

06 Travel Grants

The Merit-Based Travel Grant is now open for application. The grant will be awarded based on the location of each student's home university. If a student is already in mainland China, the grant will be adjusted to cover the actual travel expenses incurred for attending the Summer School. Awardees will receive the travel grants after completion of the Summer School.

For students from Asia (outside the mainland of China): 5,000 RMB

For students from America and Europe: 15,000 RMB

For students from other countries and regions: 13,000 RMB

Applicants will be considered for the grant based on the CVs and letters of recommendation. If you are interested in applying for a travel grant, kindly request your referee to send a letter of recommendation to Ms. Bing Li (binglisjtu@sjtu.edu.cn)

<https://en.zhiyuan.sjtu.edu.cn/>

<https://tdli.sjtu.edu.cn/en/>

2025

"The Largest and the Smallest" SJTU Physics International Summer School



01 / Organizers

Zhiyuan College and the Tsung Dao Lee Institute (TDLI) at Shanghai Jiao Tong University (SJTU) launched “The Largest and the Smallest” Physics International Summer School (PISS) in 2024. The Summer School mainly aims at providing undergraduate students with strong passion in physics from China and overseas universities with a platform to gain experience with cutting-edge research and build friendships among their peers.

The Largest and the Smallest represent the two extremes of the universe, one being the vast cosmos and the other being the tiny fundamental particles. Although they are vastly different, they are intricately connected to some extent. To understand the essence of this connection, a deep understanding of the fundamental physical laws of the universe is required. This event will revolve around the vast and the minuscule. All courses and activities will be conducted in English and will include the following modules:

- 32 hours of specialized courses
- A series of cutting-edge academic lectures
- Team research practice projects
- "Visit SJTU" & Shanghai exploration
- Exciting cultural and sports activities

This year's SJTU PISS will take place at Tsung-Dao Lee Institute (1 Lisuo Road, Pudong New Area, Shanghai) from July 7 to 18. We warmly welcome students from across the world to join us.

Please scan the QR code to register



Deadline: April 25, 2025.

Zhiyuan College: A Cradle for Elite Talents

Zhiyuan College, founded in 2010, is directly funded by Ministry of Education, China. It is an undergraduate institute within SJTU that provides an elite-education for the top 10% undergraduate students and bear a mission to train them to become future leaders in science and technology. In 2016, its “Curiosity-Driven Initiative Learning” project won the “Cultivating Curiosity Award” and “Natural Sciences Award” at the Education Innovation Conference of the 3rd Global “Reimagine Education 2016”, which was jointly held by Wharton School of Business, University of Pennsylvania and International Education Rating Organization QS. In 2024, Zhiyuan College was recognized as one of the National Advanced Organizations in Education.



TDLI: A Highland for Research and Innovation

Proposed by the Nobel laureate Tsung-Dao Lee and with support and endorsement from governments and ministries at national and municipal levels, Tsung-Dao Lee Institute (TDLI) is a basic research institute established at Shanghai Jiao Tong University in November 2016, aiming to build itself as a world-leading science institute. By bringing the research to extreme environments or creating extreme conditions, TDLI strive to explore and control exotic and extreme states of matter with extreme detection methods. Eying on the greatest unsolved mysteries of the universe, TDLI is pledged to systemically assemble the teams of close to 100 scientists to carry out pioneering research and collaboration on particle and nuclear physics, astronomy and astrophysics, and condensed matter



02/Courses & Seminars

Astrophysics of Compact Objects, Transients and Exoplanets

Instructor: Lai Dong

Course content: Compact objects (white dwarfs, neutron stars and black holes) are the end states of the evolution of normal stars. They are associated with some of the most exotic phenomena and environments in the universe. They have been observed in all electromagnetic wave bands and in gravitational waves. Their strong gravities, high densities and magnetic fields provide a unique avenue for exploring physics under extreme conditions. On the other hand, many Sun-like stars have been found to host planets. These "exoplanets" have diverse properties and often quite different from the solar system counterparts. Their extreme properties challenge our understanding of planet formation. The studies of compact objects and exoplanets constitute some of the most exciting areas of astrophysics research.

This mini-course will review the basic physics and astrophysics of compact objects, and various time-domain transient phenomena associated with them (e.g. supernovae, gamma ray bursts, tidal disruption events). Contemporary research topics will be introduced along the way. The course will also review some current observational puzzles related to exoplanets, and the physics needed for their understanding

Elementary Particle Detection

Instructor: Liu Jianglai

This short survey course provides an overview of particle astrophysics—a field that employs elementary particles to explore fundamental questions in astrophysics and cosmology. The curriculum begins with foundational concepts, including the properties of elementary particles, their interaction processes, and relevant detector technologies. Building on this groundwork, the course delves into key unresolved challenges in the field, such as:

- What is the nature of dark matter?
- How do the fundamental properties of neutrinos influence the evolution of the universe?
- What is the origin of the ultrahigh energy cosmic rays?

Students will engage with global experimental efforts addressing these questions, gaining insight into cutting-edge research methodologies. To reinforce learning, periodic quizzes will incorporate hands-on, back-of-the-envelope calculations and concrete examples. Additionally, laboratory tours will connect theoretical concepts to real-world applications, offering students a tangible understanding of experimental practices in the field.



Geometric phase in solid state physics

Instructor: Niu Qian

Course content: Geometric phase (Berry phase) is one of the most fundamental concepts in condensed matter physics. Together with the band structure, it can connect the microscopic crystal structure with the macroscopic physical properties. Therefore, it has inspired the study of the topological phase and led to a systematic re-formulation of the solid state physics.

In this set of lectures, we offer a concise introduction of the Berry phase effect in solid state physics. Lecture 1 is an overview of the Berry phase effect, with the concept of parallel transport explained in detail. Lecture 2 introduces the semiclassical dynamics theory which is an intuitive and systematic way to include the Berry phase effect in solids. The generalization of this theory up to second order is also discussed, leading to the intrinsic nonlinear Hall effect. In lecture 3, we will discuss the adiabatic pumping effect and the semiclassical transport theory, with the nonlinear Hall effect from the Berry curvature dipole explained in detail. In lecture 4, we will discuss how to calculate equilibrium response functions, with special attention paid to the magnetic properties.

Subjects of Seminars

In addition to the courses, the Summer School also features a series of seminars, with topics including

- | | |
|-------------------------------------|---|
| -Direct Dark Matter Detection | -Superconductivity |
| -Deep Sea Neutrino Telescope | -Quantum Computing |
| -Muon Physics | -Quantum Materials and new states of matter |
| -Origin of Mass | -Large Scale Structural Evolution of the Universe |
| -Dark Photons and Dark Matter | -Laboratory Astrophysics |
| -Exoplanets and Alien Civilizations | -Axion Dark Matter |
| -Black Hole Imaging | -AI for Physics |
| -Quantum Atmosphere | |



03/Instructors

Anothy Zee (professor)



Anothy Zee is a professor in the Department of Physics at the University of California, Santa Barbara and a member of the American Academy of Arts and Sciences. His research interests include high-energy physics, quantum field theory, cosmology, biophysics, condensed matter physics and mathematical physics. He has authored or co-authored more than 200 scientific publications and several books.

Dong Lai (professor)

Dong Lai is a professor at Cornell University and Distinguished Chair Professor at TDLI. His research focuses on theoretical astrophysics, including compact objects, exoplanets, and gravitational wave astrophysics. He has published over 200 papers and received prestigious awards such as the Alfred P. Sloan Fellowship and Simons Fellowship.



Jianglai Liu (Professor)

Jianglai Liu is a Distinguished Professor at SJTU and Deputy Director of the TDLI. He is the spokesperson for the PandaX dark matter experiment and has received awards including the National Science Fund for Distinguished Young Scholars and the First Prize in Natural Science from the Ministry of Education.



Qian Niu (professor)

Qian Niu is a Distinguished Chair Professor at USTC and former Sid W. Richardson Foundation Chair at UT Austin. His research focuses on quantum Hall effects, quasicrystals, ultracold atoms, spin transport, and graphene materials. He has published around 280 papers with over 33,000 citations and is a Fellow of the American Physical Society.



04/Activities

In addition to hard-core academic programs, the summer school also arranges a variety of recreational extracurricular activities!



05/Logistics

Tuition and housing are free, but students are responsible for meals and personal expenses.

Dining: Dining options are accessible in the building of TDLI.

Insurance: Admitted students must provide proof of personal accident insurance that covers the entire duration of the summer school before July 7, 2025.

Contact: binglisjtu@sjtu.edu.cn (Ms. Bing Li, Zhiyuan College, SJTU)

Housing: During the summer school, students will be accommodated at the Ji Hotel (Shanghai Zhangjiang Jinke Road Branch), which is about 900 meters from the Tsung-Dao Lee Institute (1 Lisuo Road, Pudong New Area, Shanghai), approximately an 12-minute walk.

