# 课程详述

## COURSE SPECIFICATION

以下课程信息可能根据实际授课需要或在课程检讨之后产生变动。如对课程有任何疑问，请联系授课教师。

The course information as follows may be subject to change, either during the session because of unforeseen circumstances, or following review of the course at the end of the session. Queries about the course should be directed to the course instructor.

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|---|---|---|
| 1. | **课程名称 Course Title** | 行星科学前沿 Frontiers of Planetary Science |
| 2. | **授课院系 Originating Department** | 地球与空间科学系 Department of Earth and Space Sciences |
| 3. | **课程编号 Course Code** | ESS420 |
| 4. | **课程学分 Credit Value** | 3 |
| 5. | **课程类别 Course Type** | 专业选修课 Major Elective Courses |
| 6. | **授课学期 Semester** | 秋季 Fall |
| 7. | **授课语言 Teaching Language** | 中英双语 Chinese and English |
| 8. | **授课教师、所属学系、联系方式（如属团队授课，请列明其他授课教师）Instructor(s), Affiliation& Contact （For team teaching, please list all instructors）** | 范斯腾，地球与空间科学系<br>邮箱：fanst@sustech.edu.cn<br>电话：18810518089<br>办公室：理学院 E5138<br><br>Siteng Fan, Department of Earth and Space Sciences<br>Email: fanst@sustech.edu.cn<br>Tel: 18810518089<br>Office: College of Science E5138 |
| 9. | **实验员/助教、所属学系、联系方式 Tutor/TA(s), Contact** | 待公布 To be announced |
| 10. | **选课人数限额(可不填) Maximum Enrolment （Optional）** | |

| 11. | 授课方式<br>Delivery Method | 讲授<br>Lectures | 习题/辅导/讨论<br>Tutorials | 实验/实习<br>Lab/Practical | 其它(请具体注明)<br>Other（Please specify） | 总学时<br>Total |
|---|---|---|---|---|---|---|
| | 学时数<br>Credit Hours | 48 | 0 | 0 | 0 | 48 |

| | | |
|---|---|---|
| 12. | 先修课程、其它学习要求<br>Pre-requisites or Other Academic Requirements | ESS211 行星科学基础<br>ESS211 Fundamentals of Planetary Science |
| 13. | 后续课程、其它学习规划<br>Courses for which this course is a pre-requisite | 无 None |
| 14. | 其它要求修读本课程的学系<br>Cross-listing Dept. | 无 None |

## 教学大纲及教学日历 SYLLABUS

### 15. 教学目标 Course Objectives

本课程介绍行星科学领域的基本问题和主要框架，结合近几十年深空探测的进展和未来的探测计划，展示该领域的最新进展和前沿，为学生对这一领域的了解和未来从事相关可能的研究打下基础。

This course introduces the fundamental questions and the big picture of planetary science. It combines the findings made by the deep space exploration in the last few decades, and future space missions and concepts, to present the recent developments and frontiers of this research field. This course aims to provide a comprehensive picture of planetary science and to equip the students with knowledge for potential future research in this area.

### 16. 预达学习成果 Learning Outcomes

学生完成本课程后，将会掌握以下知识：

1. 行星科学领域的基本问题和研究框架
2. 行星科学领域的探测技术手段和学科发展过程
3. 行星科学领域的研究前沿和未解决的科学问题
4. 行星科学领域的未来可能发展方向



Upon completing the course, students will gain the following knowledge：

1. The fundamental questions and the big picture of planetary science;
2. The developments of planetary exploration techniques, and the research scope of planetary science;
3. Frontiers and the known unknowns in planetary science;
4. Possible future development of the research field.

### 17. 课程内容及教学日历 （如授课语言以英文为主，则课程内容介绍可以用英文；如团队教学或模块教学，教学日历须注明主讲人）

**Course Contents (in Parts/Chapters/Sections/Weeks. Please notify name of instructor for course section(s), if this is a team teaching or module course.)**

**第一章：课程介绍和行星科学概览（2 学时）**

课程安排、内容和目标简介；行星科学发展概览。

**第二章：太阳系概览及近期探测结果简介（4 学时）**

当前太阳系结构概览；太阳系各天体的基本知识和整体规律；近些年的主要探测结果概览；尚未解决及近期提出的重要科学问题。

**第三章：太阳系天体的起源（4 学时）**

太阳系的初始条件；原始行星盘中的气体和尘埃；星子的形成过程; 行星的吸积过程；行星环的形成；星云的耗散。

**第四章：轨道动力学与天体碰撞（4 学时）**

行星的轨道迁移；行星与小天体的相互作用；天体碰撞；碰撞对内部、表面和大气的影响。

**第五章：类地天体的内部和表面（4 学时）**

类地天体的成分、内部结构和演化；内部与表面的相互作用；表面与大气的相互作用；表面与行星外部过程的相互作用。

**第六章：类地天体的大气和气候演化（6 学时）**

类地天体大气的起源与演化；大气动力学和能量平衡；与内部和表面的相互作用；大气逃逸；大气化学和微观物理过程。

**期中报告展示（2 学时）**

**第七章：巨行星的结构和演化（4 学时）**

巨行星的成分和探测手段；巨行星的内部结构和动力学过程；大气与环流；电离层和磁层。

**第八章：环行星系统（4 学时）**

行星环和卫星的形成；卫星的结构和演化；卫星的潮汐作用；磁层和行星环以及卫星的相互作用。

**第九章：地球生命和宜居性（4 学时）**

生命产生的条件和过程；地球环境的演化；生命信息的探测和解译；生命信息探测的偏差。

**第十章：系外行星（6 学时）**

原始行星盘的演化；行星的起源和迁移；太阳系的启示；宜居性；生命信息的探测和生命的搜寻。

**第十一章：行星科学发展趋势（2 学时）**

课程回顾；行星探测规划及近期任务；学科发展前景和趋势。

**期末报告展示（2 学时）**

**Chapter 1: Course introduction and overview of planetary science (2 hours)**

Introduction to the course philosophy, content, and goals; overview of the history and development of planetary science.

**Chapter 2: Overview of solar system and recent exploration (4 hours)**

Overview of the current architecture of the solar system, and the exploration of the last few decades; unsolved and recently raised core scientific questions.

**Chapter 3: Origin of solar system bodies (4 hours)**

Initial condition of the solar system; gas and dust of the protoplanetary disk; formation of planetesimals; accretion of solar system planets; formation of the planet rings; disperse of the nebula.

**Chapter 4: Orbital dynamics and impacts (4 hours)**

Planetary migration; interactions between planets of the protoplanetary disk and small bodies; evolution of planetary body collisions throughout the solar system history; the influence of impact on interiors, surfaces, and atmospheres.

**Chapter 5: Interiors and surfaces of terrestrial bodies (4 hours)**

Compositions and internal structure of terrestrial bodies and their evolutions; interactions between surface and interior; interactions between surface and atmosphere; interactions between surface and external processes.

**Chapter 6: Atmospheres and climate evolution of terrestrial bodies (6 hours)**

Origins and evolutions of terrestrial atmospheres; dynamics and energy budgets; interactions with surfaces and interiors; atmospheric escape; atmospheric chemistry and microphysics.

**Mid-term presentations (2 hours)**

**Chapter 7: Structure and evolution of giant planets (4 hours)**

Compositions and observation techniques of giant planets; structures and dynamics inside giant planets; atmospheres and circulations; magnetospheres and ionospheres.



**Chapter 8: Circumplanetary systems (4 hours)**

Formations of ring systems and satellites; structures of satellites and evolution; tides on satellites; interactions between magnetospheres and rings and satellites.

**Chapter 9: Terrestrial life and habitability (4 hours)**

Conditions and processes leading to life emergence; the evolution of the terrestrial environment; biosignature detection and characterization; bias in biosignature detection.

**Chapter 10: Exoplanets (6 hours)**

Evolution of protoplanetary disk; origin and migration of planets; insights from the solar system; habitability; biosignature detection and search for life.

**Chapter 11: Future of planetary science (2 hours)**

Course review; plan of planetary exploration and near future missions; future of the research field of planetary science.

**Final presentations (2 hours)**

18. 教材及其它参考资料 **Textbook and Supplementary Readings**

National Academies of Sciences, Engineering, and Medicine. 2023. Origins, Worlds, and Life: A Decadal Strategy for Planetary Science and Astrobiology 2023-2032. Washington, DC: The National Academies Press. https://doi.org/10.17226/26522.

## 课程评估 ASSESSMENT

19.

| 评估形式 Type of Assessment | 评估时间 Time | 占考试总成绩百分比 % of final score | 违纪处罚 Penalty | 备注 Notes |
|---|---|---|---|---|
| 出勤 Attendance | | | | |
| 课堂表现 Class Performance | | 10 | | |
| 小测验 Quiz | | | | |
| 课程项目 Projects | | | | |
| 平时作业 Assignments | | 30 | | |
| 期中考试 Mid-Term Test | | 30 | | |
| 期末考试 Final Exam | | 30 | | |
| 期末报告 Final Presentation | | | | |
| 其它（可根据需要改写以上评估方式） Others (The above may be modified as necessary) | | | | |



20. 记分方式 **GRADING SYSTEM**

√ A. 十三级等级制 **Letter Grading**
☐ B. 二级记分制（通过/不通过） **Pass/Fail Grading**

## 课程审批 REVIEW AND APPROVAL

21. **本课程设置已经过以下责任人/委员会审议通过**
**This Course has been approved by the following person or committee of authority**

地球与空间科学系科教学指导委员
Undergraduate Teaching Steering Committee of Department of Earth and Space Sciences

**教学负责人签字：**
**日期：**