國 立 成 功 大 學 模 組 化 課 程

開課學年度/學期：115 學年度第 1 學期　　領域：自然與工程科學

宜居行星的物理與化學
Physics and Chemistry of Planetary Habitability

授課教師	任職單位	畢業學校
林俊孚	德州大學奧斯汀分校 Department of Earth and Planetary Sciences	The University of Chicago

課程類別	學分數	選必修	開課人數	其他注意事項
Lecture + Recitation	1.5	選修	35	

先修課程或先備能力

無

課程難易度

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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 55%，實作 30%，討論 5%，報告 10%

評量方式

問題考試 40%：

one-hour written exam on Friday afternoon, multiple-choice questions, True or False , and short answer questions. The scope of the exam covers lecture materials and suggested textbook chapters.

報告 10%：

each student will give an oral presentation 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%).

實驗操作 40%：

lab exercises and assignments with solving scientific questions with the lecturer and TA. Students are encouraged to work as a team with classmates to work on the questions, but responses need to be in your own words. There are natural samples and scientific instruments involved in the lab exercises.

出席率 10%

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

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understanding of the subject. You're encouraged to work with your classmates in lab exercises, but your reports should be in your own words.

課程概述

本課程探討如何從原始行星物質出發，建構如地球般的宜居行星，並理解其當前的物理、化學與生物過程。數千顆系外行星的發現，重新激發了科學界對於尋找其他潛在宜居世界的興趣。迄今為止，地球仍是我們所知唯一孕育生命的行星，其中若干關鍵過程——例如生命關鍵物質（如能量、水、CHON 元素與金屬）及地球與生物的演化——在維持宜居性方面扮演核心角色。其他行星是否可能透過不同機制來支持生命？要回答這一問題，必須從根本上理解行星的物理、化學與生物演化過程。

我們將探討早期宇宙中的元素如何凝結形成有機與無機物質，生命關鍵物質如何支持生命在空間及時間尺度上的演化，以及物理與化學過程如何在多樣環境中促進生物演化。本課程整合行星材料科學、物理、化學、天文學與生物學等領域，探討宜居行星的環境特徵，以及將能量與揮發物輸送至宜居行星的各種機制。學生將學會從不同時空尺度思考宜居性，並深入探討一項最根本的科學問題：宇宙中是否只有我們？

關鍵字：宜居行星、生命演化、生命關鍵物質

課程概述(英文)

This course explores how to build a habitable planet like Earth, from its primordial materials to its present-day physical, chemical, biological processes. The discovery of thousands of exoplanets has renewed scientific interest in identifying other potentially habitable worlds. Earth remains the only known planet that hosts life, where key processes—such as critical materials to life (e.g., energy, water, CHON, metals) and co-evolution of geobiology—play essential roles in sustaining habitability. Could other planets operate under different mechanisms to support life? Addressing this question requires a fundamental understanding of planetary materials and their governing physical, chemical, and biological processes.

Students will investigate how elements in the early universe condensed to form organic and inorganic materials, how critical materials to life are differentiated and enriched to support life evolution through time, and how physical and chemical processes facilitate biological evolution over a wide range of environments. The course integrates concepts from planetary materials science, physics, chemistry, astronomy and biology to examine the environments of habitable planets and the evolution of human intelligence and technology. Ultimately, students will learn to think about habitability across spatial and temporal scales and critically engage with one of the most profound scientific questions: Are we alone in the universe?

Keywords：Planetary habitability、Biological Evolution、Critical materials to life

課程進度

日期	時間	進 度 說 明
2026/7/20(一)	09:00-12:00	From Stardust to Habitable Planets (講義課)
	13:00-15:30	演習/實作: Primordial Meteorites and Materials

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2026/7/21(二)	**09:00-12:00**	**Habitable Planet Formation: Physical and Chemical Processes (講義課)**
	13:00-15:30	**演習/實作: Critical Materials for Life: CHON, Metals and Energy**
2026/7/22(三)	**09:00-12:00**	**Habitable Conditions and Disasters (講義課)**
	13:00-15:30	**演習/實作: Co-evolution of Rocks and Life**
2026/7/23(四)	**09:00-12:00**	**Chemical Cycles through Time (講義課)**
	13:00-15:30	**演習/實作: Biological Evolution**
2026/7/24(五)	**09:00-12:00**	**Origin and Evolution of Life and Intelligence (講義課)**
	13:00-15:30	**實作/考核: Presentation and Written Exam**

課程學習目標

1. **Understand how planetary materials form from the early universe and evolve through physical, chemical, and biological processes to create habitable environments.**
2. **Analyze how critical materials for life (e.g., energy, water, CHON elements, and metals) are differentiated, cycled, and coupled with geobiological processes to sustain habitability.**
3. **Apply interdisciplinary knowledge to evaluate habitable conditions across planetary systems, including exoplanets, and develop hypotheses about life-supporting mechanisms in diverse environments.**

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 and biological 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

課程教材：幻燈片,參考書目, natural samples and models

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

本課程若因天災等不可抗力之因素或中央、地方政府公告停課，授課教師需依情況依建議補課方式調整課程進度與補課；若需使用假日、國定假日補課，則需與所有修課學生達成共識方能用例假日補課。

建議補課方式：

1. 線上授課方式補課；
2. 當預期可能會因天災(颱風、超大豪雨…等)宣佈停課時，建議老師先行調整加快課程進度或預先增加可能天氣預警之前幾次課程時數；

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3. 停課後隔天起延後下課，補足停課延誤的進度；若停課超過 1 天，則在開始上課後延後下課補課，或當週星期六、日補課；
4. 更改課程授課方式，例如：DEMO 改以考試、報告、作業取代。