从爱因斯坦到黑洞的发现

FROM EINSTEIN TO THE DISCOVERY OF BLACK HOLES

CONFERENCE HANDBOOK 会议手册

2026.10.27
TSINGHUA UNIVERSITY

清华大学丘成桐数学科学中心 Yau Mathematical Sciences Center, Tsinghua University
清华大学求真书院 Qiuzhen College, Tsinghua University
中国科学院高能物理研究所 Institute of High Energy Physics, Chinese Academy of Sciences
National Astronomical Observatories, Chinese Academy of Sciences

主办方介绍 / About YMSC

清华大学丘成桐数学科学中心

Yau Mathematical Sciences Center (YMSC), Tsinghua University

189	100	89
教师和科研人员	教师	博士后

数学科学中心成立于 2009 年 12 月，特聘国际著名数学大师丘成桐先生担任中心主任。作为支持清华大学发展数学学科的重大战略举措，教育部于 2014 年底同意依托清华大学成立“丘成桐数学科学中心”。笃行不怠、赓续前行，十七年来，数学中心在高端人才引进、杰出人才培养、高水平学术研究和数学学科建设等方面实现了跨越式发展，成为具有重要国际影响力的数学研究中心。

截至 2026 年 3 月，数学中心共有全职教师和科研人员 189 人，其中教师 100 人（外籍 22 人），博士后 89 人（外籍 29 人）。中心已经建成以纯粹数学为核心的“五大领域”和“三个交叉研究方向”的综合性学科布局，共六大科研团队。代数与数论、数学物理以及动力系统与随机分析这三个科研团队，已达到世界顶尖水平。

中心国际一流学者云集，目前在职包括丘成桐、Caucher Birkar、Nicolai Reshetikhin、Akito Futaki、Vladimir Markovic、Kenji Fukaya 等国际知名教授，中心有 2 位菲尔兹奖获得者、2 位邵逸夫奖得主、5 位院士；中青年学者出类拔萃，多人入选国家级人才政策和科研基金支持项目。

集美清华，求真淬炼。清华大学丘成桐数学科学中心、数学科学系、求真书院，与北京雁栖湖应用数学研究院紧密合作，携手构筑高水平数学科学人才培养、学术研究的基地，为清华大学迈向世界一流大学前列和中国数学学科的繁荣发展贡献力量。

About YMSC

Yau Mathematical Sciences Center

Tsinghua University

In December 2009, Tsinghua University established the Mathematical Sciences Center, with internationally renowned mathematician Professor Shing-Tung Yau as the director. In late 2014, China's Ministry of Education officially approved the establishment of the YMSC at Tsinghua University. Over 17 years of development, the YMSC has emerged as a world-class research institute. It has excelled in recruiting a prestigious group of faculty members, nurturing a new generation of talented scholars, and spearheading cutting-edge research across various disciplines within the Mathematical Sciences.

As of March 2026, the YMSC has a total of 189 full-time faculty members and researchers, including 100 faculty members (22 international faculty) and 89 postdoctoral researchers (29 international postdoctoral researchers). Mathematical research at YMSC covers five major areas and three interdisciplinary research fields. Notably, of the six pillar research teams, the research teams in Algebra and Number Theory, Mathematical Physics, Dynamical Systems and Random Analysis have achieved remarkable original results that contribute significantly to their respective fields.

The YMSC boasts internationally renowned scholars, currently working at YMSC including Shing-Tung Yau, Caucher Birkar, Nicolai Reshetikhin, Vladimir Markovic, Kenji Fukaya and Akito Futaki. Among these esteemed members, there are two Fields Medalists, 2 Shaw Prize Winners and five Academicians. Many promising young mathematicians of YMSC have been recognized with various national funds and talent support programs.

The YMSC has collaborated with the Department of Mathematical Sciences, the Qiuzhen College of Tsinghua University, and the Beijing Institute of Mathematical Sciences and Applications, to build a top platform for mathematical education and research, contributing to Tsinghua University's goal of becoming one of the world-class universities, and promoting the growth and prosperity of the mathematical sciences in China.

中心主任 / Director



丘成桐
Shing-Tung Yau

清华大学讲席教授
中国科学院外籍院士
美国国家科学院院士
美国艺术与科学院院士

丘成桐教授开创了数学中极为重要的分支“几何分析”。他解决的卡拉比猜想在数学界和物理学界被称为卡拉比 - 丘空间，不单单是代数几何和数论中的主要工具，也成为高能物理中宇宙的主要模型。他先后获得菲尔兹奖 (Fields Medal)、克拉福德奖 (Crafoord Prize)、沃尔夫奖 (Wolf Prize)、马塞尔·格罗斯曼奖 (Marcel Grossmann Awards)、邵逸夫奖 (The Shaw Prize) 等国际科学大奖。

Shing-Tung Yau is a Member of the U.S. National Academy of Sciences, a Member of the American Academy of Arts and Sciences, and a Foreign Member of the Chinese Academy of Sciences. He is the Chair Professor of Tsinghua University, the emeritus William Casper Graustein Professor of Mathematics and emeritus professor of physics at Harvard University. He has received the Fields Medal (1982), the Crafoord Prize (1994), the Wolf Prize (2010), the Marcel Grossmann Award (2018), and the Shaw Prize (2023).

About the Meeting

从爱因斯坦到黑洞的发现

FROM EINSTEIN TO THE DISCOVERY OF BLACK HOLES

本次为期一天的学术会议以“从爱因斯坦到黑洞的发现”为主题，回顾从爱因斯坦广义相对论的建立到当代黑洞研究的发展历程，汇聚天文观测、引力理论与数学基础等领域的研究成果。会议学术报告将涵盖黑洞及相关现象的天文观测研究、黑洞与量子引力的理论问题，以及广义相对论的数学研究进展。

会议晚间将举办一场面向公众的科普讲座，由事件视界望远镜（Event Horizon Telescope，EHT）项目创始主任 Sheperd Doeleman 主讲(https://ymsc.tsinghua.edu.cn/info/1057/5304.htm)。EHT 项目拍摄的里程碑式黑洞图像，让黑洞首次以图像的形式走入公众视野，并开启了引力观测研究的新时代。

本次会议将带领与会者从基础理论出发，走近现代黑洞研究的前沿发现，为科研工作者、青年学生及广大公众提供一次贯通数学、物理与天文学的学术交流与科学探索之旅。

This one-day conference traces the path from Einstein’s general relativity to today’s understanding of black holes, bringing together observation, theory, and mathematics. The scientific program will feature talks on astrophysical observations of black holes and related phenomena; on theoretical aspects of quantum gravity and black holes; and on mathematical developments in general relativity.

In the evening, the conference concludes with a public lecture by Sheperd Doeleman (https://ymsc.tsinghua.edu.cn/info/1057/5304.htm), founding director of the Event Horizon Telescope (EHT) project, whose landmark images have brought black holes into public view and opened a new era in observational gravity.

Together, the day offers a compact journey from foundational ideas to cutting-edge discovery - for researchers, students, and the broader public.

基本信息 / At a Glance

DATE / 日期	October 27, 2026 / 2026 年 10 月 27 日
TIME / 时间	09:00–20:30
VENUE / 地点	Tsinghua University / 清华大学
ROOM / 会场	Qiuzhen Auditorium / 求真讲堂

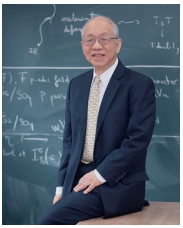
Program

October 27, 2026 ·Tuesday / 2026 年 10 月 27 日

Time	Topic	Speaker
09:00–09:05	Opening Remarks	Shing-Tung Yau
	Morning Session Chair: Qiao-Yin Pan	
09:05–10:05	In-Depth Exploration of the Extreme Universe	Shuang-Nan Zhang
10:05–11:05	Large Gaps and BTZ Entropy in Discrete Modular Spectra	Chi-Ming Chang
11:05–11:25	**Break**	
11:25–12:25	The Era of Optical Interferometric Observations: Supermassive Black Holes, Binary and Satellite Black Holes	Jian-Min Wang
12:30–14:00	**Lunch (Speakers & invited participants only)**	
	Afternoon Session Chair: Liangyu Chen	
14:00–15:00	Constraining the Yukawa Metric with Supermassive Black Hole Systems	Yuan Tan
15:00–16:00	Weighing Supermassive Black Holes with Quasi-Periodic Eruptions	Zhen Pan
16:00–16:20	**Break**	
16:20–17:20	Mathematical Foundations of Black Holes	Shing-Tung Yau
17:30–19:00	**Dinner (Speakers & invited participants only)**	
19:30–20:30	**Public Lecture / 公众讲座** From Still Images to Video: Observing Supermassive Black Holes on Event-horizon Scales	Sheperd Doeleman

Note: Lunch and dinner are for **speakers and invited participants only**. Other participants are kindly requested to make their own meal arrangements.

Speakers



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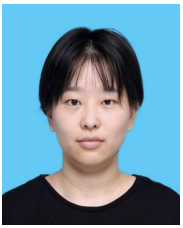


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Speakers



Yuan Tan

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Sheperd Doeleman

Senior Research Fellow

Center for Astrophysics, Harvard & Smithsonian

sdoeleman@sao.si.edu

Titles and Abstracts

09:05–10:05

In-Depth Exploration of the Extreme Universe

Shuang-Nan Zhang (张双南) ·IHEP, CAS



In recent years, China has launched and operated several space astronomy missions such as Wukong, POLAR, Insight-HXMT, GECAM, Einstein Probe (EP), and SVOM, embarking on a journey to explore the extreme universe, including studies on black holes. Nevertheless, numerous key scientific questions about the extreme universe remain to be solved. These include problems related to extreme origin, extreme energy, extreme celestial objects, extreme gravity, extreme density, and extreme magnetic fields.

In the next 5–15 years, we plan to address and solve these questions through several internationally leading large-scale space high-energy astrophysics missions. These include the “High Energy cosmic-Radiation Detection” (HERD) experiment, to be operated on China’s space station; the enhanced X-ray Timing and Polarimetry (eXTP) space observatory; and the “Chasing All Transients Constellation Hunters” (CATCH) plan, consisting of about one hundred of microsatellites controlled by AI. These projects are poised to bring revolutionary advancements to the in-depth exploration of the extreme universe.

Titles and Abstracts

10:05–11:05

Large Gaps and BTZ Entropy in Discrete Modular Spectra

Chi-Ming Chang (张其明) ·YMSC, Tsinghua University



A microscopic description of pure AdS_3 gravity calls for a discrete spectrum with positive integer multiplicities, a unique vacuum, and a large primary gap, all compatible with modular invariance.

I will present a construction satisfying these genus-one requirements for every sufficiently large real central charge ($c_L = c_R = c$). Starting from the modular completion of the Virasoro vacuum, the construction combines exact local spectral repair with integer moment matching to replace a signed continuum by a locally finite spectrum while preserving modular invariance. The resulting families include primary gaps exceeding $c/12$ by an amount of order c, as well as gaps $\Delta_1 = (c-1)/12 + \delta$ for any fixed $\delta \geq 0$.

For the latter family, the spectral entropy agrees with the perturbative BTZ prediction through every fixed finite order in $1/c$, using the same fixed energy smoothing on both sides and holding $E/c > 0$ fixed. This agreement extends to energies where the BTZ saddle is canonically subdominant. Different microscopic spectra can share the same perturbative entropy expansion. I will discuss the implications for pure AdS_3 gravity and the additional consistency conditions required for a full CFT realization.

Based on joint work with Reiko Liu and Wen-Jie Ma.

Titles and Abstracts

11:25–12:25

The Era of Optical Interferometric Observations: Supermassive Black Holes, Binary and Satellite Black Holes

Jian-Min Wang (王建民) ·IHEP, CAS



The Very Large Telescope Interferometer (VLTI) of the European Southern Observatory (ESO) has successfully carried out optical interferometric observations of the Galactic Centre black hole as well as distant quasars.

This lecture will introduce how optical interferometric arrays can achieve further precise observations of individual supermassive black holes (SMBHs), binary black holes, and satellite black holes surrounding SMBHs, together with their close synergy with gravitational waves.

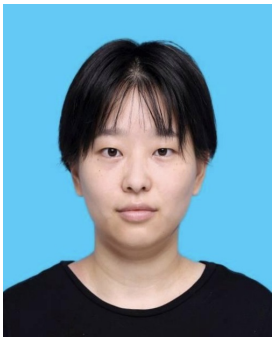
Moreover, the arrays will allow us to measure geometric distances of quasars for cosmology.

Titles and Abstracts

14:00–15:00

Constraining the Yukawa Metric with Supermassive Black Hole Systems

Yuan Tan (谭媛) ·NAOC, CAS



Over the past century, general relativity has achieved great success yet faces fundamental challenges, motivating modified gravity theories such as $f(R)$ gravity and entropic gravity, many of which predict a Yukawa metric with parameters λ and κ.

Most existing bounds on this metric come from weak-field tests, while strong-field constraints remain rare. We use Galactic Center S-stars and EHT black hole shadow observations to constrain Yukawa gravity. We derive post-Newtonian equations and perform joint fits with S2, S38 and S55, obtaining tight limits on κ.

We also extract constraints from Sgr A* and M87* shadows and discuss improvements expected from future ngEHT and BHEX facilities using second photon ring.

Titles and Abstracts

15:00–16:00

Weighing Supermassive Black Holes with Quasi-Periodic Eruptions

Zhen Pan (潘震) ·TDLI, SJTU



Quasi-periodic eruptions (QPEs) are recurrent soft X-ray flares from galactic nuclei. More and more analyses show that QPEs are the result of collisions between a stellar mass object (a stellar mass black hole or a main sequence star) and an accretion disk around a supermassive black hole (SMBH). Therefore, QPEs provides an unprecedented opportunity to trace stellar mass objects in the vicinity of extragalactic SMBHs and consequently measure the SMBH masses.

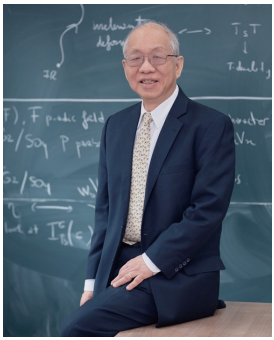
In this talk, I will first review QPE observations and the QPE timing method, then outline the roadmap for weighing a large sample of SMBHs with wide-field survey and spectroscopic follow-up instruments in the time-domain astronomy era.

Titles and Abstracts

16:20–17:20

Mathematical Foundations of Black Holes

Shing-Tung Yau (丘成桐) ·YMSC, Tsinghua University



The mathematical theory of black holes centers on three fundamental problems: formation, stability, and uniqueness. The Oppenheimer–Snyder model describes gravitational collapse under restrictive spherical symmetry, while Penrose's trapped-surface principle provides a mathematical framework, leaving open its realization in general physical spacetimes. Schoen–Yau established a deeper geometric foundation through the Einstein constraint equations, and Yau subsequently identified an intrinsic mechanism independent of matter. These developments provided geometric motivation for Christodoulou's dynamical black-hole formation without symmetry, further advanced by recent work of Mondal–Yau to much more general spacetimes.

I will discuss how these results connect horizon formation and stability with classical uniqueness, toward a unified understanding of black holes and their genericity.

Public Lecture

19:30–20:30 ·Tuesday, October 27



From Still Images to Video: Observing Supermassive Black Holes on Event-horizon Scales

Sheperd Doeleman

Center for Astrophysics, Harvard & Smithsonian

Black holes are cosmic objects so small and dense, that nothing, not even light can escape their gravitational pull. Until recently, no one had ever seen what a black hole actually looked like. Einstein's theories predict that a distant observer should see a ring of light encircling the black hole, which forms when radiation emitted by infalling hot gas is lensed by the extreme gravity near the event horizon.

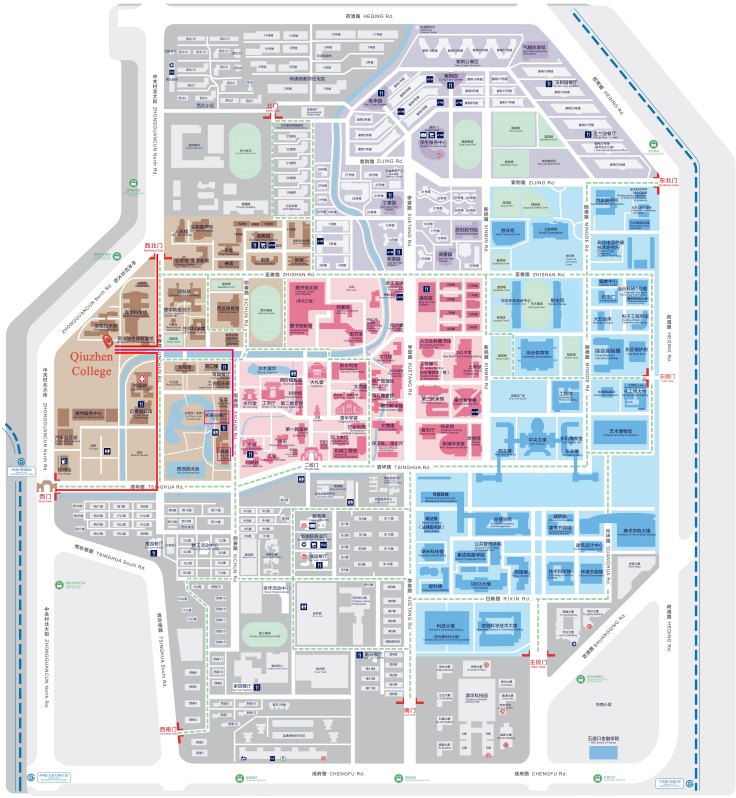
The Event Horizon Telescope (EHT) is a global array of radio dishes that has now successfully imaged the 6.5 billion solar mass black hole at the center of galaxy M87, and the 4 million solar mass black hole at the center of the Milky Way – both exhibiting the predicted strong gravitational lensing. Subsequent observations have revealed ordered magnetic fields on horizon scales with implications on how black holes launch relativistic jets of material.

What's next? The next-generation EHT (ngEHT) is a project to expand the EHT in several ways, enabling us to make full-color, high definition movies of black holes in pursuit of the next big questions. This talk will cover the first EHT results, what we have learned about black holes from these observations, future directions, and progress towards realizing the ngEHT.

Useful Information / 会务信息

Campus Location / 校园位置

Tsinghua University Campus Map / 清华大学校园总图



Qiuzhen College is marked on the campus map. / 图中已标出求真书院的位置。

Venue / 会场

Qiuzhen Auditorium
Qiuzhen College, Tsinghua University
清华大学求真书院·求真讲堂

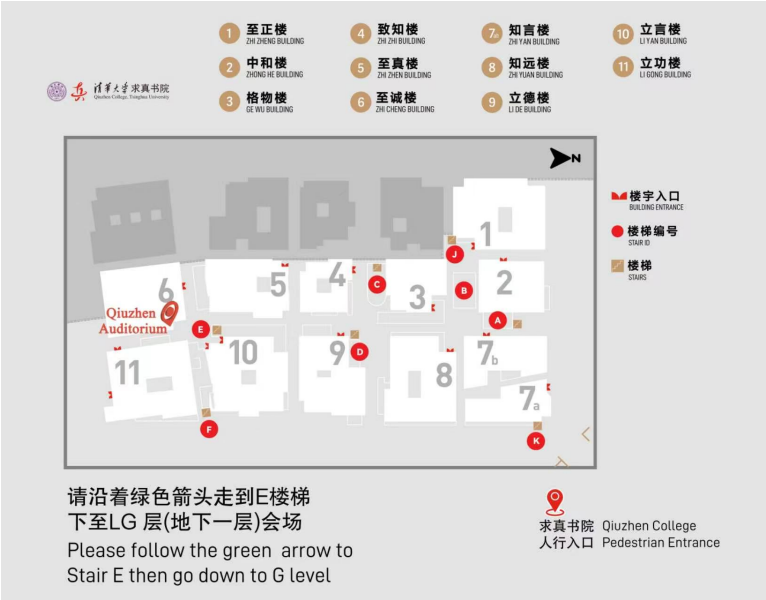
Contact / 联系

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Access to Venue / 会场导览

Qiuzhen College / 求真书院

Qiuzhen Auditorium / 求真讲堂



Stair E to LG level / 经 E 楼梯下至 LG 层（地下一层）

Organizers / 主办及联合主办单位

Host	Yau Mathematical Sciences Center, Tsinghua University
Co-hosts	Institute of High Energy Physics, Chinese Academy of Sciences
	National Astronomical Observatories, Chinese Academy of Sciences
	Qiuzhen College, Tsinghua University