THE UNIVERSITY OF HONG KONG
FACULTY OF SCIENCE

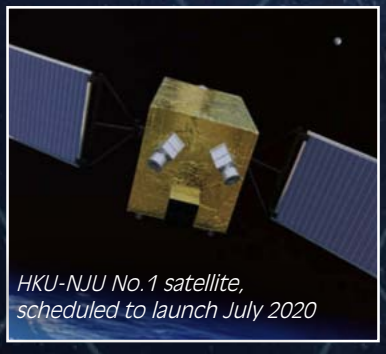
Department of Physics
The University of Hong Kong

Master of Science in the field of

Space Science

Apply now for entry in September 2020

The University of Hong Kong



HKU-NJU No.1 satellite, scheduled to launch July 2020

LSR Laboratory for Space Research

The Department of Physics is offering an exciting new Taught Postgraduate Master of Science in the field of Space Science. Modern Space Science is a highly multi-disciplinary field that encompasses a broad range of sub-disciplines, from astrophysics, to aerospace engineering, electronics, remote sensing, and space exploration. China has recently been investing heavily in Space Science, launching 39 satellites in 2018 alone, over twice as many as in 2017 and more than any other country in the world. Given its status as a global metropolis, its strong international links, and its location in the "Greater Bay Area" (GBA), Hong Kong is ideally placed to capitalize on the growth of China in the area of Space Science. The establishment, in 2016, of the Laboratory for Space Research (LSR) under the Faculty of Science at The University of Hong Kong (HKU), combined with our strong ties to leading space institutes across the world and in Mainland China[1] makes HKU the ideal place for a Taught Master Programme in Space Science. Our programme taps into our strengths in high-energy astrophysics, planetary sciences, statistics, and engineering, while leveraging our connections with elite Mainland and global partners. Our MSc will provide a basic foundation to enter this exciting field, with promising employment opportunities, both in the public and private sectors, in China, and worldwide.

[1] *Nanjing University (NJU, China), Zhejiang University (ZJU, China), National Astronomical Observatories of China (NAOC), Shanghai Academy of Space Flight Technology (SAST), CNNC and Chinese Institute for Atomic Energy (CIAE), Beijing Institute for Science and Mechanical Electricity (BISME), DFH Satellite Company LTD (China), Dongguan Science & Technology Bureau, Greater Bay Area Alliance (GBA, China), Joint Innovation Centre for Space Science (China), China Space Utilization, Chinese Academy of Sciences (CSU, CAS), Padova-CISAS (Italy), Natural History Museum (UK).*

Programme Highlights

- English as the medium of instruction
- Either 1 year (full-time) or 2 years (part-time)
- Offered by the Department of Physics, with contributions from the Department of Earth Sciences, Department of Statistics and Actuarial Science and the Department of Electrical and Electronic Engineering under the auspices of the LSR
- Key partners in Mainland China (ZJU, NJU, CASC) and Europe (Padova-CISAS, Italy) and Natural History Museum (NHM, U.K.)
- Highly multi-disciplinary degree, convering broad areas of science, engineering, and statistics, as related to space science and technology
- Strong focus on Chinese Space Science programme
- Elite guest lecturers
- Internship opportunities in top space science labs in the Mainland and globally
- Promising employment opportunities, in public and private sectors
- Scholarships available

Programme Curriculum

Our MSc programme is composed of 60 credits of courses. Students must enroll in 6 courses (36 credits) of "core" (compulsory) courses, offered mainly in the first semester. Students may then choose 3 "elective" courses out of a broad range of courses. In addition, students must carry out a "capstone project" by enrolling in the 6-credit course SPSC7031. Students are encouraged to approach faculty members in their areas of interest to choose a project. The final project will typically be undertaken over the course of the second semester. The curriculum of the MSc in Space Science is the same for both full-time and part-time modes of study.

Core Courses (36 credits):

SPSC7001	Space flight propulsion (6 credits)
SPSC7002	Introduction to space weather (6 credits)
SPSC7003	Remote sensing (6 credits)
SPSC7004	Radiation detection and measurement (6 credits)
SPSC7005	Space science entrepreneurship (6 credits)
SPSC7006	Small satellite design (6 credits)

Elective Courses* (18 credits)

SPSC7011	Introduction to space plasma physics (6 credits)
SPSC7012	Climate change (6 credits)
SPSC7013	Habitable planets and the origin of life (6 credits)
SPSC7014	Big data, AI and machine learning in space science (6 credits)
SPSC7015	Introduction to planetary science (6 credits)
SPSC7016	Overview of space astrophysics (6 credits)
SPSC7017	Introduction to astrochemistry and astrobiology (6 credits)
SPSC7018	Project management for space science (6 credits)
STAT6014	Advanced statistical modelling (6 credits)
STAT6016	Spatial data analysis (6 credits)
ELEC6008	Pattern recognition and machine learning (6 credits)
ELEC6026	Digital signal processing (6 credits)
ELEC6065	Data compression (6 credits)
ELEC6100	Digital communications (6 credits)

Capstone Project (6 credits)

SPSC7031	Space science final project (6 credits)

** Timetabling of courses may limit availability of some electives. The actual offering of such electives will be based on student demand.*

Course Description

Core Courses

SPSC7001 Space flight propulsion (6 credits)

This course covers an introduction to the basic concepts of space flight propulsion. Topics include: Mechanics of particle motions under central forces, Newton's law applied to the orbital mechanics of particles under central forces, orbital transfers, dynamics of mass-varying system, an application of kinetic principles to rocket and jet propulsion via the first-order differential equations, multi-stage design for energy efficiency, particles under velocity-dependent resistance, terminal velocity and its application to parachute and small particulates, peak deceleration of spacecraft re-entry trajectories.

Assessment: 40% coursework, 20% midterm exam, 40% final exam

SPSC7002 Introduction to space weather (6 credits)

Our modern lifestyles rely on satellite technology which can be severely affected by the Earth's local particle environment. Much of this is due to the influence of the Sun, which emits large quantities of radiation and charged particles that interact with the Earth's magnetic field. This course will cover the fundamentals of space weather, from its origins, to its effects, and forecasting.

Assessment: 40% coursework, 20% midterm exam, 40% final exam

SPSC7003 Remote sensing (6 credits)

This course is focussed on the theory behind, and practical application of, planetary remote sensing. The course covers the use of visible, infrared, radar, and laser remote sensing data to analyse planetary surfaces. Specific applications will include compositional and morphological analyses to support geological studies, landing site characterisation, and exploration for natural resources in space.

Assessment: 40% coursework, 20% midterm exam, 40% final exam

SPSC7004 Radiation detection and measurement (6 credits)

This course will provide an overview of the various ways in which we can detect radiation to make physical measurements. The course will cover the fundamentals of radiation interactions, properties of radiation detectors, including some of the most commonly used ones (e.g. Proportional Counters, Geiger-Mueller Counters). The course will include discussions of the principles of detection and some practical applications.

Assessment: 40% coursework, 20% midterm exam, 40% final exam

SPSC7005 Space science entrepreneurship (6 credits)

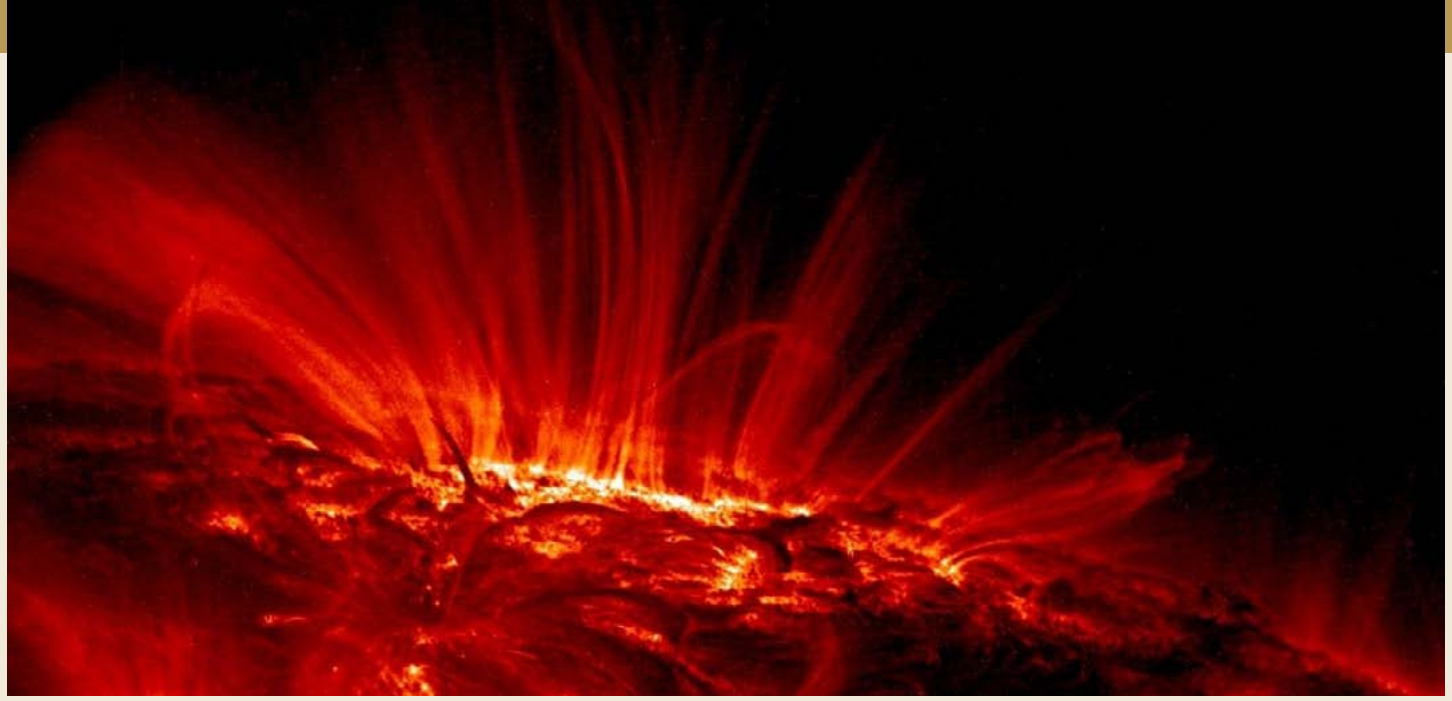
Unlike the early days, space science in modern times is not driven just by governments. Businesses like SpaceX, Blue Origin, or Virgin Galactic are not only capturing people's imagination, but also proving that space provides big business opportunities. This course will cover the basics of designing, launching, and running a business, with a special emphasis on the space industry.

Assessment: 25% coursework and written assignment, 20% midterm exam, 40% final case study and presentation 15% Group discussions, attendance, and class engagements.

SPSC7006 Small satellite design (6 credits)

Small satellites (sometimes referred to as microsatellites, CubeSats, etc.) are becoming increasingly popular. Once proposed mainly for educational purposes, due to their low cost and shorter development time scales, these days many such satellites are being proposed and launched with a range of cutting-edge scientific goals. This course will cover the practical aspects of designing a small satellite, based on the principle of purchasing "off-the-shelf" components, and benefitting from "open source" solutions to many of the technical challenges. Topics include: science instruments and payloads, satellite subsystems, ground networks, space science data and software, ground networks, launchers, and operations.

Assessment: 50% coursework, 50% project



Elective Courses

SPSC7011 Introduction to space plasma physics (6 credits)

Most of space is filled with plasma, the fourth state of matter where freely moving charges from ionized gas interact with (and generate) electric and magnetic fields, leading to a complicated set of phenomena. This course will provide an introduction to the field, covering such topics as orbit theory, electromagnetic waves in cold plasmas, collision theory, magnetohydrodynamics, force-free magnetic-field configurations, stochastic processes, and interaction of particles and waves. The course will emphasize some of the applications of plasma physics in the fields of geophysics and astrophysics.

Assessment: 40% coursework, 20% midterm exam, 40% final exam

SPSC7012 Climate change (6 credits)

Global warming is one of the biggest challenges faced by this generation, posing potentially an existential threat to the planet: since 2001, the Earth has experienced 16 of the 17 warmest years in recorded history. The study of climate change from space has been one of the key goals of NASA going back to the 1960s. This course will cover the evidence for human-caused climate change, explaining the causes, including sources of greenhouse gas emissions. The course will explore all the various ways in which satellites are providing the necessary measurements, provide possible solutions. Topics include: Climate conditions on Earth, the greenhouse effect, satellite observations, climate modeling, future prospects for climate change mitigation.

Assessment: 40% coursework, 20% midterm exam, 40% final exam

SPSC7013 Habitable planets and the origin of life (6 credits)

The discovery of large numbers of exoplanets has provided the first solid piece of evidence that our Earth may not be as unique as our ancestors believed. The next step in humankind's quest for the search of the origin of life will involve finding planets that are close enough in their conditions to Earth to harbour life similar to our own. This course will examine the quest for life outside our planet, including the search for planets in the so-called habitable zone. The course will also cover the origin of life outside our solar system and describe the various space observations being carried out in this effort.

Assessment: 40% coursework, 20% midterm exam, 40% final exam

SPSC7014 Big data, AI and machine learning in space science (6 credits)

These areas overlap, are interdependent and increasingly influential in the real world under the broad umbrella of data science. Big data and data analytics have been widely used in different fields of physics and other sciences. They have direct application in Space and satellite technologies. This course introduces the basics of all these areas. Data analytics is the science of analyzing raw data to make conclusions, a particular challenge in the Big data era, while Machine learning (ML) is a technique enabling computers to learn without being explicitly programmed and is part of the broader concept of Artificial Intelligence (AI). Key concepts across these overlapping and interdependent fields will be explored including practical processes, techniques and algorithms. There will be a focus on real-world examples with specific emphasis on applications in space and planetary sciences. The course will also cover some ML software packages in Python and R including basic techniques in supervised, unsupervised, and reinforcement learning. Examples in all areas will be drawn from fields such as astrophysics, particle physics and complex systems, including rare source identification from vast data, training sets, smart classification, time series, imaging and spectral analyses.

Assessment: 40% coursework, 20% midterm exam, 40% final exam

SPSC7015 Introduction to planetary science (6 credits)

We live in a golden age of planetary science, with new missions being proposed at an unprecedented rate by all the major space agencies. This course will provide an overview of planetary science, covering the major topics of the field: planetary dynamics, planetary properties, solar heating and energy transport, planetary atmospheres, planetary surfaces, planetary interiors, magnetospheres, meteorites and asteroids, comets, planet formation, and the search for extrasolar planets.

Assessment: 40% coursework, 20% midterm exam, 40% final exam

SPSC7016 Overview of space astrophysics (6 credits)

Astrophysics from space was historically proposed to cover those parts of the electromagnetic spectrum not visible from earth (e.g. X-rays, gamma rays), however, almost every part of the spectrum can benefit from space observations, removing the obstacles posed by our atmosphere. Some of the most iconic astrophysical images have been produced by the Hubble Space telescope, a relatively modest (in size) instrument which has made some stunning discoveries over the course of its almost 30-year lifetime. This course will provide an overview of past, present, and future astrophysical space missions, including their major science goals and achievements, and the technologies that made them possible.

Assessment: 40% coursework, 20% midterm exam, 40% final exam

SPSC7017 Introduction to astrochemistry and astrobiology (6 credits)

The notion that life may have originated in space has gained support in recent decades from the discovery of large numbers of complex molecules in space. How are these molecules detected? Where do they come from? Can these molecules eventually lead to the building blocks of life? This course will explore the tools, methods, and major results of astrochemistry and astrobiology, exploring in the process the origins of life in space.

Assessment: 40% coursework, 20% midterm exam, 40% final exam

SPSC7018 Project management for space science (6 credits)

The course will cover the fundamental aspects of project management, as they apply to space projects. Topics will include: initiation of a project, performance specifications, technical aspects of a project cycle, project planning, project execution, risk assessment and mitigation, project closure. The course will introduce students to hands-on aspects of project management, including management tools.

Assessment: 80% coursework, 20% final exam

STAT6014 Advanced statistical modelling (6 credits)

This course introduces modern methods for constructing and evaluating statistical models and their implementation using popular computing software, such as R or Python. It will cover both the underlying principles of each modelling approach and the model estimation procedures. Topics from: (i) Generalized linear models; (ii) Mixed models; (iii) Kernel and local polynomial regression; (iv) Generalized additive models; (v) Hidden Markov models and Bayesian networks.

Assessment: 40% coursework, 20% midterm exam, 40% final exam

STAT6016 Spatial data analysis (6 credits)

This course covers statistical concepts and tools involved in modelling data which are correlated in space. Applications can be found in many fields including epidemiology and public health, environmental sciences and ecology, economics and others. Covered topics include: (1) Outline of three types of spatial data: point-level (geostatistical), areal (lattice), and spatial point process. (2) Model-based geostatistics: covariance functions and the variogram; spatial trends and directional effects; intrinsic models; estimation by curve fitting or by maximum likelihood; spatial prediction by least squares, by simple and ordinary kriging, by trans-Gaussian kriging. (3) Areal data models: introduction to Markov random fields; conditional, intrinsic, and simultaneous autoregressive (CAR, IAR, and SAR) models. (4) Hierarchical modelling for univariate spatial response data, including Bayesian kriging and lattice modelling. (5) Introduction to simple spatial point processes and spatio-temporal models. Real data analysis examples will be provided with dedicated R packages such as geoR.

Assessment: 50% coursework, 50% final exam

ELEC6008 Pattern recognition and machine learning (6 credits)

This course aims at providing fundamental knowledge on the principles and techniques of pattern recognition and machine learning.

Specifically, the course covers the following topics: Bayes decision theory; parametric and non-parametric methods; linear discriminant functions; unsupervised learning and clustering; feature extraction; neural networks; context-dependent classification; case studies.

Assessment: 25% coursework, 75% written examination

Pre-requisite: A good background in linear algebra, programming experience.

ELEC6026 Digital signal processing (6 credits)

This course provides an introduction to the fundamental concepts of digital signal processing (DSP) including a wide variety of topics such as discrete-time linear time invariant systems, sampling theorem, z-transform, discrete-time/discrete Fourier transform, and digital filter design. Furthermore, the course will also discuss in detail about other advanced topics in digital signal processing such as multidimensional signals and systems, random processes and applications, and adaptive signal processing.

Assessment: 20% coursework, 80% written examination

ELEC6065 Data compression (6 credits)

This course provides an introduction to the state-of-the-art compression techniques for typical media including files, digital images, videos and audios. Specifically, the course will discuss in detail about the coding and quantization techniques commonly used for images, videos and audios. Finally, the course will cover basic concept and terminologies of common image, video and audio standards.

Assessment: 20% coursework, 80% written examination

ELEC6100 Digital communications (6 credits)

This course aims at enabling the fundamental understanding of the digital communication systems. After an overview on basic probability and random processes, the module will cover different modulations and their optimal decision rules, with an emphasis on signal space representation. Then, performance analyses under additive white Gaussian noise channel and fading channel are examined. This is followed by topics on spatial diversity and channel equalization.

Assessment: 30% coursework, 70% written examination

Capstone Project

SPSC7031 Space science final project (6 credits)

Students must carry out a research project in space science, under the guidance of a faculty member. Students are encouraged to approach faculty members in their areas of interest, in order to choose an appropriate project, which they will typically carry out over the course of the second semester. If students cannot choose, they will be offered a project (in consultation with the programme director), supervised by a member of our faculty. A final (oral) presentation is required and a report must be submitted.

Assessment: 25% oral presentation, 75% final report

Tuition Fees

The composition fee is HK$210,000. The fee shall normally be payable in two installments over 1 year for full time and four installments over 2 years for part time.

Minimum Requirements

A bachelor's degree in a relevant science (e.g. Physics, Astronomy, Earth Sciences) or Engineering (e.g. Aerospace, Electrical, Mechanical).

Application

Deadline for non-local students: May 29, 2020 (extended)
Deadline for local (HK) students: June 30, 2020

Online Application: https://aal.hku.hk/tpg/

Programme Director

Professor Quentin Parker, FRAS, FASA
Department of Physics
Director, Laboratory for Space Research (www.lsr.hku.hk)
Senate Member; The University of Hong Kong

Professor Quentin Parker is an eminent Astrophysicist who has worked at the Royal Observatory Edinburgh, Anglo-Australian Observatory Sydney and HKU. He is director of the Laboratory for Space Research (see https://www.lsr.hku.hk/). Research activities include Wide Field Astronomy, redshift surveys, Galactic Archaeology, supernova remnants and Planetary Nebulae where he has discovered more than anyone in history. He has authored 545 papers including 250 refereed with >15,000 citations and has successfully supervised significant numbers of PhD, MSc and honours students. Interests include Chinese Bronze artifacts and cultural heritage, interdisciplinary studies and science pedagogy.

Co-Programme Director

Dr Pablo Saz Parkinson
Department of Physics
Laboratory for Space Research

Dr Saz Parkinson has been PI on projects with all the major high-energy astrophysics observatories over the last two decades (e.g. Chandra, Fermi, NICER, NuSTAR, XMM) and has authored over 170 refereed publications with > 25,000 citations. Dr Saz Parkinson has over 20 years of experience working on space projects, dating back to his PhD work on the Unconventional Stellar Aspect X-ray experiment at SLAC (Stanford University). After spending over a decade at the University of California, Santa Cruz working on various projects, including the Fermi Gamma-ray Space Telescope, he moved to HKU in 2013, where he is currently based, at the Laboratory for Space Research (LSR).

Enquiries

Department of Physics
Tel: +852 2859 2360 Email: mspace@hku.hk

Support for Students

Centre of Development and Resources for Students, HKU
All Students: https://www.cedars.hku.hk/
Non-local Students: https://wp2.cedars.hku.hk/nonlocal/

Scholarships & Internships

We are delighted to offer a limited number of scholarships valued from HK$ 50,000 to HK$ 100,000, via support from the LSR and our most important partners (e.g. BISME, SAST, and DFH). Scholarships will be awarded in two categories: i) Academic Excellence; ii) Financial hardship. To apply for a scholarship Please contact the programme director directly at the time of application, together with a strong justification (less than 2 pages) under either i), ii) or indeed both.

We have also negotiated excellent internship opportunities for our MSc programme with some of our key partners. These internships can be tailored to individual circumstances but will take place between semesters, or during the summer (after 2nd semester). Internships are currently likely to be available within the LSR (in Hong Kong), as well as with BISME, SAST, CSU, DFH, ZJU (Mainland China), and Padova-CISAS (Italy) and the NHM (UK).

STAFF LIST

The University of Hong Kong (HKU)

Professor S C Chan (EE)	BSc (Eng), PhD *HK*; M.I.E.E.E. Digital Signal Processing
Dr Stephen W K Cheung (PHYS)	BS *Wisconsin*, MS, PhD *U Virginia* Space Science Entrepreneurship
Professor Lixi Huang (ME)	BSc, M.S. *BUAA*, PhD *Cambridge* Space flight propulsion
Dr Simon K C Cheung (STATS)	BSc *HK*, MSc *ANU*, PhD *CUHK* Advanced Statistical Modelling
Dr Y K Chung (STATS)	BSc, Phil *CUHK*, PhD *HK* Spatial Data Analysis
Professor Gregg Li (PHYS)	BA, Wash U; MBA, UCLA; Eng. D, Warwick Business, Economics, Entrepreneurship
Dr Joseph Michalski (DES)	BS *BGSU*; MS *ASU*; PhD *ASU* Remote Sensing, Planetary science
Dr Stephen Ng (PHYS)	BS, MPhil *HKU*, PhD *Stanford* Space Astrophysics
Professor Quentin Parker (PHYS)	BSc, PhD *St Andrews* Space Plasma Physics, Remote Sensing
Dr Michael Pittman (DES)	BSc, MSc, PhD *UCL* Life beyond Earth
Dr Pablo Saz Parkinson (PHYS)	BS *Columbia*, MS, PhD *Stanford* Radiation Detection and Measurement
Dr Meng Su (PHYS)	BA Phys/Astro *PKU*, PhD *Harvard* Cosmology, Astronomical Instrumentation, Spaceborne Detectors
Dr Shawn Wright (DES)	BS Geol *SRSU*, MS Geol *Pitt*, PhD Geol *ASU* Planetary Geology and Habitability
Dr Y C Wu (EE)	BEng, MPhil *HKU*, PhD *Texas A&M* Digital communications
Dr Binzheng Zhang (DES)	BE, MS *ZJU*, PhD *Dartmouth* Geospace science, magnetospheres

Zhejiang University (ZJU)

Assoc. Professor Xiaojun Jin	BSc, MSc, PhD *ZJU* Satellite Communications, Telemetry, Tracking and Command (TTC)
Professor Huiquan Wang	BE, Dr. Eng *ZJU* System design of small satellite/On board computer (OBC)
Assoc. Professor Zhaobin Xu	BSc, PhD *ZJU* Satellite Communications System design of small satellite/ADCS

Nanjing University (NJU)

Dr Zhiyuan Li	BS, MS *NJU*, PhD *UMass* Space Astrophysics
Dr Chuan Li	PhD *NJU* Space Weather

Other

Professor Denis Bastieri (Padova/Guangzhou)	MSc, PhD *Padua* Microsatellites, Space Science
Dr Marcos Lopez-Caniego (Aurora Technology for ESA)	BS, MS *Autonoma Madrid*, PhD *Cantabria* Cosmology, Big Data
Dr Massimiliano Razzano (Pisa/INFN)	BS, MS, PhD *Pisa* Space Detectors
Dr Sadjadi Seyedabdolreza (SYSU)	BS *SBU (Tehran)*, MS *Tehran*, PhD *HKU* Astrochemistry & Astrobiology