PTYS/ASTR 416/516: Asteroids, Comets and KBOs

Summary:
Small bodies (asteroids, comets and KBOs) are time capsules that have recorded the conditions under which our Solar System formed. Understanding the physical characteristics and dynamical nature of these bodies provides us with an opportunity to constrain the temperature, density, composition, and orbital organization of the circumstellar disk from which the solar system formed. Individual bodies can be characterized by source region, evolutionary state, bulk composition, impact history, and parent bodies. A sub-group of planetesimals (Near-Earth asteroids) have orbits that cross 1 AU and can therefore pose a threat to the Earth. The discovery, follow up and characterization of NEAs is a Congressional mandate for NASA. In this course, students will participate in a NASA Planetary Defense exercise that would require the graduate students to observe and spectrally characterize near-Earth asteroid 2012 TC4 using the NASA IRTF in Hawai'i. Undergraduate students will collect astrometry and photometry data of 2012 TC4 using the RAPTORS 24-inch telescope on campus and participate remotely in the IRTF observations from Tucson. In addition, comet C/2017 O1 will be available during the same time period as a second target from both telescopes.

Class: Tuesday/Thursday 2:00-3:15 pm in Kuiper Space Sciences 312

Suggested Textbook: None. Peer-reviewed papers and relevant material will be posted on D2L for students.

Instructors: Prof. Walt Harris
office: Kuiper Space Sciences 221
email: wharris@lpl.arizona.edu (putting PTYS/ASTR 416/516 in the subject line is appreciated)
phone: 520-621-6971
office hours: Wednesdays 12:30-1:30 pm in Kuiper 221 (or by appointment)
Outside of office hours email is the best method of contact. Please identify the course in your subject line.

Instructors: Prof. Vishnu Reddy
office: Kuiper Space Sciences 233
email: reddy@lpl.arizona.edu (putting PTYS 416/516 in the subject line is appreciated)
phone: 520-621-6969
Office hours: Thursdays 3:30-4:30 pm in Kuiper 233
I am also happy to answer questions via email or schedule appointments during office hours. I'm required to provide my office phone number, but there is no answering system so I do not recommend that as a way to contact me. I will do my best to answer emails within 24 hours, although this might not always be possible.

Graded Effort:

Observing (25%): Graduate students will be required to participate in spectroscopic observations of the NEA 2012 TC4 and/or comet C/2017 O1 using the facilities of the IRTF. This participation may be in person (supported) or remote. Undergraduate students are required to participate in imaging studies of the NEA 2012 TC4 and/or comet C/2017 O1 using the RAPTORS telescope in the Kuiper Building.

Analysis (30%): Students will work in teams to analyze data obtained from the IRTF (Graduate Students) and RAPTORS (Undergraduate Students) and provide a written report on their findings.

Laboratory and Homework (30%): The students will participate in a laboratory spectroscopy exercise. A written summary is required. Outside homework exercises (2-3) will be assigned where students will implement the techniques described in lecture.

Final Presentation (15%): On December 5, 2017 the student groups will present the results of their reduction projects.

Grading Scale for the Course

A — 90-100%
B — 80-90%
C — 70-80%
D — 60-70%
E — 0-60%

This scheme might be subject to a *downward* curve, but the above represents the minimum grade you will be assigned for the listed scores (e.g. a score of 80% guarantees *at least* a B).

Resources:

Web site: Course materials and supplemental reading will be posted at D2L (https://d2l.arizona.edu)

Required Texts: None.

Course Changes: The workload and course requirements are subject to change at the discretion of the instructor with proper notice to the students.

Academic Integrity: Integrity and ethical behavior are expected of every student in all academic work. This Academic Integrity principle stands for honesty in all class work, and ethical conduct in all labs and clinical assignments. This principle is furthered by the student Code of Conduct and disciplinary procedures established by ABOR Policies 5-308 through 5-404 (see chapter 5), all provisions of which apply to all University of Arizona students. This Code of Academic Integrity (hereinafter "this Code") is intended to fulfill the requirement imposed by ABOR Policy 5-403.A.4 and otherwise to supplement the Student Code of Conduct as permitted

by ABOR Policy 5-308.C.1. (See also http://deanofstudents.arizona.edu/policies-and-codes/code-academic-integrity)

Disability Resources: At the University of Arizona we strive to make learning experiences as accessible as possible. If you anticipate or experience physical or academic barriers based on disability or pregnancy, you are welcome to let me know so that we can discuss options. You are also encouraged to contact Disability Resources (520-621-3268) to explore reasonable accommodation.

Inclusiveness: Excellence is a fundamental part of the University of Arizona's strategic plan and culture. As part of this initiative, the institution embraces and practices diversity and inclusiveness. These values are expected, respected and welcomed in this course.

Absences: Absences for any sincerely held religious belief, observance, or practice will be accommodated where reasonable. Absences pre-approved by the UA Dean of Sciences (or designee) will be honored. Absences for outside coursework or research related activities will be excused where reasonable.

Behavior and Non-discrimination: This course follows the UA Threatening Behavior by Students policy, which prohibits threats of physical harm to any member of the University community. (See also http://policy.arizona.edu/education-and-student-affairs/threatening-behavior-students) The University of Arizona is committed to creating and maintaining an environment free of discrimination. In support of this commitment, the University prohibits discrimination, including harassment and retaliation, based on a protected classification, including race, color, religion, sex, national origin, age, disability, veteran status, sexual orientation, gender identity, or genetic information. The University encourages anyone who believes he or she has been the subject of discrimination to report the matter immediately as described in the section below, "Reporting Discrimination, Harassment, or Retaliation." All members of the University community are responsible for participating in creating a campus environment free from all forms of prohibited discrimination and for cooperating with University officials who investigate allegations of policy violations. (See also http://policy.arizona.edu/human-resources/nondiscrimination-and-anti-harassment-policy)

The information contained in this course syllabus, other than the grade and absence policies, may be subject to change with reasonable advance notice, as deemed appropriate by the instructor. This particularly applies to the tentative course schedule and due dates below.

Tentative Course Schedule

Class #	Date	Topics	Other Activities and Deadlines
1 (Harris)	T Aug. 22	Introduction and Course Overview	Course Content and Expectations Discussion of Observations
2 (Harris)	Th Aug. 24	Organization and Composition of Protoplanetary Disks	
3 (Harris)	T Aug. 29	Formation of Planetesimals	
4 (Harris)	Th Aug. 31	Bulk Composition and Structure of Icy Planetesimals	
5 (Harris)	T Sept. 05	Orbits, Organization, and Classes of Icy Planetesimals	
6 (Harris)	Th Sept. 07	Comet Volatiles and Compositional Differences	
7 (Harris)	T Sept. 12	Comet Activity Patterns & Morphology (Gas)	
8 (Harris)	Th Sept. 14	Comet Activity Patterns & Morphology (Dust)	Observational Techniques: Overview of Image Analysis
9 (Harris)	T Sept. 19	Inversion Techniques and Production Rate	Theoretical Approaches and Convergence
10 (Harris)	Th Sept. 21	Encounters and Surface Morphology	
11 (Harris)	T Sept. 26	Asteroid Introduction	Guest Lecture: Prof. Erik Asphaug
12 (Reddy)	Th Sept. 28	Overview of Asteroid Populations (NEOs, MBAs)	Discussion of Asteroid Discovery, astrometry, Online Tools
13 (Reddy)	T Oct. 03	Asteroid Characterization	Photometry and Spectroscopy, Tour of RAPTORS Nest Observatory
14 (Reddy)	Th Oct. 05	TC4 Campaign, NASA IRTF Visit	Goals of the Campaign, Planning the Observing Run, Logistics,
15 (Reddy)	T Oct. 10	NASA IRTF Observations in Hawaii for TC4 campaign	Graduate Students travel to Hawaii Undergraduates participate remotely
16 (Reddy)	Th Oct. 12	NASA IRTF Observations in Hawaii for TC4 campaign	Graduate Students travel to Hawaii Undergraduates participate remotely
17 (Reddy)	T Oct. 17	DPS Meeting (No Class)	
18 (Reddy)	Th Oct. 19	DPS Meeting (No Class)	

Class #	Date	Topics	Other Activities and Deadlines
19 (Reddy)	T Oct. 24	TC4 Observations Review.	Review all observations collected, Data reduction and Analysis Plan
20 (Reddy)	Th Oct. 26	Introduction to Mineralogy, Asteroids Spectral Classes	
21 (Reddy)	T Oct. 31	Asteroid-Meteorite Link	Hands on spectroscopy lab activity
22 (Reddy)	Th Nov. 02	Spaceweathering	
23 (Reddy)	T Nov. 07	Vesta and Ceres	Overview of key results from NASA Dawn Mission
24 (Reddy)	Th Nov. 09	Asteroid Interiors	Guest Lecture: Dr. Mike Nolan and Prof. Erik Asphaug
25 (Harris)	T Nov. 14	Evolution and Organization of the Kuiper-Edgeworth Belt	
26 (Harris)	Th Nov. 16	Compositional characteristics and variability	
27 (Harris)	T Nov. 21	Detection and size distribution	
28 (Harris)	Th Nov. 23	Hydrostatic bodies	
29 (Harris)	T Nov. 28	Centaurs, Moons, Rings & Debris	
30 (Harris)	Th Nov. 30	Open Questions & Future Study	
31 (Joint)	T Dec. 05	Final Presentations	

The schedule below is provisional and only the basic topics covered are listed. The term project due dates and exam dates are very unlikely to change, but homework assignments and topics might shift with advance notice.