Term Information

Effective Term	Autumn 2020

General Information

Course Bulletin Listing/Subject Area	Earth Sciences
Fiscal Unit/Academic Org	School of Earth Sciences - D0656
College/Academic Group	Arts and Sciences
Level/Career	Graduate, Undergraduate
Course Number/Catalog	5205
Course Title	Planetary Science
Transcript Abbreviation	Planetary Science
Course Description	A multidisciplinary approach to planetary science, integrating modern methods with the Earth and Astrophysical Sciences
Semester Credit Hours/Units	Fixed: 3

Offering Information

Length Of Course	14 Week, 12 Week, 8 Week, 7 Week, 6 Week
Flexibly Scheduled Course	Never
Does any section of this course have a distance education component?	No
Grading Basis	Letter Grade
Repeatable	No
Course Components	Lecture
Grade Roster Component	Lecture
Credit Available by Exam	No
Admission Condition Course	No
Off Campus	Never
Campus of Offering	Columbus

Prerequisites and Exclusions

Prerequisites/Corequisites	Prereq: a Data Analysis GE course; or permission of the instructor
Exclusions	
Electronically Enforced	Yes

Cross-Listings

Cross-Listings	ASTRON 5205

Subject/CIP Code

Subject/CIP Code	40.0601
Subsidy Level	Doctoral Course
Intended Rank	Junior, Senior, Masters, Doctoral

Requirement/Elective Designation

Required for this unit's degrees, majors, and/or minors
The course is an elective (for this or other units) or is a service course for other units

Course Details

Course goals or learning objectives/outcomes

- Upon successful completion of the course, students will be able to
  (1) place current knowledge of planetary science in the broader context of the Earth and Astrophysical Sciences
- (2) integrate geophysical and astrophysical datasets to test scientific hypotheses across planetary time- and length-scales.
- (3) apply systems-level thinking to planetary-scale scientific questions.

Content Topic List

- Introduction to Planetology
- Measuring Stars
- Measuring Planets
- Nucleosynthesis overview
- Connection between the Stars and the Planets: Cosmochemistry
- Connection between the Stars and the Planets: Planetary formation models as informed by cosmochemistry & exoplanetary system dynamics
- Planetary interior modeling
- Planetary Atmospheres & Atmospheric escape
- Astrobiology

Sought Concurrence

No

Attachments

- Screen Shot 2019-08-30 at 12.10.23 PM.png: Astronomy initial endorsement
  (Other Supporting Documentation. Owner: Panero,Wendy R)
- Proposal for Team Teaching Grant.docx: team teaching proposal
  (Other Supporting Documentation. Owner: Panero,Wendy R)
- EARTHSC.ASTRO 5205 syllabus.pdf: syllabus
  (Syllabus. Owner: Panero,Wendy R)

Comments

- 08/30: Returned at department's request. *(by Haddad,Deborah Moore on 08/30/2019 02:23 PM)*
- Astronomy will submit this course as cross-listed course early next week, to permit their newly formed curriculum committee to formally endorse the plan. *(by Panero,Wendy R on 08/30/2019 12:11 PM)*

Workflow Information

Status	User(s)	Date/Time	Step
Submitted	Panero,Wendy R	08/30/2019 12:11 PM	Submitted for Approval
Approved	Panero,Wendy R	08/30/2019 12:12 PM	Unit Approval
Revision Requested	Haddad,Deborah Moore	08/30/2019 02:24 PM	College Approval
Submitted	Panero,Wendy R	08/30/2019 03:02 PM	Submitted for Approval
Approved	Panero,Wendy R	08/30/2019 03:06 PM	Unit Approval
Approved	Haddad,Deborah Moore	08/30/2019 03:44 PM	College Approval
Pending Approval	Vankeerbergen,Bernadette Chantal Oldroyd,Shelby Quinn Hanlin,Deborah Kay Jenkins,Mary Ellen Bigler	08/30/2019 03:44 PM	ASCCAO Approval

ASTRO/EARTHSC 5205
Planetary Science

Instructors
Professor Panero, School of Earth Science
377 Mendenhall Labs
614-292-6290
panero.1@osu.edu
Office Hours: TBD

Professor Wang, Department of Astronomy
4003 McPherson Lab
614-514-5897
wang.12220@osu.edu
Office Hours: TBD

Meeting Time and Location
TBD, 3 hours of lecture and discussion per week
Prerequisites – A Data Analysis GE course; or permission of the instructor

Upon successful completion of the course, students will be able to
(1) place current knowledge of planetary science in the broader context of the Earth and Astrophysical Sciences
(2) integrate geophysical and astrophysical datasets to test scientific hypotheses across planetary time- and length- scales.
(3) apply systems-level thinking to planetary-scale scientific questions.

Recommended Texts:
The Exoplanet Handbook (Michael Perryman)
Exoplanets (Sara Seager)
Fundamental Planetary Science: Physics, Chemistry and Habitability (Imke de Pater and Jack J. Lissauer)

Additional reading material will consistent of published work in the peer reviewed literature, which will be available to students on Carmen.

Grading:
Problem sets 40%
Team project 50%
Attendance and in-class engagement 10%
Letter grades will be according to the standard OSU scheme as in Carmen.

Class attendance policy: Class attendance is critical, as those missing class will not participate in group meetings, will miss critical background lecture material and guidance on problem sets. We expect all students to be present the majority of all class meetings, yet we understanding that illnesses and research travel obligates missing the occasional class. You must contact both instructors should you miss class, as well as coordinate with group members if you miss a group meeting. Just as important as attendance is full engagement in the course, as marked by asking questions, collaborating with others with in-class problems, avoiding off-task behavior, while also allowing others to participate. The attendance and in-class

engagement grade will be graded holistically, with the intention that all good-faith efforts for attendance and engagement will earn full marks.

Weekly topical outline of course meetings, topics to be covered, readings, and homework

Weeks 1-2: Introduction to Planetology
Week 1: Tour of the solar system (Panero)
group formation

Week 2: Tour of exoplanets, populations (Wang)
initial group meeting, 20 minutes
Problem set 1 due: Planetary populations and trends

Week 3: Measuring Stars
Size, temperature, composition (Wang)
One hour dedicated to group meetings
Problem set 2 due: Fundamental stellar properties

Week 4: Measuring Planets
Size, mass, and structure (Wang)
20 minute group meeting
Problem set 3 due: Planet size measurement from TESS Data

Week 5:
Nucleosynthesis overview (Wang)
20 minute group meeting
Connection between the Stars and the Planets: Cosmochemistry; evidence from meteorites (Panero
Isotopes and geochemistry (Panero)
Problem set 4 due: Nuclear Chemistry Basics

Week 6: Connection between the Stars and the Planets: Planetary formation models as informed by cosmochemistry & exoplanetary system dynamics (Wang & Panero)
1 hour group meeting/work session
Problem set 5 due: Cosmochemistry modeling

Week 7: Planetary interior modeling (Panero)
1 hour group meeting/work session
Problem set 6 due: Build a planet using ExoPlex

Week 8-10 Planetary Atmospheres & Atmospheric escape
Earth, Mars, Venus, & Titan (Panero)
Jupiter & Ice Giants (Wang)
Exoplanets (Wang)
1 hour group meeting/work session

Week 11: Astrobiology
Habitability, biosignatures, discussion of evolution of life on Earth (Panero)
Observational approaches (Wang)

Week 12-13: Major unsolved problems (Wang & Panero)
Topics will evolve with each offering

Week 14: Student Poster Session

Problem sets:
Problem sets will explore a variety of aspects of planetary science through exercises designed to build familiarity with methods, tools, and approaches to planetary science. As much of the course focus is on the project, most problem sets will be assigned and due early in the semester. We encourage students to work with others, particularly those with a different skill sets or background.

Problem sets
Problems sets/homework to include:
Create population plots from exoplanets.org
Build a planet (ExoPlex)
Calculate insolation as a function of star and distance
Think through greenhouse as a function of blackbody temperature
Mantle dynamics calculations (using ASPECT and Zhong U Colorado online tool)
Design realistic, data-driven solar system architecture
Describe the structure, atmosphere, and assess habitability of two planets in the system
Design an observational experiment to test.
Detect exoplanets with various techniques (RV, transit, direct imaging, etc.)
Test dynamical stability of multi-planet systems
Model habitable planet atmospheres and understand the significance of biosignatures

Team project:
1, Propose a space exploration mission to address a planetary science question. It can be addressed by either investigating a planetary body in the solar system or an already-discovered exoplanetary system.
or
2, Propose a space mission to detect exoplanets based on existing studies (e.g., Kepler, TESS, JWST, WFIRST, HabEx, LUVOIR, Origins Space Telescope, EarthFinder).
Note: this is a team project, not a group project. In collaboration with the course instructors, you will build a balanced team, ensuring there is expertise in astronomy, earth science, and data analysis or computation on each team. You will develop the project as a group, assigning unique roles to each member of the team.

25% Project Proposal (graded as a team) DUE WEEK 4
Your proposal will include:
*Title of the mission
*Description of scientific question, hypothesis to be tested, and justification for significance (300 words)
*Scientific team and expertise of each team member (100 words each)
*Initial reference list, annotated (at least 5 references)
*List of planned work, who will be responsible for each task, and anticipated completion dates for each task

10% Revised Project Proposal DUE WEEK 8

Things never go as smoothly as we anticipate. Your revised research proposal will follow the format of the initial proposal, incorporating instructor feedback and the realities of the project as it progresses.

15% Laboratory notebook (graded individually) DUE WITH PROPOSAL

You will keep a notebook with your progress and details of your own research, as well as notes from group meetings (including those held during class). Notes should include derivations, notes on the location of sources, file name conventions, problem solving, etc.

Each page should have the date and the task (e.g. "group meeting," "working on calculations")

50% Mission Proposal (⅔ graded individually for individual contributions, ⅓ graded jointly as a team for coherence, editing, and formatting) DUE WEEK 14

Your proposal must include

- Scientific relevance
- Feasibility
- Relevant figures and figure captions, tables and table captions
- Figures that demonstrate the mission design, sample calculations, predicted results

Each section must be written by the person responsible for the work, but must be edited by each member of the team.

5% Group presentation (graded as a team) WEEK 14

Academic Misconduct:

It is the responsibility of the Committee on Academic Misconduct to investigate or establish procedures for the investigation of all reported cases of student academic misconduct. The term "academic misconduct" includes all forms of student academic misconduct wherever committed; illustrated by, but not limited to, cases of plagiarism and dishonest practices in connection with examinations. Instructors shall report all instances of alleged academic misconduct to the committee (Faculty Rule 3335-5-487). For additional information, see the Code of Student Conduct http://studentlife.osu.edu/csc/.

Disability services:

The University strives to make all learning experiences as accessible as possible. If you anticipate or experience academic barriers based on your disability (including mental health, chronic or temporary medical conditions), please let me know immediately so that we can privately discuss options. To establish reasonable accommodations, I may request that you register with Student Life Disability Services. After registration,

make arrangements with me as soon as possible to discuss your accommodations so that they may be implemented in a timely fashion. SLDS contact information: slds@osu.edu; 614-292-3307; slds.osu.edu; 098 Baker Hall, 113 W. 12th Avenue.

As a student you may experience a range of issues that can cause barriers to learning, such as strained relationships, increased anxiety, alcohol/drug problems, feeling down, difficulty concentrating and/or lack of motivation. These mental health concerns or stressful events may lead to diminished academic performance or reduce a student's ability to participate in daily activities. The Ohio State University offers services to assist you with addressing these and other concerns you may be experiencing. If you or someone you know are suffering from any of the aforementioned conditions, you can learn more about the broad range of confidential mental health services available on campus via the Office of Student Life's Counseling and Consultation Service (CCS) by visiting ccs.osu.edu or calling 614-292-5766. CCS is located on the 4th Floor of the Younkin Success Center and 10th Floor of Lincoln Tower. You can reach an on call counselor when CCS is closed at 614-292-5766 and 24 hour emergency help is also available through the 24/7 National Suicide Prevention Hotline at 1-800-273-TALK or at suicidepreventionlifeline.org.

Title IX makes it clear that violence and harassment based on sex and gender are Civil Rights offenses subject to the same kinds of accountability and the same kinds of support applied to offenses against other protected categories (e.g., race). If you or someone you know has been sexually harassed or assaulted, you may find the appropriate resources at http://titleix.osu.eduor by contacting the Ohio State Title IX Coordinator, Kellie Brennan, at titleix@osu.edu

The Ohio State University affirms the importance and value of diversity in the student body. Our programs and curricula reflect our multicultural society and global economy and seek to provide opportunities for students to learn more about persons who are different from them. We are committed to maintaining a community that recognizes and values the inherent worth and dignity of every person; fosters sensitivity, understanding, and mutual respect among each member of our community; and encourages each individual to strive to reach his or her own potential. Discrimination against any individual based upon protected status, which is defined as age, color, disability, gender identity or expression, national origin, race, religion, sex, sexual orientation, or veteran status, is prohibited.

Proposal for Team Teaching Grant
School of Earth Sciences and Department of Astronomy

We propose a dual-career course, EARTHSC/ASTRON 5205 *Planetary Science*, jointly offered by the School of Earth Sciences and the Department of Astronomy, targeted at upper division earth science and astrophysics majors, as well as students interested in physics, aerospace engineering, and related fields. The class will be offered for the first time in Spring 2021.

This course will be a required part of a newly proposed Planetary Science certificate, jointly administered by Earth Sciences and Astronomy, submitted August 30, 2019. We anticipate that this certificate will be in high demand as there are a number of students in Physics, Astrophysics, Geophysics, and Aeronautical Engineering with an interest in planetary exploration. This course addresses a long-unmet need at Ohio State. To date, the only courses that explicitly address these topics are at the General Education level (e.g. EarthSc 2205 “The Planets”; Astro 1141 “Life in the Universe”).

Wendy Panero (Earth Science) and Ji Wang (Astronomy) are experts in complementary aspects of this class. Bringing them together into one course will give students access to the forefront of the science. Panero is a geophysicist and an expert in the structure, dynamics, and composition of planets in both this solar system and exoplanets. Wang is an astronomer and an expert in the observation and characterization of exoplanets.

Panero and Wang have developed the course together, and will each give approximately the same number of lectures and will develop the homework problems and projects jointly. Integral to the course and course assessment is the development of student-led projects for the discovery and exploration of planets in the Solar System and beyond. The design of the project is to teach the team-work skills necessary to enable large space missions, drawing on complementary, not overlapping, skillsets among students. Such work will naturally draw upon the advice and expertise of both Panero and Wang.

From: **Weinberg, David** weinberg.21@osu.edu
Subject: Re: Call for Proposals: Team-Teaching Grants
Date: August 30, 2019 at 10:28 AM
To: Panero, Wendy panero.1@osu.edu, Gaudi, Scott gaudi.1@osu.edu, Saltzman, Matthew saltzman.11@osu.edu

DW

Thanks, Wendy.
I'm all for it. I am in DC at a panel meeting today, so I won't be able to solve any problems about accessing the curriculum system for submission, but I hope you'll be able to do it on the SES end.

Cheers,
David