalo mass function.
However, some recent researchers claim that CDM subhaloes are quite resistant to tidal effects, suggesting that the disruption events observed in simulations could be unphysical, thereby challenging current cosmological simulations. Through a detailed analysis of subhalo evolution in the Aquarius simulations, we demonstrate that the subhalo disruption rate corresponds to the physical segregation of subhaloes into two distinct acquisition channels. Most disrupted subhaloes are sub-subhaloes, accreted through major mergers at high redshift, while first-order subhaloes, accreted through minor mergers at low redshift, survive to the present day. Supported by semi-analytical modelling, we conclude that numerical effects do not undermine our understanding of resolved subhaloes as captured by current cosmological simulations.

活动星系核光变：从超大质量黑洞到中等质量黑洞

苏镇波 中国科学技术大学

基于宇宙学数值模拟的星系形成演化历史研究

汪洋 鹏城国家实验室

星系的恒星形成历史（SFH）是星系演化的核心过程。精准测量的 SFH 能够帮助研究者理解星系形成演化背后的大量物理过程，包括它们的形成机制、形成时间和发生时标等性质。另一方面，在通过星系的谱线或能谱测量星系的性质（恒星质量、恒星形成率、金属丰度、尘埃成分等），恒星形成历史模型是一个必不可少的重要的限制条件。因此，对于星系恒星形成历史研究非常重要。通过研究大量数值模拟，我们从中提取了星系的 SFH 并采用不同的模型进行拟合，研究星系恒星形成历史的可能模式，并基于这些拟合模型的性质讨论了背后的物理机制。

我们发现分析了 THETHREEHUNDRED、Illustris-1 和 TNG100-1 三个模拟，发现它们的演化历史可以分解程“主序演化”和“随机波动”两个部分。“主序演化”部分通过追踪星系质量与恒星形成率（SFR−M∗）主序关系的时间演化来生成。由于 SFR−M∗关系可以直接观测，所以这个模型能够通过观测来进行限制。“随机波动”部分则由偏置布朗运动来模拟，因为我们发现偏置布朗运动能够重新模拟 SFH 中的很多波动的特征。同时，偏置布朗运动的参数与物理驱动有着内在联系，这给了我们间接测量影响恒星形成的物理过程的探针。

我们还发明了一种基于多种基函数混合的多成分拟合方法来拟合恒星形成历史曲线。这个模型能够很好地拟合星系形成演化历史的形状，提取出其中的多

个恒星形成阶段。通过拟合 TNG100-1 模拟中的星系恒星形成历史，我们发现一个星系的恒星形成阶段的数量和发生时间与星系颜色、质量和类型（中央星系或卫星星系）有显著的关系，恒星形成阶段之间的间隔时长与这些性质有微弱的关系，而恒星形成阶段的持续时间仅在部分小质量红星系处与别的星系有所区别。相比过去的恒星形成历史模板，我们的拟合方法更能够刻画多阶段的恒星形成过程，对于精确描绘星系的形成演化历史有重要意义。

基于机器学习的活动星系核分类

李杰　上海工程技术大学

活动星系核（AGN）对于理解星系演化及宇宙大尺度结构形成具有重要作用。根据其观测特征，AGN 可分为多种类型，如类星体、赛弗特星系、耀变体、射电星系等。区分不同种类的 AGN 往往需要借助其多波段辐射特征。受限于不同波段观测设备灵敏度和分辨率的差异，现有判据在应用于全天巡天样本中时，往往无法同时保证分类结果的准备性和完备性。我们利用有监督机器学习算法，结合射电、中红外和光学特征，主要是各波段颜色特征，实现了对 AGN 和恒星形成星系（SFG），以及Ⅰ型类星体和Ⅰ型赛弗特的高精度分类。相对于 SFG，我们的分类算法对少数类别 AGN 的 F1 分数可以达到 0.9 左右。而在对Ⅰ型类星体和Ⅰ型赛弗特的区分中，少数类Ⅰ型赛弗特的 F1 分数可以达到 0.8 左右。我们的分类算法可以方便的扩展到大规模全天巡天样本中。

Constraints on Primordial Magnetic Fields from High Redshift Stellar Mass Density

张其乐 北京师范大学

Primordial magnetic fields (PMFs) play a pivotal role in influencing small-scale fluctuations within the primordial density field, thereby enhancing the matter power spectrum within the context of the ΛCDM model at small scales. These amplified fluctuations accelerate the early formation of galactic halos and stars, which can be observed through advanced high-redshift observational techniques. Therefore, stellar mass density (SMD) observations, which provide significant opportunities for detailed studies of galaxies at small scales and high redshifts, offer a novel perspective on small-scale cosmic phenomena and constrain the characteristics of PMFs. In this study, we compile 14 SMD data points at redshifts $z > 6$ and derive stringent constraints on the parameters of PMFs, which include the amplitude of the magnetic field at a characteristic scale of $\lambda = 1$ Mpc, denoted as B0, and the spectral index of the magnetic field power spectrum, nB. At 95% confidence level, we establish upper limits of $B0 < 4.44$ nG and $nB < -2.24$, along with a star formation efficiency of approximately $f^*0 \sim 0.1$. If we fix nB at specific values, such as −2.85, −2.9, and

−2.95, the 95% upper limits for the amplitude of the magnetic field can be constrained to 1.33, 2.21, and 3.90 nG, respectively. Finally, we attempt to interpret recent early observations provided by the James Webb Space Telescope using the theory of PMFs and find that by selecting appropriate PMF parameters, it is possible to explain these results without significantly increasing the star formation efficiency.

Unified Dark Fluid Model with a cosmic age parametrization

王俊超 中山大学

The unified dark fluid model unifies dark matter and dark energy into a single component, providing an alternative and more concise framework for interpreting cosmological observations. We introduce a PAge-like Unified Dark Fluid (PUDF) model based on the PAge approximation (Huang 2020), which is parameterized by the age of the universe and an η parameter indicating the deviation from Einstein-De Sitter Universe. The PUDF model shares many similar features of the standard Lambda cold dark matter (ΛCDM) model and can effectively describe the large-scale structure formation and late-time cosmic acceleration. We constrain the PUDF model with the Planck 2018 cosmic microwave background anisotropies, baryon acoustic oscillation measurements including those from the most recent DESI 2024, the Pantheon+ sample of Type Ia supernovae, and the Cosmic Chronometers compilation. Although the PUDF performs well in fitting all the cosmological datasets, the joint analysis of the data still favors the ΛCDM model over the PUDF model, according to the Bayesian evidence of model comparison.

A galaxy cluster finding algorithm using machine learning

田大川 北京师范大学

Building a comprehensive catalogue of galaxy clusters is a fundamental task for the studies on the structure formation and galaxy evolution. In this paper, we present an algorithm utilizing machine learning techniques for the efficient detection of galaxy clusters. Our method involves two steps, including the identification of the brightest cluster galaxies and the estimation of the cluster richness. We trained our models on the galaxy data from the Sloan Digital Sky Survey and WHL galaxy cluster catalogue. Validated to a test data in the region of northern galactic cap, our method demonstrates a high completeness when cross-matching with previous optical catalogues. Richness comparison with optical and X-ray cluster catalogues also demonstrated a tight correlation. Our methodology showcases robust performance in galaxy cluster detection and holds promising prospects for applications in upcoming

large-scale surveys.

The Nucleus Evolution of Mrk～1018

卢开兴 中国科学院云南天文台

In past forty-five years, changing-look AGN of Mrk 1018 underwent a significant modification of the central engine. This talk will report a full-cycle type transition for the first time in single AGN (Mrk 1018), which was driven by strongly varying accretion rate. And many other observation properties, which also regulate by accretion rate.

Exploring the dependence of the Hubble constant from the cluster-lensed supernova SN Refsdal on mass model assumptions

刘宇婷 内蒙古大学

The Hubble constant, H_0, which is a crucial parameter in astrophysics and cosmology, is under significant tension. We explore an independent technique to measure H_0 based on the time-delay cosmography with strong gravitational lensing of a supernova lensed by a galaxy cluster, focusing on SN Refsdal in MACS J1149.5+2223, the first gravitationally lensed supernova with resolved multiple images. We carefully examine the dependence of constraints on the Hubble constant on the choice of lens mass models, employing 23 lens mass models with different assumptions on dark matter halos and external perturbations. Remarkably, we observe that the dependence on the choice of lens mass models is not significantly large, suggesting the robustness of the constraint on the Hubble constant from SN Refsdal. We combine measurements for the 23 lens mass models to obtain $H_0=70.0^{+4.7}_{-4.9}km/s/Mpc$ assuming equal weighting. We find that best-fitting Hubble constant values correlate with radial density profiles of the lensing cluster, implying a room for improving the constraint on the Hubble constant with future observations of more multiple images. We also find a clear correlation between best-fitting Hubble constant values and magnification factors of supernova multiple images. This correlation highlights the importance of gravitationally lensed Type Ia supernovae for accurate and robust Hubble constant measurements.

早期星系中恒星反馈对热气体演化的影响

缪炜　　中国科学院上海天文台

大部分大质量紧凑星系的红移都在 z > 2，据推测它们可能是早期类型星系的潜在祖先。最近在附近星系中观测到的类似的大质量紧凑星系支持了这样的假设，即这些星系在宇宙演化历史中并没有与其他星系发生合并。因此，它们很可能是遗迹星系，Mrk1216 就是一个例子。观测结果表明，Mrk1216 中的热气体分布一直延伸到远离恒星群的几十 kpc 处。因此，我们利用 Zeus-MP2 代码构建了一系列一维、球对称、流体力学模拟，以研究恒星反馈在这类星系演化中的作用。结果表明，恒星反馈的能量不足以驱动星系中的气体外流。相反，引力压缩引起的气体加热起了更重要的作用，大量气体在向内流动的过程中冷却，在大约 2 Gyr 的时间跨度内形成了大约 10^9 M_sun 的冷气体，表现出大约 1-2 M_sun/yr 的冷气体生成率。鉴于 Mrk1216 是一个快速旋转的星系，在冷气体大量产生的情况下，星系凸起周围很可能会形成一个冷气体盘。因此，我们进行了一系列 2.5D 流体力学模拟，以确定冷气体圆盘的半径。结果表明，圆盘可以从 0.3 kpc 延伸到接近 2.7 kpc 的位置。

Instantaneous Size Growth of Star-Forming Galaxies: Insights from Size Variation on Rest-Frame Wavelength with JADES

贾澄　　中国科学技术大学

We investigate size variation on rest-frame wavelength for a sample of 6473 star-forming galaxies log M*/Msun > 8 based on the second JWST Advanced Deep Extragalactic Survey data release. Star-forming galaxies are typically smaller at longer wavelength from UV-to-NIR at z < 3.5, especially for more massive galaxies, indicating the inside-out assembly with in-situ star formation if ignoring dust attenuation. The size variation with wavelength shows strong dependence on stellar mass, and shows little or not dependence on redshift, specific star formation rate and galaxy environment. This suggests that the size growth of star-forming galaxies is a self-regulated process primarily governed by stellar mass. We model size as a function of both mass and redshift simultaneously, obtaining R_e ∝ M*^0.23 (1+z)^-1.04 at wavelength of 0.45 micron, and R_e ∝ M*^0.20 (1+z)^-1.08 at 1.0 micron. Based on this size evolution and the star formation main sequence from the literature, we obtain the locus of typical size growth for individual galaxies of different masses on the mass-size plane. The move trend on mass-size plane strongly correlates with the size ratio between 0.45 micron and 1.0 micron, supporting that the size variation on wavelength provides important information on instantaneous size growth of galaxies.

galactic winds in M82 revisited II: development of

multiphase outflows

李学夫 中山大学

星系形成模型对宇宙再电离的影响

马清波 贵州师范大学

The ultra-diffuse-galaxy AGC 242019 with a negative metallicity gradient

倪俊保 南京大学

The origin of ultra diffuse galxies (UDGs) remain poorly understood. While the metallicity gradient can offer key clues about the formation mechanisms of UDGs, no such studys have been conducted for field UDGs. We carry out deep MUSE observations of one of the brightest UDG in the HI -- AGC 242019. With various strong emission line metallicity calibrators, we found that this galaxy shows a negative metallicity gradient: -0.11±0.02 kpc^{-1} for N2S2Halpha metallicity calibrator and -0.019±0.005 kpc}^{-1} for O3N2, with average metallicities of 7.7 and 8.4, respectively. In contrast to general dwarf galaxies that prefer flat metallicity gradient, AGC 242019 aligns more closely to spiral galaxies. Our finding suggest that field UDGs may not experience strong feedback, consistent with other characteristics found in this galaxy.

Chandra X-ray Measurement of Gas-phase Heavy Element Abundances in the Center ?of the Galaxy

华子乾 南京大学

Elemental abundances are key to our understanding of star formation and evolution in the Galactic Centre. Previous work on this topic has been based on infrared (IR) observations, but X-ray observations have the potential of constraining the abundance of heavy elements, mainly through their K-shell emission lines. Using 5.7 Ms Chandra observations, we provide the first abundance measurement of Si, S, Ar, Ca, and Fe, in four prominent diffuse X-ray features located in the central parsec of the Galaxy, which are the manifestation of shock-heated hot gas. A two-temperature

non-equilibrium ionization spectral model is employed to derive the abundances of these five elements. In this procedure, a degeneracy is introduced due to uncertainties in the composition of light elements, in particular, H, C, and N. Assuming that the hot gas is H-depleted but C- and N-enriched, as would be expected for a standard scenario in which the hot gas is dominated by Wolf-Rayet star winds, the spectral fit finds a generally subsolar abundance for the heavy elements. If, instead, the light elements had a solar-like abundance, the heavy elements have a fitted abundance of ~1-2 solar. The α/Fe abundance ratio, on the other hand, is mostly supersolar and insensitive to the exact composition of the light elements. These results are robust against potential biases due to either a moderate spectral signal-to-noise ratio or the presence of non-thermal components. Implications of the measured abundances for the Galactic Centre environment are addressed.

Joint analysis of small-scale galaxy clustering and galaxy-galaxy lensing from BOSS galaxies

高文豪 上海交通大学

We present a joint analysis of galaxy clustering and galaxy-galaxy lensing measurements of BOSS galaxies using the method of simulation-based emulation combined with halo occupation distribution model. Our emulator is constructed using the Aemulus ν simulations with massive neutrinos, a suite of wνCDM N-body simulations designed for emulation. We combine the small-scale analysis of galaxy clustering from 0.1 Mpc/h to 60 Mpc/h and galaxy-galaxy lensing from 1.7 Mpc/h to 60 Mpc/h to perform cosmological constraint. We split the BOSS galaxies into three redshift bins to measure their clustering and employ galaxies from Dark Energy Camera Legacy Survey and Hyper Suprime-Cam as source galaxies to measure galaxy-galaxy lensing separately. We find that the addition of galaxy-galaxy lensing will significantly improve constraint power on S8, with weak improvement on the constraint of fσ8. Our results of fσ8 indicate a tension of around ~2-4σ below the results of CMB observations from Planck. For S8, our results based on different data at different redshifts are also ~3σ lower than the Planck result. These tensions with CMB observations in our work are consistent with some recent works of large-scale structure analysis, including measurements of galaxy clustering, galaxy-galaxy lensing, cosmic shear and so on.

Is quasar variability regulated by the close environment of accretion?

吴亮 中国科学技术大学

Ultraviolet/optical variability in quasars is a well-observed phenomenon, yet its

primeval origins remain unclear. In this report, we present our recent findings on the ultraviolet/optical variability of luminous quasars and its connection to the close environment of accretion. Through correlation analysis, we have found that the dusty torus dominates near-infrared emission, while polar dust primarily contributes to mid-infrared radiation. Building on this understanding, we further investigate how these components influence quasar variability using a compilation of the best available quasar light curve samples, including data from SDSS, Pan-STARRS, and Zwicky Transient Facility. Our analysis reveals a significant anticorrelation between the g-band variability amplitude (σrms) and the infrared covering factor LIR(λ)/Lbol, which is strongest at wavelengths of 2-3um but gradually weakens towards longer wavelength. This suggests the equatorial dusty torus plays a significant role in influencing the UV/optical variability, while the cooler polar dust does not. The findings indicate that quasar variability may be connected to the physical conditions within the dusty torus which feeds the accretion, and support the notion that the close environment of the accretion plays an important role in regulating the accretion disk turbulence.

类星体风的加速和减速

易卫敏 中国科学院云南天文台

宽吸收线（BAL）在类星体光谱中普遍存在，是最无争议的活动星系核（AGN）驱动的一种外流，亦即类星体风。低电离宽吸收线（LoBAL）外流往往被认为与触发不久的类星体活动密切相关，并且正处在清除核区大量尘埃（即类星体由红变蓝）的阶段，因此它们是研究 AGN 反馈的一个关键环节。考虑到外流的加速和减速可以为研究该环节提供独特和宝贵的线索，我们在过去几年开展了寻找 LoBAL 加/减速候选体的研究。基于新发展的判据，我们在一个类星体样本中找到了两个强有力的 BAL 加速候选体，以及两个可能的加/减速候选体。这四个候选体的 SED 在 10 um 处都有一个峰值，意味着 BAL 加/减速与热的尘埃辐射可能有关。另外，有加速特征的两个候选体的 SED 在 1 ~ 3 um 之间具备更陡的上升而且是陡谱的弱射电辐射源。我们的这项研究表明，BAL-ISM 的耦合过程是类星体红化与部分遮蔽的主要途径之一，并且在距离类星体很远处最终转变为稳定的、速度接近于 0 的窄吸收线群。另外，该过程中的 BAL 减速可能导致弱的射电辐射，这也解释了 LoBAL 族群中有着比正常类星体更高的射电探测率。

MULTIPLE MEASUREMENTS OF HUBBLE CONSTANT FROM DESI 2024 BAO OBSERVATIONS

郭无筝 北京师范大学物理与天文学院

In this Letter, we present the latest results from the Dark Energy Spectroscopic

Instrument (DESI) survey to measure the Hubble constant. We establish a cosmological-model-independent method to extract multiple measurements of Hubble constant (H0), based on a combination of independent geometrical data sets without calibration. The baryonic acoustic oscillation (BAO) observations by
the Dark Energy Spectroscopic Instrument (DESI) survey, allow us to determine H0 from the first principles unleashing any universal assumption. We find H0 = 66.9+1.1−1.0 km s−1 Mpc−1 at 68% C.L., which provides the Hubble constant at an accuracy of 1.5% with minimal assumptions. Specially, our newest measurements of this fundamental constant at z = 0.51 − 2.33 agree very well with Planck's results. This also demonstrates a 4σ tension with the results of the Supernova H0 for the Equation of State (SH0ES).

使用未分辨的 HI 谱线测量近邻星系的暗物质分布

雷雨　　中国科学院上海天文台

Measuring the dark matter distribution within galaxies is crucial for testing the baryonic-dark matter co-evolution in simulations. However, we are still lacking of reliable measurements of dark matter content in a large number of galaxies. The dark matter distributions constrained by IFU data are largely uncertain due to the limited spatial coverage of IFU observations. We developed a dynamical model combing IFU stellar kinematic data and integrated HI spectrum, which significantly reduced the uncertainty of dark matter fraction, from relative uncertainty of ~100% (with IFU only) to ~40%. We then apply this method to a sample of 140 nearby galaxies combing IFU data from MaNGA and high-quality HI spectra from FAST, the sample is representative of the general properties of present-day galaxies in the local universe. We find that TNG simulation predicts higher dark matter fraction within 1Re and 5Re compared to observation.

JWST 图像中的强引力透镜建模

邓力艋 紫金山天文台

Enhancing dark siren cosmology through multi-band gravitational wave synergetic observations

dongyueyan　　东北大学

Multi-band gravitational-wave (GW) standard siren observations are poised to herald a new era in the study of cosmic evolution. These observations offer higher signal-to-noise ratios and improved localizations compared to those achieved with single-band GW detection, which are crucial for the cosmological applications of dark sirens. In this work, we explore the role multi-band GW synergetic observations will play in measuring cosmological parameters, particularly in comparison with single GW observatory data. We used mock multi-band dark siren data from third-generation GW detectors and the baseline Decihertz Interferometer Gravitational-Wave Observatory to infer cosmological parameters. Our analysis was conservative, involving only the 89 actual GW events from the current Gravitational Wave Transient Catalogs in our data simulation, facilitating a direct comparison with existing dark siren results. Multi-band GW observations significantly improve sky localization accuracy by two to three orders of magnitude over single-band observations, although their impact on luminosity distance error remains limited. This results in a substantial improvement in the constraints on matter density and the Hubble constant, enhancing them by 81%
to 89% and 70% to 79%, respectively. We conclude that the significant potential of multi-band GW synergistic observations for detecting GW signals and resolving the Hubble tension is highly promising and warrants anticipation.

Cosmological model-independent constraints on the Hubble constant from a time-delay gravitational lens system and GWTC-3 standard sirens

Ji-Yu Song 东北大学

The Hubble tension has emerged as a significant enigma in cosmology in recent years. This confusion stems from a more-than-5σ discrepancy between the values of the Hubble constant (H0) inferred from the Planck 2018 CMB observation based on the ΛCDM model and results of other late-universe cosmological probes. This inconsistency hints at the possibility of new physics beyond the standard ΛCDM model. Still, we can not dismiss the possibility of unknown systematic error in these measurements yet. Therefore, it is necessary to remeasure H0 using the cosmological model-independent method. In this presentation, we show our newly cosmological model-independent constraint on H0 based on the distance-sum rule and using a strong gravitational lensing time delay (SGLTD), RXJ1131-1231, combined with gravitational-wave (GW) standard sirens in GWTC-3. Our results show that RXJ1131-1231 and 42 binary black holes (BBHs) can constrain H0 to around 9%. Considering the bright siren GW170817 and 42BBHs can constrain H0 to around 7.7%. If we consider the galaxy catalog GLADE+ and fix the mass model of BBH, we can constrain H0 to 5.2%. Our results are the first to use real GW standard siren data and real SGLTD data to constrain H0 independently of cosmological models via the distance-sum rule, demonstrating the great potential of this approach in resolving

the Hubble tension.

Impacts of dark energy on weighing neutrinos after DESI BAO

杜国宏 东北大学

Recently, DESI released baryon acoustic oscillation (BAO) data, and DES has also published its five-year supernova (SN) data. These observations, combined with cosmic microwave background (CMB) data, support a dynamically evolving dark energy at a high confidence level. When using cosmological observations to weigh neutrinos, the results will be significantly affected by the measurement of dark energy due to the degeneracy between neutrino mass and the dark-energy equation of state. Therefore, we need to understand how the dynamical evolution of dark energy in the current situation will affect the measurement of neutrino mass. In this work, we utilize these latest observations and other additional distance measurements to discuss the mutual influence between neutrinos and dark energy, then calculate the Bayes factor to compare models. We consider three neutrino mass hierarchies including degenerate hierarchy (DH), normal hierarchy (NH), and inverted hierarchy (IH), as well as three dark energy models including the ΛCDM, wCDM, and w0waCDM models. Cosmological data combined with the prior of particle physics experiments can provide strong to decisive evidence favoring the w0waCDM + $\sum m_\nu$ model with NH. In the w0waCDM model, using the CMB+DESI+DESY5 data, we obtain constraints on the total neutrino mass, $\sum m_\nu < 0.171$ eV, 0.204 eV, 0.220 eV, for DH, NH, and IH, respectively. Furthermore, taking into account the neutrino hierarchy or incorporating additional distance measurements results in a more pronounced deviation from the ΛCDM model for dark energy. The latter, particularly, exhibits a deviation at a confidence level that surpasses 4σ.

Extragalactic Radio Sources : a robust cosmological distance indicator

南亚龙 北京师范大学物理与天文学院

Over the past decades, considerable advances have been made in the search for possible candidates to serve as true standard rulers in the Universe. Among these, the milliarcsecond-scale structures of flat-spectrum radio quasars (FSRQs) have aroused wide attention in the context of their potential serve as cosmic standard rulers. Previous works have shown that under intermediate luminosity, their linear size shows no significant correlation with luminosity and redshift in the range from 0.5 to 3. Based on the VLBA Calibrate Survey (VCS) images, we conducted multi-wavelength

morphological analyses. Using cosmic chronometers and Baryon Acoustic Oscillations (BAO) for cosmology-independent calibration, we constructed the largest currently available sample of compact radio sources that can serve as cosmic standard rulers. Additionally, the linear size-Luminosity relation of compact symmetric objects (CSOs) has also been considered as a promising candidate for standard distance indicators. Due to the limited number of confirmed CSOs, we generated a simulated samples based on the recently proposed CSO semi-analytic model. By comparing simulated sample with existing CSO observational data, we analyzed the observational errors in the simulated samples and tested the feasibility of the P-D relationship as a standard distance indicator.

Disentangling the Impacts of Feedback and Environment: the HI Gas–Dark Matter Halo Connection in TNG Simulations

Xingyao Cai Zhejiang University

n this study, we explore the connection between HI gas and dark matter halos to disentangle the impacts of internal feedback mechanisms and environmental factors on galaxy evolution, using the IllustrisTNG-100 simulation. By calculating the HI content and distribution within galaxies, and comparing the quenching fractions between the SDSS survey and IllustrisTNG, we investigate the role of HI gas in galaxy quenching. This analysis reflects how feedback processes and large-scale environments influence the evolution of galaxies.

Our key findings show distinct differences in HI distribution between AGN and non-AGN galaxies. We observe an inverse relationship between HI content and dark matter halo mass. In massive galaxies, HI is predominantly located beyond 10 kpc from the center, leaving a gas depletion zone in the core. Furthermore, the correlation between HI content and dark matter halo mass weakens when controlling for stellar mass.

These results highlight the importance of HI gas distribution in understanding the interplay between internal feedback and environmental effects, providing new insights into the HI gas–dark matter halo connection in galaxy evolution.

The HST narrowband deep field survey and related sciences

朱帅儒 中国科学院上海天文台

在本次报告中，我将展示首个基于哈勃望远镜的窄带深场巡天——Hubble Deep Hydrogen Alpha （HDHA）项目。在本项目中，我们分析了自 HST 第 7 周期以来的所有窄带观测数据，优先处理了窄带数据积累较多的天区。在这里我讲

介绍目前在 GOODS-S 天区的窄带数据成果。该天区的数据共包含 72 个轨道的观测图像，观测面积约为 76 平方角分，累计曝光时间为 195.7 ks，其中 68.8 ks 覆盖了最深区域。这些图像经过对齐、重投影，并与 Hubble Legacy Field 图像的数据在同一像素网格上进行合并。HDHA 项目的科学目标包括建立发射线星系(ELGs)的样本，涵盖 z ~ 0.3 的[O iii]发射线星系、z ~ 0.8 的[O ii]发射线星系及 z ~ 4.4 的 Ly α 发发射线星系(LAEs)。在本报告中，我还将介绍基于 HDHA 选择的发射线星系样本以及其莱曼连续谱辐射性质。

Unveiling the Temporal and Spectral Variability in Nearby and Distant Gamma-NLS1 Galaxies

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The variability in intensity across the electromagnetic spectrum is a defining feature of active galactic nuclei (AGNs), providing crucial insights into their emission mechanisms at scales that remain beyond the reach of current imaging technologies. Such variability is a potent diagnostic tool for elucidating the underlying physics and properties of AGNs, offering valuable information on the spatial and temporal distribution of emitting regions, the structure and dynamics of accretion disks, and the characteristics of the central supermassive black hole. This study presents a comprehensive analysis of flux and color variability in the optical and Infrared wavelengths for two gamma-ray detected Narrow-line Seyfert 1 galaxies (gamma-NLS1s), representing the extreme ends of redshift. The selected sources are 1H 0323+342 (z = 0.06), the nearest known gamma-NLS1, and TXS 1206+549 (z = 1.344), the farthest detected to date. Both galaxies exhibit optical flux variability on timescales ranging from minutes to years, as observed with 1-4 meter class ground-based telescopes. Notably, a rapid optical flare was detected from 1H 0323+342, with a magnitude change of 0.07 within 20 minutes during an intra-night observation. In the infrared regime, data from the Wide-field Infrared Survey Explorer (WISE) reveal variability on daily timescales for both gamma-NLS1s. Additionally, a high-cadence color variability analysis using data from the Zwicky Transient Facility (ZTF) indicates that neither galaxy follows the typical "bluer when brighter" (BWB) or "redder when brighter" (RWB) trends in the optical domain. However, a BWB trend is observed in the infrared data from WISE. We will discuss potential physical mechanisms driving the observed flux and color variability in both optical and infrared wavelengths.

强引力透镜研究中的若干问题探讨

杜伟 上海师范大学

强引力透镜作为引力场中的光线偏折现象之一，包含宇宙物质分布和时空几何的重要信息。自 1979 年第一个强引力透镜被发现以来，强透镜样本已积累了大约几百个高像质系统和几千个候选体。近年来，随着新一代大型巡天项目的实施，预计在未来五到十年内将观测到约十万个强引力透镜系统。海量新数据将为我们利用强引力透镜现象理解宇宙结构的形成和演化提供重要的依据和支持。随着数据质量和数量的提升，强透镜研究对数据分析的精度和效率提出了更高要求，在样本搜寻、图像处理、理论建模和科学应用等方面还存在许多亟待解决的问题。本报告将汇报我们在强引力透镜研究方面取得的一些进展，并对若干问题进行探讨。

两个量子修正参数对重整群改进史瓦西黑洞附近粒子混沌动力学的影响

鲁俊杰 上海工程技术大学

重整化群改进史瓦西黑洞时空包含两个量子中心方向参数。其中一个参数γ表示距离尺度截断的识别，另一个参数Ω 源于非摄动重整化群论。这两个参数受到来自 M87*中心黑洞阴影的数据的约束。黑洞周围带电测试粒子的动力学是可积的，但当黑洞浸入外部渐近均匀磁场中时，它不可积，而且可能有混沌的发生。利用显式辛积分器，研究了这两个参数对混沌动力学行为的贡献。发现在 M87* 黑洞的阴影约束下，参数 γ 的微小变化对粒子从有序到混沌的动力学跃迁的影响几乎可以忽略不计。然而，参数 Ω 的微弱减小会导致混沌强度从全局相空间结构增强。并且对不同的贡献给出了理论解释。特别是，Ω 参数起到了排斥力的作用，它的减小意味着排斥力的减弱，或者等效地增强了来自黑洞的引力。另一方面，当Ω ≥0 并且是一个较小值，外加磁场消失时，由黑洞表面引力通常会得出一个正的李雅普诺夫指数。在这种情况下，视界将影响带电粒子在被外部磁场包围的黑洞周围运动的混沌行为。这一点可以解释为什么较小的重整化群参数值比较大的值更容易引起混沌。它也可以解释为什么当这样一个外部磁场包括在内时，带电粒子的混沌在史瓦西黑洞时空中比在重整化群改进的史瓦西黑洞时空中更容易发生。

The properties of Lyman Continnum candidates through combined spectroscopic and imaging observations

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Identifying Lyman continuum (LyC) leakers at intermediate redshifts is crucial for understanding the properties of cosmic reionizers, as the opacity of the intergalactic medium (IGM) prevents direct detection of LyC emission from sources during the

Epoch of Reionization (EoR). In this study, we confirm two new LyC leakers at z~3 in the Abell 2744 cluster field, with absolute escape fractions (f_esc) of 0.9 and 0.22, respectively. The LyC emission was detected using HST/WFC3/F275W and F336W imaging. These two leakers appear faint M_UV = -18.1 and -17.81, exhibit blue UV continuum slopes -2.68 and -2.24, have low masses, and show Lya EW of 90 angstrom and 28 angstrom, respectively. Their discovery was achieved without any preselection, as we constructed a catalog of 98 spectroscopically confirmed sources using JWST and/or MUSE public spectra. We also discuss the possible indirect indicators (like Lyman alpha, O32 ratio, and M_star, etc) and find clues between these properties and the LyC escaping. By integrating this sample into the currently limited sample of known LyC leakers at z~3, we aim to enhance our understanding of LyC escape mechanisms and improve our predictions of the LyC f_esc during the EoR.

红移 1 左右的富尘埃星系形态研究

梁飘冉 国家天文台

我们对 Huang (2021) 研究中的 0.8<z<1.3 红移范围内的 16μm 流量限制的星系样本进行了形态分析。在这个红移范围内，16μm 辐射对应于强烈的恒星形成中多环芳烃特征，或被活动星系核(AGN)加热的尘埃。我们的样本包括来自三个 CANDLES 场（EGS、GOODS-N、GOODS-S）的 479 个星系，其中 67%是红外亮星系(LIRGs)，并根据它们的光谱能量分布类型进一步划分为 AGN 主导型、恒星形成主导型、复合型和 blue-compact 星系。大多数样本(71%)形态具有盘状结构，少数 AGN 主导的星系比恒星形成主导星系和复合型星系在形态上更加由核球主导。在 Gini vs. M_20 图上的分布与以往的研究一致，Sérsic 指数 n 在位于并合分界线下方的区域呈现向更小的 M_20 和更高的 Gini 值而增大的趋势。超红外亮星系（ULIRGs）的子样本遵循陡峭的质量-大小关系，接近早型星系的质量-大小关系。此外，随着 4.5μm 超出光度(AGN 强度的估计量)的增加，我们的样本表现出更明显的由核球主导的形态特征（即更高的 n）。根据比恒星形成率和致密程度，我们这个由 LIRG 主导的星系样本的大多数遵循一个慢演化的轨迹，其的演化过程中无需涉及任何并合活动。在我们样本中的 16 ULIRGs 中，有 6 个是比较致密的且具有强 AGN 贡献，可能沿着由剧烈活动引发的快速演化轨迹演化。

A new parametrization of Hubble function and Hubble tension

杨荣佳 河北大学

A surprising excess of radio emission in Extremely Stable Quasars: a unique clue to jet launching?

康文泳 中国科学技术大学

Quasars are generally divided into jetted radio-loud and nonjetted radio-quiet ones, but why only 10% of quasars are radio-loud has been puzzling for decades. Other than jet-induced phenomena, black hole mass, or Eddington ratio, a prominent difference between jetted and nonjetted quasars has scarcely been detected. Here we show a unique distinction between them, and the mystery of jet launching could be disclosed by a prominent excess of radio emission in extremely stable quasars (ESQs; i.e., type 1 quasars with extremely weak variability in UV/optical over 10 yr). Specifically, we find that >25% of the ESQs are detected by the FIRST/VLASS radio survey, while only ∼6%–8% of the control sample, matched in redshift, luminosity, and Eddington ratio, are radio-detected. The excess of radio detection in ESQs has a significance of 4.4σ (99.9995%) and predominantly occurs at intermediate radio loudness with R ∼ 10–60. The radio detection fraction of ESQs also tends to increase in the ESQ samples selected with more stringent thresholds. Our results are in contrast to the common view that radio-loud quasars are likely more variable in UV/optical due to jet contribution. New clues/challenges posed by our findings highlight the importance of extensive follow-up observations to probe the nature of jets in ESQs and theoretical studies on the link between jet launching and ESQs. Moreover, our results make ESQs, an essential population that has never been explored, unique targets in the burgeoning era of time domain astronomy, like their opposite counterparts of quasars exhibiting extreme variability or changing-look features.

Quantifying the Coupling Effects of Supernova Feedback on Black Hole Accretion in Galactic Nuclei

陈可鉴 北京大学

Growth of massive black holes (BHs) in the galactic centers are regulated by the environment. Modern cosmological galaxy-formation simulations suggest that supernova (SN) feedback evacuates the gas in galactic center, suppressing the BH growth until the host galaxies have grown sufficiently to develop a deep gravitational potential, leading to under-massive growth track relative to the local relationship. However, this scenario does not explain the over-massive nature of BHs observed at high redshift through JWST. In this work, we perform a suite of 3D high-resolution hydrodynamical simulations that investigates the properties of turbulent, multi-phase gas driven by individual SN explosions and the dynamics of accreting gas onto a BH through its gravitational influence radius. We explore a broad parameter space of the BH mass (~ 1-10^8 Msun), density of the surrounding gas (~ 1-10^5 cm^-3), and

frequency of explosions (given by star-formation timescale, tau ~ 10-10^4 Myr). When the density in the nucleus is as high as 10^3 cm^-3 (tau / 10^2 Myr)^(-2), where the volume filling factor of SN bubbles within the BH influence radius is less than 0.1, the BH is fed at a high rate comparable to the Bondi accretion rate by dense cold gas formed between SN bubbles. This result, unlike most large-scale galaxy simulations that hardly resolve the nucleus, suggests that SN feedback is inefficient to expel the gas and prevent the BH from growing. These high-resolution simulations enable us to provide a physically motivated subgrid feedback model, which can be applied to large-scale simulations.

The Stellar Formation History and Evolution of Blue Compact Dwarf Galaxy

张泸丹 国家天文台

Blue compact dwarf (BCD) galaxies have a metallicity range of 1/10 to 1/3 of solar metallicity. This low metallicity makes them ideal samples for studying galaxy evolution in the early universe. The shallow gravitational potential of BCDs cannot effectively retain gas from outflowing due to star formation feedback. Nevertheless, starburst phenomena have been observed in some BCDs in recent years. Previous studies have proposed several possible explanations: 1) The high-metallicity gas generated by starburst events is completely blown away. 2) Gas that had not undergone star formation for a long time suddenly began to form stars recently. 3) Entry of low-metallicity gas, which subsequently forms stars. In order to recover the star formation history of the blue compact dwarf galaxy and reveal the occurrence of starburst phenomena, we analyze HST F336W, F438W, F606W, and F814W images of W1016+37, a blue compact dwarf galaxy, to determine the age and mass distribution of star clusters. Additionally, we develop a comprehensive method to analyze high-resolution images of nearby starburst dwarf galaxies from HST, considering metallicity, emission line contamination, and reddening, for future BCD studies.

Pulsar Timing Array, Astrophysics and Cosmology

陈偲源 中国科学院上海天文台

Galaxy Stellar Mass function from z=2.0 to z=0 using

Kilo-degree Survey(KiDS)

王清山 中山大学物理与天文学院

The Galaxy Stellar Mass Function (GSMF) is a crucial statistical tool for understanding how the stellar mass of galaxies is distributed, offering insights into the assembly of galaxies across different redshifts. By analyzing GSMFs across redshifts, we can track the evolution of galaxy mass assembly. Furthermore, since cosmological simulations and semi-analytic models (SAMs) also provide GSMFs, comparing observational data to these models helps refine and constrain them. In this study, we utilize data from the Kilo-Degree Survey (KiDS) to construct GSMFs across redshifts from 2.5 to 0 using the 1/Vmax method. Our results are compared with previous studies as well as state-of-the-art simulations and SAMs. We find strong agreement with existing works in the redshift range 1–0. Additionally, our results reveal resolution-dependent trends in the TNG simulation series.

Joint spectrophotometric decomposition method for quasar host galaxies

孙圣修 北京大学

One Dark Fluid or Two? （暂定）

Yan Su 中山大学

X-ray properties of small galaxy groups from eRASS1

郑云亮 上海交通大学

The diverse physical origins of stars in the dynamically hot bulge: CALIFA vs. IllustrisTNG

Le Zhang 中国科学院上海天文台

Oxyster: A Circumgalactic Low-ionized Nebula Associated with a Starburst System at z=0.9

卢芃君 清华大学天文系

We present the discovery of an extensive ionized nebula in the COSMOS field, featuring a ~20 kpc [OIII] nebula within a larger ~30 kpc [OII] nebula, both aligned with a starburst galaxy at z = 0.924. Thanks to the vast availability of COSMOS images, we find this galaxy exhibits a ``single arm'' bursty structure. While O32 ratio lower than 1 indicates a low ionization state, the lower limit of [OIII]]/Hbeta suggests the ionization source may be an AGN, as it falls within AGN-dominated regions on diagnostic diagrams. However, SED fitting, X-ray and radio emission provide no strong evidence for an active nucleus. The nebula might indicate the presence of a low luminous central AGN that was active within the last 10^5 years. The possibility of a recent merger, a "positive feedback" scenario, and further ionization diagnostics from additional emission lines are avenues for future exploration. This object offers valuable insights into the z~1 epoch, and discovering similar systems are expected to help constrain AGN variability and the galaxy ecosystem phenomenon.

Quasars with Flare/Eclipse-like Variability Identified in ZTF

郑致远 南京大学

Active galactic nuclei (AGNs) are known to exhibit optical/UV variability and most of them can be well modeled by the damped random walks. Physical processes that are not related to the accretion disk, such as tidal disruption events (TDE) or moving foreground dusty clouds, can cause flare-like and eclipse-like features in the optical light curve. Both long-term and high-cadence monitoring are needed to identify such features. By combining the Sloan Digital Sky Survey (SDSS), Panoramic Survey Telescope, and Rapid Response System (Pan-STARRS) with the Zwicky Transient Facility (ZTF) survey, we are able to identify a rare sample (11) out of the SDSS quasar catalog ($\sim 83,000$). These quasars exhibit more or less constant brightness but show rapid optical variation in the ZTF DR2 epochs. To investigate the possible origins of these flare/eclipse-like variabilities, we propose the second epoch spectroscopic observations with the Gran Telescopio CANARIAS (GTC). We find that the change in accretion rate plays a significant role in these quasar variabilities. Among them, we identify two Changing-Look Active Galactic Nuclei (CL-AGN) candidates: SDSS J1427+2930 and SDSS J1420+3757. The luminosity change of the former may be caused by the enhanced SMBH's accretion or the tidal disruption event, while the latter is more related to the change in the accretion rate.

Unveiling the galactic baryon cycle process by an empirical model

陈瑶鑫 浙江大学

The Remarkable X-ray Spectra and Variability of the Ultraluminous Weak-Line Quasar SDSS J1521+5202

王守一 南京大学

We present a focused X-ray and multiwavelength study of the ultraluminous weak-line quasar (WLQ) SDSS J1521+5202, one of the few X-ray weak WLQs that is amenable to basic X-ray spectral and variability investigations. J1521+5202 shows striking X-ray variability during 2006--2023, by up to a factor of ≈ 32 in 0.5--2 keV flux, and our new 2023 Chandra observation caught it in its brightest X-ray flux state to date. Concurrent infrared/optical observations show only mild variability. The 2023 Chandra spectrum can be acceptably described by a power law with intrinsic X-ray absorption, and it reveals \textbf{a nominal intrinsic level of X-ray emission relative to its optical/ultraviolet emission}. In contrast, an earlier Chandra spectrum from 2013 shows apparent spectral complexity that is not well fit by a variety of models, including ionized-absorption or standard Compton-reflection models. Overall, the observations are consistent with the thick-disk plus outflow model previously advanced for WLQs, where a nominal level of underlying X-ray emission plus variable absorption lead to the remarkable observed X-ray variability. In the case of J1521+5202 it appears likely that the outflow, and not the thick disk itself, lies along our line-of-sight and causes the X-ray absorption.

The Growth Mode of Low-mass Galaxies at Cosmic Noon

白万悦 天津师范大学

Previous studies indicate that massive galaxies exhibit inside-out growth, while low-mass galaxies may follow a self-similar growth mode. Lyα Emitters (LAEs) represent an important population in the low-mass regime. This work aims to investigate the growth mode of low mass galaxies using LAEs at z~2.23, based on JWST and HST imaging data. The sample consists of 22 LAEs in the ECDF-S field and 9 LAEs in the COSMOS field by cross-matching the LAE catalog in Hao et al. (2018) with the public JWST photometric catalog by the DJA. The stellar mass of the LAEs mainly covers a range of 10^7-10^9 M⊙, with a median mass of ～4*10^8 M ⊙. Two dimensional multi-wavebands image decomposition was carried out to derive

the structural parameters using GalfitM software, involving HST WFC3/F606W, F814W, F160W bands and JWST NIRCAM/F444W band. We find that the LAEs follow the rest-frame optical waveband stellar mass-size relation defined by more massive star-forming galaxies at similar redshifts, in agreement with a previous study conducted by Shimakawa et al. (2017). More importantly, we reveal that LAEs show larger sizes in longer wavebands than in shorter wavebands, contrary to the findings for massive galaxies. The size dependence on wavelength of our LAEs sample is not consistent with the self-similar growth mode either.

Galaxy Clustering in the Numerical Simulation

李晨帆 中山大学

The clustering of galaxies has been recognized as one of the most important observational constraints in cosmology. We analyze the two-point correlation function (2PCF) of low-redshift mock galaxies from the TNG100-1 simulation recently developed by Tang et al. (2021). We concentrate our analysis on mass-limited subsamples of specified luminosity ranges, for which we measure the projected correlation function ωp(rp). In agreement with previous studies, the 2PCF of galaxies is close to a power-law over a wide range of scale. In the halo model, the results have a characteristic scale at r ~ 1-2 h-1Mpc, where the 2PCF of galaxies transits from the one- to the two-halo term. We also study the contribution to the clustering strength of galaxies resulting from galaxy properties, such as stellar mass, luminosity and color, selected the galaxy samples with mass in range 109 to 1012 M*. More massive or more luminous groups exhibit steeper clustering amplitude; and red old galaxies are more strongly clustered than groups with blue centrals. This shows that the simulated mock galaxies are in good agreement with the real galaxies, and can be further mined to help understand the galaxy formation model.

利用宇宙大尺度结构巡天数据研究类轴子粒子性质

吴嘉丽 北京师范大学

Axion-like particles (ALPs) are promising dark matter candidates with a wide range of possible masses and couplings. These particles can decay into two photons, contributing to cosmic background radiation that may correlate with large-scale structures (LSS). ALPs with a mass around 1 eV decay into monochromatic photons in the near-infrared spectrum, which can be detected by the upcoming SPHEREx mission. In this study, we correlate the intensity maps from SPHEREx with data from the Chinese Stage-IV survey CSST to search for ALP signals. We exploit photometric

galaxy-imaging data to trace large-scale structures through galaxy clustering and weak lensing, alongside the 96 spectral channels provided by SPHEREx. Additionally, we account for the effects of intrinsic alignment and astrophysical emission lines. Using a Fisher analysis, we forecast constraints on ALP parameters. Our results suggest that current bounds on $g_{a\gamma\gamma}$ could be improved by an order of magnitude for ALPs in the mass range around 1 eV. Moreover, we can place tighter constraints on the parameters governing intrinsic alignments and astrophysical emission lines, particularly by binning galaxy redshift distributions.

Dark Matter Halos in Interacting Dark Energy Model: Structural Properties and Constraints using c-M Relation

刘赟　　中国科学院国家天文台

Type Ia Supernovae From the First Generation Stars

李振威 中国科学院云南天文台

8、天文学史、教育与科普分会场报告日程

浙大城市学院天文通识课程对大学生创新思维与创新能力培养的思考与探索

陈志平 浙大城市学院

全国中学生天文知识竞赛的发展现状及其对中小学天文教育的启示

方媛媛 北京天文馆

全国中学生天文知识竞赛是一项重要的全国性青少年天文教育活动，是当前中学生天文爱好者和天文科技教师展示交流和科创实践平台。基于 2003 至 2023 年的参赛数据，总结发展历程、发展现状及存在的问题，并结合 2022-2023 学年竞赛决赛学生的问卷调研，深入探讨天文知识竞赛对中国天文科普教育的启示，研究认为天文知识竞赛适合我国青少年天文科学教育的现状，有助于促进天文科学教育的改革、天文教育资源的丰富及中学天文科学拔尖人才的培养。

从天文知识竞赛题中梳理高中多学科知识点

田蕾 浙江省杭州高级中学

从天文知识竞赛题中梳理高中多学科知识点

山东天文学会的天文科普与科学教育工作

曹晨 山东大学

回顾介绍山东天文学会自 2021 年成立以来，开展的各类天文科普活动与面向大中小学生青少年的天文科学教育工作，分享经历、促进交流合作。

双减形势下开展天文科普教育的几点思考

宋华刚 中国科学院新疆天文台

2023 年 5 月 17 日，教育部等十八部门下发了关于加强新时代中小学科学教育工作的意见。《意见》既强调普及又突出提升，旨在普遍提高亿万青少年科学素质的基础上，培养大批有科学家和工程技术人才潜质的青少年。本报告从天文科普教育方面进行了一定思考，提出了几点建议。

《天文连线的课程、活动、国际合作》

史静思 天文连线教育科技有限公司

学科交叉融合视域下的行星科学导论教学——以“恒星核合成”专题为例

尹睿鹏 成都理工大学

成都理工大学开设了国内第一个行星科学本科班。报告介绍了我校开设行星科学导论课程采取的翻转课堂模式，并以“恒星核合成”专题为例，在学科交叉融合的视角下呈现了教学设计、教学过程、题例评析与教学效果评估环节，探讨了在真正“以学生主导”的课程教学中，教学活动各主体的角色定位。该课程体现了中华传统教育观念“教学相长”，也吸收借鉴了西方“费曼学习法”的精髓，使同学在自主获取与传授知识的过程中意识到跨学科学习与科学研究的基本特点和规律，有望理清行星科学教学培养渗透天文学知识的基本思路。

“无界博物馆”理念下科普与游戏融合创新的探索

施韡　　上海天文馆(上海科技馆分馆)

苏颂水运仪象台与古代中国的天文实践系统

张楠　　中国科学技术大学

在中国古代天文传统之中，观星象、正天度、示昏明、验天运，既是一套完整的思维方式与实践体系，又是历代观象台进行实际天文观测的核心目标。可以说每一个或一组天文仪器和实践步骤，都是为这个目标而制作和设定的。本文以历代司天台基础仪器与实践内容考订为基础，对北宋水运仪象台的集成性结构与功能进行讨论。圭表、漏刻、浑仪和浑象，苏颂水运仪象台试图将观象台的核心仪器设计成一个同步系统，从而通过一个整体装置，实现对古代中国天文观测候验实践传统中立表、计时、观测、成象等不同步骤和功能的集成与展示。

世纪沧桑，观象其昌——中国接管青岛观象台 100 周年

孙恒阳 紫金山天文台

青岛观象台作为我国第一个从外国人手中接管的近代观象台，是我国近代天文、地磁、地震、海洋诸学科的发祥地之一。它虽始创于德人，两度日领，但其主要天文工作却是我国接管后由中国人自己发展起来的，并为我国近代天文事业的奠基和开拓作出重要贡献。 1924 年我国正式从日本人手中接管了青岛观象台，并迎来了其第一个发展时期。在这个时期，蒋丙然，高平子，王应伟，宋春舫等老一辈科学家开创和发展了我国的气象、天文，海洋等诸学科。 1937 年抗日战争时期，日本再度占领青岛观象台，而后直到 1945 年抗日战争胜利，青岛观象台再度回归中国。这期间，由王华文担任台长，进入第二个发展时期。解放战争胜利以后，青岛观象台进入军管时期。此期间，青岛观象台一分为二，气象划归军管，天文，地磁，海洋等则移交中国科学院，并进行学科分流，其中，天文部分划归紫金山天文台。1978 年，青岛观象台撤销建制，划归海洋研究所，后于 1993 年重归紫金山天文台，此为第三个发展时期。 1993 年以后，青岛观象台工作重点由科学观测研究转为科普宣传，成为紫金山天文台科普基地，致力于青少年天文科普推广工作，此为第四个时期。百年来，青岛观象台几易建制，学科内容及方向也不断变化，由原来的综合性研究机构，变为现在科普教育基地，但其在我国天文、气象、海洋等科学史的发展留下了浓重的一笔。

中古时期佛教中的四份二十八宿图像研究

宋神秘 上海中医药大学

晚唐至宋元时期的佛教文献中有四份记载了二十八宿的星点图和星神图，分

别是：唐晚期及以后的《七曜星辰别行法》（805-？）、日本奈良藏《炽盛光佛顶大威德销灾吉祥陀罗尼经》（972 年）、高昌胜金口石窟出土回鹘时期（866-1383 年）的星宿图壁画和藏于日本京都教王护国寺的《火罗图》（1166 年）。这四份文献的特殊之处在于星点图和星神图结合在一起。因为中国传统的二十八宿星点图存在于墓葬、天文星图和天文星占文献中，而且仅有星点图；而对域外二十八宿星点数量和形状的描绘只存在于汉译佛经的文字叙述中，并无具体的图例。同时，带有域外元素的二十八宿星神图主要出现在历代流传的《五星及廿八宿神形图》、佛教星曼荼罗和炽盛光佛图像中，且一般不包含星点图。

这四份佛教文献将中国传统的星点图和源自域外的星神图结合，虽然在对应上存在许多配置错误，但最重要的作用在于赋予星点图不同于以往纯粹天象意义、类似于星神图的神力，同时突出了各星宿在宗教信仰和实践仪式中的个体差异性。但自此以后，星点图的神力主要体现在道教仪式和实践中；而星神图的威力主要展现在佛教和民间信仰中，但这些信仰及其实践多以整体性突出二十八宿图像的功能，其差异性逐渐减弱。

汉正南北龙汉开图两万年——以史籍和道经为主要线索的中国传统星象体系萌芽及变迁略探

易宏　北京独立学者

天文学，产生于古人的时空意识萌发和相伴而生的命运意识觉醒与自主渴望。星占及各类术数和农耕乃至各种科学技术，都实为这些渴望的自然呈现。这，大概也是（古）天文学可被认为是人类最早科学乃至文明开端的原因。

而标志传统天文学成熟度的星象体系，是人们对天球乃至宇宙或时空的体系化认知和标定，是一种总结，而非事先规划。能够称得上体系的星象，首先应该有在自我中心之外殊地与共的中心，即（赤道）天极或/和黄极（特别是北天极和北黄极）；其次应该有可标识日月星辰周天运行和时节的赤道/黄道带星象。

星象体系的开启，应当始于特征明显而易观测且长期可见的星象。始于大约六七千年前的以北斗为中心的中国传统星象体系广为人知，更早的星象传承也被伊世同先生等一些学者注意，但罕见系统性考察。

两万多年前，正南北走向天汉银河通极直连龙虎二星，可见三辰一线过顶中天状观星象。受此启示，吾族古人的北极意识由此萌生，并联系到可能更早关注的赤道-黄道带龙虎二星，这实为我们目前可以推定的华夏星象体系最早萌芽。本文拟综合文献记载、考古发现、天象仿真、集体记忆或文化传承四重证据，尝试对中国传统星象体系的萌芽和发展变迁做一些探索。

二

起初，华夏先民或因贵生而重水，以致把夜空中那巨大的光亮带想象成天上河流，并名之以河、汉，或天河、天汉、星河、星汉、云汉、河汉……在约 23000 多年前开始的约万年间，这天河接近或穿越北极的时候，那北极天区，仿佛就是一切水之源，流布周天，并降至地上原野湖海山川，而且还可时常见到云汉天河过顶中天星象壮观。于是有“汉正南北”、“北极大泉”等等明显描述那一星象

的说法承传并见于《史记》、《道藏》等传世文献。在人们尚未确认北极点的时候，把天河近极段视作（泛）北极，有效方便，且不依赖具体星点。（恒显圈段）银河，还可能被用作回旋授时指示器。发现于洛阳的北魏元乂墓室顶部壁画星图，就是正南北走向银河崇拜的重要古传星图证据。至于多见于道经的“大泉”、“大渊”、“太渊”、“洞渊”、“洞极”等说，应当就是缘起于银河经过北极或其附近时人们对北极天区的指称传承。这些，大概也是，在众多河中河边亮星里只有北极渐远天河时点的织女星，留下这一可综合天文学与人类学等方法推定的当时（母系社会）实际极星名的原因。其间，人们的生产活动开始从采集狩猎向农耕过渡；以天道信仰为核心的，足以获得广泛认同的堪称宇宙宗教的华夏原始道教乃至中华文明的雏形和相关核心概念开始萌生。

另一方面，无关天河视走向而一直位于河畔的龙虎二星官偕日升降与伴河中天星象，同岁时变换的关联，可能早已为人们所注意（“五星出东方”崇拜大概也同偕日升观测相伴而生）。在可见星河通极直连龙虎过顶中天时，华夏先民受此启示，发现周天空间可由此粗略对半二分，周年时间可据之大致（春秋）平分（至少在周天经度位置上可被平等以待的龙虎二星中，龙星或因近银心等因素，而比更亮的虎星更受尊崇）。这，很可能就是道书所记载的：“昔往初劫，龙汉开图”；“龙汉初时，元始开图”；“龙汉开图，天地始分”；“赤明启运，大道流光”；……所传且堪称鸿蒙开辟、文明肇造、元始创教的那个伟大年代。如此以天汉银河直连北极为中心萌生星象体系和时空架构的文明，维持约万年，堪称华夏天道信仰和天道文明星象体系第一期。而且，中国传统上特有的冲日法，很可能就是受直连龙虎二星（对应商参二宿）和北极（星）、三大辰一线牵的通极银河星象的启示而产生；易学、三清、丹道……等等中华文化内核的缘起，还有河出昆仑、黄河之水天上来、天河注水等说，堪称体系化的水源北（方）说，以及太一生水、水几于道等说，以及识中尚中传统，可能也多有那个天启人悟伟大时代的天象渊源。华夏文明的核心概念，多在这期间孕育、萌生。于是，一些局限于北斗体系难以讲得通的古传关星关天说法，以及人类文明的演化与传承传播，也将因据此获得更加广阔且久远的解读时空而更加顺畅。

天汉银河崇拜或信仰文化，不仅在古代传承不绝，而且在当今社会依然活跃，相关典型实例比比皆是。以北京城市中轴线为代表，承自远古的华夏城镇乃至乡村或院落布局所讲究的南北中轴线，实为正南北走向天汉银河与北极崇拜的一种落地具象呈现；1983 年秋我有幸在星城长沙于公开之前隔窗参观的中国首台超算就是“银河 1 号”；中国科幻小说最高奖被名之为“银河奖”；2023 年 5 月发布的汉语大模型“天河天元”，以寓含天汉银河过极（天元为北极别称）经天之象为其名，以处理汉语为其实；有着银河 1 号渊源的银河麒麟被誉为国产操作系统之光；华为鸿蒙操作系统宣发词“没有人能够熄灭满天星光”、“满天星光终汇成璀璨星河”、“星河璀璨，加入鸿蒙正当时”，等等，都传承着银河崇拜等星象文化和天道信仰。诸如此类，不忘天道文明初心，让人感觉这也正是天河文明的新发展。

又，银河天汉，“其称甚美”（见于《汉书·萧何传》），汉、中统一，而且对中华文明影响之深远广博，超越地上任何实体江河，当被尊为母亲河。华夏文明，亦可称天河文明或天汉文明，或地天通的河汉文明。而且，“汉正南北”、“北极大泉”等似为迄今所知见于传世文献记载且可考的人类最早星象记忆，应当列入人类非物质文化遗产名录。

三

极移星易，天汉银河远离北极，拱极星象大变异。织女星近极既是华夏传统星象体系第一期的尾声，又是这一体系第二期的序曲。如见女像而不见织女星象的万年前吉县柿子滩岩画所示，这期星象体系很可能在约 13000 年前天纪九近极和天纪星官被认作群极星时确立。在《北斗经》等道经里，北斗六开阳不仅被称北极星，而且还被称作纪星，应当就是天纪曾被认作群极星的记忆延续。无亮星的长条状七公星官，很可能就是人们对恒显圈段银河绕极回旋授时的怀念，而新构建的回旋授时指示器，这种用途还被后来的近极北斗承继。

这一体系维持约六七千年。这期间，除了开头有织女星开启即远离，而几无堪称耀眼的星辰点明北极，可以说这或实为若非银河体系先立而未必会有的河斗间过渡期。大概也正因此而罕见相关文献记载或传说，以致柿子滩岩画上下星点多被认作天时不符的北南二斗。但是，换一个视角，曾经近极的最亮星织女被以女名，显然不大可能是在父系社会所起，而应当是足够长时间的母系社会命名传世以致难以被抹去；柿子滩岩画的年代和星象均同天纪七公近极高度相符；在道经里，开阳也被称纪星，还有“步罡蹑纪”、“飞罡蹑纪”等说，可能都是对天纪曾被认作群极星的名号承继，当今道士“踏罡步斗”仪态同柿子滩岩画女像高度相似，也可被认为就是稳定的仪式文化传承。

四

斗转极移，在大约 7000 年前，北斗七星全部进入中原地区恒显圈，开启华夏传统星象体系第三期。这个第三期以明亮且近极的北斗七星为中心奠基，并从约 6000 年前北斗六开阳近极开始明确认定北极，且把开阳又命名为北极星（《道藏》所收《北斗经》、《洞真太上八素真经精耀三景妙诀•服北斗九星法》等多种道经里有相关图文传承为证）。河南濮阳西水坡遗址 45 号墓龙虎加上中天北斗星象蚌塑，以及多数出土古式盘，都应是北斗星象体系的考古发现或文物遗存证据。还有汉传“斗极”说，以及堪称西方“熊极”说的源自希腊语 arktos（熊，大熊星座北部）的英语 arctic 等说，表明世界多地都曾把北斗认作群极星。借助科学计算又可知，北斗七星中的最近极星约在-4244 年由北斗七摇光转移到北斗六开阳，而开阳又在约-3392 年达其小于 10 度的最近极点，且为北斗七星全岁差周期最近极点。

西方熊极说和中土斗极说，也都可以视作文献线索（或文化传承），同开阳北极说的时空背景基本一致，只是存在前二者作为群极星之宽泛，和后者作为单极星之精细的差别。北斗六开阳又名北极（星），是迄今所知人类明确命名且有传世文献记述的最早北极星。从群极星到单极星，是北极认知由粗略到精细的飞跃，虽然这并不直接就是精准，但无疑是精准化的开始。

以北斗七星为中心建立的传统星象体系第三期，经北极-勾陈星官接力，延续至今，或许还有上千年续存。

尽管北斗七星已经远离北极，渐次脱离中原地区恒显圈，以致现在用标准镜头对准北极（或今北极星勾陈一）拍不到北斗七星中的任何一颗，显然已不再适合用作指向授时。但是，在当今世界几大卫星导航系统拥有者中，依然有中国，且唯有中国，以其传统的星象崇拜和天道信仰的主要对象或象征之一——北斗，来命名，并用它的近极下中天星象做 LOGO。实际上，北斗导航系统 LOGO 里的那个下中天北斗星象，和能够给人以被天上星星所参意象的北斗，以及能够用作定向授时标识的北斗，都只能是古人对始于约 BP6500 年的约 3000 年间的近极北斗的深刻印象与后世传承，可以说是已成华夏文化 DNA 的北斗。这些，既

是星象体系很难从信仰天道的族人心里消失的生动体现，又是族人相关心灵记忆或文化传承的重要证据。

五

综观古今，便可发现，华夏天道文明史上最尊贵的星象，就是天汉银河与北斗，且当有光辉瞬间作为其标准像千古流传。经深思久想，我确信，它们的标准像应该分别是：汉正南北通极过顶中天巍巍壮观，和北斗近极下中天临制四乡。不论个人还是国家，或族群，其可考历史记忆，是文化自信的重要依凭，坚实度与时长正相关。王卡先生言：“天道信仰是中国传统文化的核心”。冯时先生说：“天文学与其说是一切科学中最早诞生的学问，倒不如说是最早诞生的宗教。”对此，笔者高度认同，并认为，对以天道信仰为传统文化核心且有上万年农耕史的中华民族来说，缘天象线索探寻其崇北极尚中正文化渊源，是很可靠的。关于依据天象的年代考察的可靠性，冯时先生也明确指出：“天象是确定年代的可信赖的依据，而当它与相关的历史的、文献的和考古的资料结合的时候，结果则会更令人瞩目。”这是有天文学和科学计算与仿真保障的。这些综合文献记载、考古发现、天文学与科学计算天象仿真、集体记忆或文化传承四重证据的考察，是科学严谨的，是高度可信的。

这些考察，超越或穿透了此前未见确认传世文献记载五千年前事的认知局限或思维障碍，为天文学史乃至科学史和文明史探索，开拓了更加广阔的空间和久远的时间，是对中华文明和人类文明探源的重要贡献。

地殊天同，教异天一，人别天齐。以星象崇拜为中心的广博而持久的天道信仰传统，很可能也是中华民族成其大、成其久的重要文化基因。面对堪称时空标识的星象，仰观开启文明，崇拜留存记忆，执着束缚发展，令人感叹。如今，人类文明演进大概已不再依赖具体星象体系，但作为华夏乃至人类天文学和天道文明的初心之探寻，我们仍可循那“妙哉龙汉道”，继续探究竟。

描绘苍穹：中外古典星空科学艺术科普展

韩鹏　　托勒密博物馆

一、展览概览

人类观察星空的记载可以追溯到一万多年前，那时的观测者会把星空画在墙壁上，寄托对苍穹的想象。印刷术发明之后，画在纸上的星图得以复制并传遍了世界，成为艺术与科学结合的瑰宝。摄影术出现之后，人类对星空的记录和探索又开启了一个全新的时代。

“描绘苍穹：中外古典星空科学艺术展”基于托勒密博物馆的特色收藏，精选中外古典星图、早期天文类科学仪器等 100 件天文文物，讲述东西方古代文明中认识星空的历程，带领观众在科学与艺术的交相辉映中，于东方眺望宇宙，从历史思考未来。

二、合作机构

托勒密博物馆致力于中外天文地理及自然史文物的收藏与传播，由国际地图收藏家协会会员、国际科学仪器协会会员韩鹏先生创办，中国自然科学博物馆学会会员单位北京春明社文化传播有限公司负责运营。收藏有大量西方及中国的古星图、古地图，原版科学史、自然史经典著作等珍稀古籍，同时还珍藏了各种类别和规

格的天文仪器、航海仪器，以及与天文地理、自然史有关的雕塑、油画等艺术品。文物年代从15世纪至20世纪初，形成了完整的天文地理、自然史文物收藏体系。依托丰富的文物收藏资源，托勒密博物馆策划主办了多个重量级科普展览。如2023年2月，托勒密博物馆与中国科学院紫金山天文台联合主办“星空影像与古典星图特展”，被中央电视台《新闻联播》等多家中央媒体报道。2023年11月，中国自然科学博物馆学会、波兰驻华大使馆指导，中国科技馆与托勒密博物馆联合主办“转动地球的人：哥白尼诞辰550周年纪念展”，《人民日报》纸质版、新华社、《China Daily》、《欧洲时报》等中外知名媒体予以报道。

三、目标观众

主体为青少年（及家长、教师）和天文、自然科学史与艺术爱好者。

四、展览亮点

1、重磅展品

此次展览汇聚100件天文文物，囊括多件早期古董望远镜、古星盘、古铜镜，稀见中国古星图、西方四大古典星图同时亮相，将成为国内迄今最大规模、最具分量的星空科学艺术特展。

2、文明互鉴中的东方画卷

展览以天文史视角展现文明互鉴下的科学进步史，同时并列展示中、日、韩天文文物，引导观众体会中华文明在东亚文化发展史上的影响力，树立文化自信。

3、科学也美丽

展品包括多件精美的古代星盘与星图版画原作等，科学史价值与艺术价值俱佳，能为观众提供愉悦的审美体验。如被誉为“有史以来最华丽的天文图集”的《和谐大宇宙》、四大古典星图等。

五、展览意义

“描绘苍穹：中外古典星空科学艺术展”不仅是一次对东西方古代文明中星空探索历程的回顾与致敬活动，更是一次集科学性、艺术性、教育性于一体的文化盛宴。它让我们在欣赏科学之美与艺术之魅的同时，也让我们更加深刻地认识到人类文明的璀璨与深邃，更加坚定走向未来、探索宇宙的宏伟目标。

在提升公众科学素养与人文素养的同时，此次展览着眼于文明交流互鉴在历史上对科学进步的积极促进作用，以小见大，凸显中华文明的包容性与文化自信，引导观众感受浩瀚宇宙的东方色彩。

中国古代恒星科学数据库的建设与服务

何勃亮 中国科学院国家天文台

中国古代有着久远的恒星观测活动，也留下了大量的观测数据，前几十年间，前辈学者做了大量的研究，也留下了大量的研究数据。除了这些数据外，近些年也不断的有新的材料被发现，基于此，我们构建了一个面向学者和公众的中国古代恒星科学数据库，数据库中不仅储藏了历代的原始数据，也存储了研究数据。并逐步开放接口以供用户使用。

与此同时，我们还在国家天文科学数据中心的支持下，筹建了数据服务界面，用户可以查询数据，也可以做一些在线的计算和可视化工作。

中国古代恒星数据库系统是一个不断发展的系统，数据和功能也在不断的充实和发展中。

“星系马戏团”一种 AI 与公众科学结合的新研究范式

贾鹏　　太原理工大学

自第一次仰望天空，天文学就吸引人类开展探索。近几十年来，天文爱好者和科学家合作获得了诸多发现。随着时域天文和大尺度巡天开展，涌现出的海量数据已经使得传统依靠几个团队的科学研究范式失效。本报告将介绍虚拟天文台公众科学矩阵中的星系马戏团项目，项目将 AI 与公众科学结合，具有网页、微信等多个登录接口和荣誉系统，能够以极少的学习成本迅速融入异常特殊星系发现的科学研究中，能够促进科普和科研结合，促进举国体制科研范式的发展。

天文大数据驱动下的科普资源开发路径探索——以中国科技馆科普实践为例

宋楠　　中国科学技术馆

科技资源科普化的实践创新对践行科技科普“两翼理论”具有重要意义。进入 21 世纪以来，天文学已成为大数据驱动下的基础科学研究，海量天文数据同样给科普资源开发带来无限新的可能：获取公开数据并从中挖掘筛选转化，打造集专业性与趣味性、体验感为一体的优质科普资源。本报告主要介绍中国科技馆从“展教研用”四个维度对天文数据进行科普资源开发的具体路径，从科普受众角度出发，分析梳理适于科普化的天文研究对象、数据类型和转化技术方法，探讨如何充分挖掘天文科学数据的科普教育价值。同时通过“天眼探秘脉冲星之声”这一实际案例，介绍基于 FAST 脉冲星数据进行球幕特色天文课和球幕短片开发制作的过程，并对下一步工作内容和研究方向进行展望。

珍贵的科学遗产—上海天文博物馆的更新改造

朱达一 天璇宇宙

基于 WWT 技术等开发的《地球的眼睛》太空望远镜传奇系列视频的开发与推广

章琢之 上海教育出版社

基于数字天象演示系统的天文科普电影开发——以中国科技馆首部球幕电影开发为例

赵然子 中国科学技术馆

球幕影院及天文馆（天象厅）是科技场馆在天文科普方面的重要宣传阵地，其实现途径主要有两种：一是基于天象演示系统的实时演示讲解；二是天文类球幕电影的播放。基于天象演示系统的实时演示讲解因其良好的互动性等优势广泛受到观众的喜爱，但其缺点是对讲解教师的能力要求较高，规模性推广和复制能力不足。天文类球幕电影有效避免了上述问题，可以普惠更多需要天文知识的公众，是现阶段国内天文科普所采取的重要手段之一。

但球幕影片的制作无论实拍或是 CG 动画，成本都十分高昂，且相对于一般商业影片，因其格式特殊、市场容量小的特点，无法摊平高昂的制作成本，所以租赁价格不菲，也导致部分场馆因经费原因无法保持较为合理的节目更新频率。随着计算机技术的飞速发展，数字天象演示设备不仅在科学可视化和三维动画模型上愈加精细和逼真，更具备了视频采集的功能，为科普场馆自主开发回放式天象节目提供了硬件基础，在天文演示视频素材的获取上，再次投入的成本相对于传统的实拍和 CG 动画制作几乎为零。综上所述，为了探索这一道路的可行性，中国科学技术馆立项《基于数字天象演示系统的球幕天象节目开发研究》课题，该课题已于2023年2月结题，成果包含完全自主制作的21分钟 4K 分辨率 30FPS 球幕电影《群星闪耀的夜空》一部，适用于 0-30° 倾角的球幕影院和天象厅播放。

影片于 2023 年 12 月获得国家电影局电影公映许可证，于 2024 年 4 月 14 日在第十四届北京国际电影节上联合十二家省级科技馆面向全球首映，并获本届电影节科技单元"最佳科学家精神影片"奖。影片入围捷克布尔诺球幕电影节、中加国际电影节和莫斯科国际科学电影节，并受邀参加北京天文馆 2024 年国际天文馆日展映活动，通过一系列电影节和展映活动面向全球展映。此外，截止 6 月 5 日，有 54 家科普场馆通过 2024 年“光影科学梦”科普、科幻、科学家精神电影全国科普场馆巡映活动申请播放本影片，取得了良好的科学文化传播效果和社会反响。

报告将对利用数字天象演示系统的天文演示功能，以极低的成本开发高质量

天文科普球幕天象节目的理论基础、可行性研究、适用范围、开发流程、项目组在影片开发过程中以及海外推广方面的相关经验进行总结阐述，为新时代科普场馆的天文科普球幕电影的自主开发探索了一条新的道路。

山东大学天文科普工作与学生天文社团建设

任大勇 山东大学

山东大学威海天文台于 2007 年 6 月 9 日建成并投入使用，山东大学空间科学与物理学院负责天文台的日常运行与管理，学院与天文台秉承“知识服务大众，科学引导人生”的理念，十余年来持续开展各类科普活动。天文台年均举办各类科普活动超 150 场次，年均受众超 12000 人次，根据学校一体化发展战略，近年来学院与天文台积极拓展“一校三地”系列科普活动，并克服诸多困难尝试探索线上科普活动，使线上科普内容与线下科普活动形式上相互结合，内容上互为补充。在组织机构与科普队伍建设方面，建有山东省首批科普专家工作室——山东大学天文与空间科学科普工作室，并获评山东省科普示范工程科普示范团队；山东大学空间科学研究院框架下设有科普工作团组，设有专职科普工作人员，学院与研究院多名专家学者、学科带头人参与科普工作；山东天文学会挂靠于空间科学研究院；山东大学威海天文台先后获评全国科普教育基地、“‘科创筑梦’助力‘双减’科普行动”试点单位、山东省科普示范工程科普示范基地等称号。与此同时，团队还指导学生天文社团建设与活动开展，指导的山东大学（威海）天文协会多次获评山东省优秀大学生科技社团、连续三年获评山东大学十佳学生社团、连续十年获评校区五星级学生社团，山东大学（青岛）天文协会在山东大学青岛校区也开展了诸多天文科普与教育活动，近年来，还不断与济南校区天文协会增强联系，联合开展活动，现“一校三地”天文社团在学院、指导教师、学生层面均已建立较为完善的联络机制，共同推进三地学生天文社团建设与发展。

本报告将主要介绍山东大学天文与空间科学科普工作开展情况、学生天文社团建设与活动开展情况，探讨科普工作与社团建设中面临的困难与不足，与各地天文科普组织与工作者共同探索天文科普与教育工作新思路，共同推进我国天文科普与教育事业发展。

苏州市青少年天文观测站迁建

孔令军 苏州市科普事业发展服务中心

简要回顾了苏州市青少年天文观测站建站及发展历程，重点介绍了迁建项目的基本概况，阐述了项目建设的总体理念，建筑的设计特点，以及对未来工作思路的初步谋划。

9、人工智能与天文大数据分会

分会背景介绍

崔辰州 国家天文台

天文图像大模型的需求和想法

沈世银 上海天文台

多模态大模型与太阳物理研究

林佳本 国家天文台

近年来 AI For Science 发展迅速，一个典型代表是生物学领域的 AlphaFold，传统的蛋白质折叠研究方法耗时且成本高昂，AlphaFold 能够快速准确地预测蛋白质结构，大大加速了药物发现、疾病机理研究等科学领域的研究进程。这一成果展示了人工智能在解决复杂科学问题方面的巨大潜力。太阳物理领域（亦或可以说天文领域？）虽然已经有很多 AI 的应用，但是至今尚没有能够媲美 AlphaFold 的人工智能工作，报告希望探讨太阳物理领域数据特点及当下热点的多模态大模型人工智能方法，梳理两者结合的技术路径，介绍我们已经开展的部分工作和接下来的工作想法。

FALCO(隼)：时域光变基础模型规划与进展

陶一寒 国家天文台

时域天文学面临着源于海量数据和对高性能实时处理需求的巨大挑战。为更好地应对这些挑战，我们借鉴人工智能领域大模型的自监督学习思想和模型架构设计，提出了 FALCO（隼），一个光变分析多任务通用的基础模型。基于 Kepler 数据预训练建立的模型，在下游任务中的测试结果展现了基础模型的潜力，未来工作将进一步扩展光变数据来源，并探索模型在更多科学任务中的应用。

FAST 数据处理与表征模型

陈华曦 之江实验室

Chemiverse: 天体化学数据库与系列模型

王佳玮 之江实验室

SpecCLIP：光谱数据的深度映射与参数估计

孔啸　国家天文台

面向天文大数据的在线科学平台

李长华 国家天文台

Human-machine cooperation in astronomy in the era of big data

李楠　国家天文台

Data Challenge of Radio Astronomy

邓新坪 中电五十四研究所

基于大规模巡天档案数据对致密双星族群的系统性搜寻研究

任亮亮 安徽科技学院

银河系极致密双星是轨道周期极短并且有可能在毫赫兹频段内产生连续引力波辐射的引力波源，也是 LISA、天琴和太极等空间引力波探测器的主要探测目标。极致密双星族群包含白矮星双星、毫秒脉冲星双星在内，并且在 X 射线、光学波段、甚至伽马射线波段等电磁波段可以观测到对应体，因此是理想的多波段、多信使研究对象。银河系极致密双星在天体物理学和基础物理学研究中发挥着一系列重要作用，例如：研究双白矮星和 AM CVn 型系统的演化机制；利用双白矮星的引力波辐射检验额外偏振模、检验毫秒脉冲星的“Recycling Process”模型等。目前，大规模巡天望远镜项目 Gaia、ZTF、LAMOST、SDSS 等提供了数十亿颗天体的天体测量、时域测光和光谱信息，这为系统性的开展极致密双星族群的调查研究提供了机会。本报告将应用空间和地基巡天望远镜数据，包括高精度天测数据和时域光变数据，4FGL-DR3 星表，考虑光变周期算法和数据爬虫技术筛选致密双星族群样本，利用光谱观测进行认证，结合空间引力波探测项目，旨在进一步发掘更多的引力波“检验双星”。

Transforming Data into Insights: AI-Driven X-Ray Source Classification within the NADC Framework

左肖雄 国家天文台

The advent of AI has revolutionized the field of astronomy, particularly in the realm of time-domain astronomy. This talk focuses on the application of AI within the framework of the National Astronomical Data Center of China (NADC), which encompasses its data infrastructure and science platform. The NADC framework plays a pivotal role in converting raw astronomical data into valuable scientific insights. The Einstein Probe (EP) serves as a case study, exemplifying the integration of AI with the NADC framework to enhance the discovery and analysis of transients and variable sources. The Time Domain Information Center (TDIC) science platform within the NADC facilitates the application of AI for science and enabling the efficient handling and interpretation of vast datasets generated by astronomical satellites like the EP.

The core of this talk focuses on the development and implementation of a classification algorithm within the NADC framework. The algorithm, a Random Forest classifier, leverages features extracted from light curves, energy spectra, and spatial information to autonomously classify observed X-ray sources. Demonstrating

remarkable accuracy rates of approximately 95% on EP simulation data and an impressive 98% on observational data from the EP pathfinder Lobster Eye Imager for Astronomy (LEIA). The integration of this AI classifier into the data processing pipeline not only accelerates the manual validation process but also serves as a testament to the NADC's commitment to advancing scientific research through technological innovation. The talk concludes with an exploration of the implications of the most effective features for X-ray source classification and the broader application of these AI techniques to other X-ray telescope data, thereby setting the stage for future advancements in time-domain astronomy. By showcasing the successful application of AI within the NADC framework, this talk aims to inspire further integration of technologies in astronomical research, paving the way for new discoveries and a deeper understanding of the universe.

CMB Delensing with Deep Learning

倪书磊 之江实验室

Accurately Predicting Halo Mass from Observables with Machine Learning: Revisiting Halo Quenching Mechanisms

Hassen Yesuf 上海天文台

Accurately estimating dark matter halo masses is essential for advancing our understanding of cosmology and galaxy evolution, but it presents substantial challenges. Direct methods, such as gravitational lensing and satellite kinematics, require deep, high-resolution imaging or spectroscopy, making them impractical for large samples and often limiting them to average data from stacking analyses. In this study, we employ machine learning techniques, specifically gradient boosting, to predict halo mass with high accuracy (R^2 = 0.98, scatter $\sigma \approx$ 0.1 dex) using observable galaxy or galaxy group properties. These include multiscale (0.1 – 10 Mpc) stellar mass distributions, group velocity dispersion, distance to halo center, and satellite/central galaxy classification. By leveraging large datasets from three state-of-the-art cosmological simulations for training and calibration, our approach provides a more precise and efficient method for inferring halo masses in large surveys such as SDSS and GAMA. Our estimates show strong agreement with previous group mass estimates from GAMA and the SDSS catalog (Tempel et al.), while revealing significant discrepancies among other methods. Applying our

measurements, we compare the halo mass and star formation quenching between observations and simulations, revealing that current cosmological simulations fail to accurately reproduce the inferred galaxy-halo connection, particularly the quenched fraction and star formation rate patterns as a function of halo mass at fixed stellar mass. This highlights the need for revisions in the treatment of environmental effects and feedback mechanisms in current simulations.

利用生成式模型进行复杂星系形态生成下的颜色可靠性

叶人豪 上海天文台

生成式人工智能在日常图像生成中所取得的显著效果让我们看见了 AI 在精确生成复杂星系以及通过少量隐变量编码星系信息的潜力。先前的许多研究中通常使用 VAE 这种 Encoder 和 Decoder 结构来让重构图像的损失函数作为隐变量构建的指导，但通常只集中于实现特定的下游任务，例如星系形态分类、光谱去噪等。为了实现更好的星系图像仿真，和建立通用的隐变量编码星系星表，在本文中，我们利用 DESI 测光图像从颜色和星等的角度讨论了图像重构损失是否能够让网络意识到星系重建的物理含义。我们发现，直接预测星系各波段的流量图能够实现较好的颜色复原能力，并且在星系的逐像素星等和总星等上能够与原图星等控制在 2%以内。考虑到星系的多波段图片本质是由星系的颜色所决定，我们利用 VAE 测试直接生成颜色图的效果，发现此方式基本等价于生成流量图。最后，对于提升星系重建效果，我们发现使用天文观测图像的误差将 VAE 常用的 MSE 损失修改为卡方损失能够进一步提升星系整体颜色的重建准确度。

基于机器学习搜寻高红移类星体

叶广平 华中科技大学

We present a machine learning search for high-redshift ($5.0 < z < 6.5$) quasars using the combined photometric data from the DESI Imaging Legacy Surveys and the WISE survey. We explore the imputation of missing values for high-redshift quasars, discuss the feature selections, compare different machine learning algorithms, and investigate the selections of class ensemble for the training sample, then we find that the random forest model is very effective in separating the high-redshift quasars from various contaminators. The 11-class random forest model can achieve a precision of 96.43% and a recall of 91.53% for high-redshift quasars for the test set. We demonstrate that the completeness of the high-redshift quasars can reach as high as 82.20%. The final catalog consists of 216,949 high-redshift quasar candidates with 476 high probable ones in the entire Legacy Surveys DR9 footprint, and we make the catalog publicly available. Using MUSE and DESI-EDR public spectra, we find that

14 true high-redshift quasars (11 in the training sample) out of 21 candidates are correctly identified for MUSE, and 20 true high-redshift quasars (11 in the training sample) out of 21 candidates are correctly identified for DESI-EDR. Additionally, we estimate photometric redshift for the high-redshift quasar candidates using random forest regression model with a high precision.

嘉宾论坛：漫谈 2024 年诺贝尔奖

李楠&施韡 国家天文台&上海天文馆

受到瞬态噪声污染时引力波波源参数的稳健性推断

熊春雨 东北大学

Gravitational wave (GW) detection is of paramount importance in fundamental physics and GW astronomy, yet it presents formidable challenges. One significant challenge is the removal of noise transient artifacts known as ``glitches'', which greatly impact the search and identification of GWs. Recent research has achieved remarkable results in data denoising, often using effective modeling methods to remove glitches. However, for glitches from uncertain or unknown sources, current methods cannot completely eliminate them from the GW signal. In this work, we leverage the inherent robustness of machine learning to obtain reliable posterior parameter distributions directly from GW data contaminated by glitches. Our network model provides reasonable and rapid parameter inference even in the presence of glitches, without needing to remove them. We also investigate various factors affecting the rationality of parameter inference in our normalizing flow network, including glitch and GW parameters. The results demonstrate that the normalizing flow can reasonably infer the source parameters of GWs even with unknown contamination. We find that the nature of the glitch itself is the only factor that can affect the rationality of the inferred results. With improvements to our model, we anticipate accelerating the localization of electromagnetic counterparts and providing priors for more accurate deglitching, thereby speeding up subsequent data processing procedures.

FAST 扩阵列成像模拟与数据处理探索

张利 贵州大学

极端质量比旋近系统的全参数估计

邹晓博 国科大杭州高等研究院

利用神经网络加速天体物理中的数值模拟

董若冰 北京大学

探索行星形成的过程不仅揭示了地球及其生命的起源，还为寻找地外生命提供了关键线索。行星在原行星盘中形成。原行星盘是由气体和尘埃构成的扁平盘状系统，围绕在新生恒星的周围，其跨度可达数千亿公里。近年来，通过分析行星对原行星盘的引力扰动，并比较观测和数值模拟，天文学家得以推断正在盘中形成的行星的质量和轨道。然而，这种方法依赖于复杂的流体力学数值模拟，因计算成本高昂而难以普及。

为了克服这一挑战，我们开发了一款基于机器学习的工具。该工具应用数据驱动的深度算子网络(DeepONet)，将系统的参数映射到流体力学偏微分方程的解，从而无需昂贵的数值模拟即可实现两项功能: 1)快速求解正问题，即从行星参数预测盘中物质分布和速度场;2) 高效求解反问题，即从观测到的扰动图像中推断行星参数。我们展示了该工具在求解速度、精确性和鲁棒性方面的显著优势，并讨论了其在理论研究和观测中的潜在应用。

我们还探索了物理信息神经网络(PINN)在这一问题的应用，特别是针对原初行星盘中旋转吸积流的时间依赖性二维可压缩 Navier-Stokes 方程。行星引力扰动引入显著的时间依赖性空间特征，使问题复杂化。通过对物理定律而非标注数据的训练，PINN 在捕捉系统演化的空间高频特征方面展现潜力。标准 PINN 在此任务中存在收敛困难、预测误差随时间累积、长时间解偏离物理定律以及捕捉空间高频特征能力不足的问题。为此，我们的研究引入了自适应激活函数、时间推进策略和网络权重继承方法，以提升 PINN 性能。改进后的 PINN 模型在与标准 PINN 的比较中表现出显著更低的预测误差，成功再现了大部分空间高频特征，无需标注数据。这项研究为将 PINN 应用于类似的时间依赖性流体力学问题提供了重要参考。

Deep learning-driven likelihood-free parameter inference for 21-cm forest observations

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The hyperfine structure absorption lines of neutral hydrogen in spectra of high-redshift radio sources, known collectively as the 21-cm forest, have been demonstrated as a sensitive probe to the small-scale structures governed by the dark matter (DM) properties, as well as the thermal history of the intergalactic medium regulated by the first galaxies during the epoch of reionization. By statistically analyzing these spectral features, the one-dimensional (1D) power spectrum of the 21-cm forest can effectively break the parameter degeneracies and constrain the properties of both DM and the first galaxies. However, conventional parameter inference methods face challenges due to computationally expensive simulations for 21-cm forest and the non-Gaussian signal characteristics. To address these issues, we introduce generative normalizing flows for data augmentation and inference normalizing flows for parameters estimation. This approach efficiently estimates parameters from minimally simulated datasets with non-Gaussian signals. Using simulated data from the upcoming Square Kilometre Array (SKA), we demonstrate the ability of the deep learning-driven likelihood-free approach to generate accurate posterior distributions, providing a robust and efficient tool for probing DM and the cosmic heating history using the 1D power spectrum of 21-cm forest in the era of SKA.

An AI-based Spectral Zoo for Science and Education

田海俊 杭州电子科技大学

LAMOST 同源光谱查看工具

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LAMOST 运行至今已积累了千万级的低分辨率和中分辨率光谱数据，其中包含了对很多天体的多次观测光谱。为了方便研究人员对 LAMOST 同源光谱分析，我们开发了一款基于网页端的 LAMOST 同源光谱检索和分析工具。利用该工具能够便捷地检索 LAMOST 同源光谱，对多条同源的中、低分辨率光谱及参数进行展示和对比。该工具还提供了线指数计算、连续谱拟合与高斯平滑处理等功能。

爱因斯坦探针卫星高能光子数据库

张震　国家天文台