

理學院

108 學年度第一學期模組化課程

宜居行星之物理及化學

Physics and Chemistry of a Habitable Planet

授課教師：

林俊孚教授

美國德州大學奧斯汀分校

課程類別	學分數	選必修	開課人數	注意事項
講義+演習	2	選修	30	

先修課程或先備能力：

無

建議修課年級：

大二、大三、大四、碩士班

建議修課學生背景：

理學院、工學院、生科院、電資學院、醫學院

教學方法：

講授 60%，報告/討論 40%

評量方式：

問題考試 50%：

one-hour written exam on Thursday afternoon of the course week. The exam includes multiple-choice questions (50%) and short-answer questions (50%). The scope of the exam covers lecture materials and suggested textbook chapters.

科學報告 50%：

each student will give an oral presentation of approximately 20 minutes on a topic related to the course in Chinese or English (student's choice) on Friday afternoon (the last day of the course). Students will discuss their selected topics with the lecturer and work with lecturer on their presentations throughout the week. Students are encouraged to ask questions after each presentation. The presentations will be graded in their scientific accuracy and originality (50%), organization and clarity (30%), and quality for answering questions (20%).

學習規範：

Please review lecture slides before you come to the class and ready to engage in discussions of class materials. Consider reading the recommended textbook in advance so you gain a basic understanding of the subject.

課程概述：

We will learn how to build a habitable planet Earth from learning its raw materials to understanding its current states in physics and chemistry. The discovery of thousands of exoplanets has renewed our interest in finding another habitable planet. Planet Earth is the only planet that harbors life in the universe that we know of. Insofar, we know Earth's magnetic fields play a key role

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in protecting lives from harmful cosmic rays while dynamic movements of the planet replenish earth surfaces with volatiles (e.g., water) and energy sources (heat). Could other planets operate at different ways to sustain life? It is thus of paramount importance for us to better understand planetary materials including its physical, chemical, and thermodynamic processes as a starting point to think about this question.

We will learn how elements in the early solar system condensates to form crystals, how atoms arrange themselves to form three-dimensional lattices that are the building blocks of planetary materials, and what are the roles of high pressure-temperature thermodynamic parameters on physical and chemical properties of the planetary materials. The course materials are interdisciplinary to material science, physics, chemistry, and biology. We will also learn the interior of a habitable planet that provides energy and volatiles to the surface. We will learn how scientists use various tools to investigate Planet Earth, how volatiles including water are recycled and replenished to sustain lives, and how magnetic fields in the outer core are generated thermodynamically. Forefront research results such as the discovery of exoplanets will be used to build hypotheses about sustainable planetary processes. Ultimately, we aim to think of the Planet Earth in various spatial and temporal scales, and be able to contemplate about the question of habitability in the universe, Are We Alone?

This class is aimed to integrate your understanding of the physical and chemical properties of planetary materials on a habitable planet through time and thermodynamic variables. Students will build their interdisciplinary knowledge base in learning physics and chemistry of earth materials under extreme pressure-temperature thermodynamic variables and through a vast scale in space and time. The goal of the class is to eventually use observable physical and chemical parameters to test hypotheses of planetary habitability and critically think about the question of Are We Alone?

課程進度：

堂次	時數	進度說明
7/1	9:00-17:30(12:00-13:00 午休)	Introduction: origin and formation of planetary materials
7/2	9:00-17:30(12:00-13:00 午休)	Physics and chemistry of materials through time and space
7/3	9:00-17:30(12:00-13:00 午休)	Crystallography and evolution of planetary materials
7/4	9:00-17:30(12:00-13:00 午休)	Thermodynamics of a habitable planet Earth through time
7/5	9:00-17:30(12:00-13:00 午休)	Contemplation of building a habitable planet

課程學習目標：

1. Understanding physics and chemistry of planetary materials through time
2. Learning a habitable planet through thermodynamics and crystallography at extremes
3. Testing hypotheses of planet habitability using physical observations of planet Earth

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課程的重要性、跨域性與時代性：

This course will address one of the most important questions for human beings: how Earth has become a habitable planet to harbor life. In the past, the focus on the topic was often on how Earth maintains a temperate climate that allows liquid water to exist on its surface for billions of years and on how organic matters were produced and evolved through time. Here we will address the planetary habitability from the prospective of the physics and chemistry of planetary material evolution under thermodynamic variables through vast time and space scales. This course aims to synthesize interdisciplinary knowledge in Earth Science, Material Science, Physics, Chemistry, and Astronomy, and will help us appreciate planet Earth and think about the sustainability of the planet into the future.

其他備註：

參考書目：

How to Build a Habitable Planet: The Story of Earth from the Big Bang to Humankind, Princeton University Press, 2012