ASTR-, PTYS-450/550 — Fall 2019

The Origin of the Solar System and Other Planetary Systems

Tuesday & Thursday 11am – 12.15pm

Space Sciences 312

Instructor: Dr. Ilaria Pascucci (ilariapascucci.com)

Office hours: Tue 1–2pm, Thu 1–2pm

Course Description

This course will review the physical processes related to the formation and evolution of the protosolar nebula and of protoplanetary disks. In doing that, we will discuss the main stages of planet formation and how different disk conditions impact planetary architectures and planet properties. We will confront theoretical models of disk evolution and planet formation with observations of circumstellar disks, exoplanets, and the planets and minor bodies in our Solar System.

Course objectives, learning outcomes, and topics:

Upon completion of this course, students will know which physical processes shape planetary systems, understand observations of disks and exoplanets, and be able to place the Solar System into context. Topics covered in class include:

– The Solar System vs Discovered Planetary Systems: similarities and differences between the planets in our Solar System and exoplanets
– The Solar Nebula Theory: collapse of rotating clouds, the angular momentum problem, viscously accreting disks, irradiated disks, theoretical vs observed disk properties
– Disk Evolution and Disk Dispersal Mechanisms: viscous evolution, internal and external photoevaporation, disk and stellar winds, planet formation, theoretical vs observed evolutionary pathways
– Condensation and Growth of Solids: predicted and observed timescales for grain growth in the solar nebula and in protoplanetary disks, dust settling, radial drift of solids and the meter-size barrier to form planetesimals
– Main Planet Formation Scenarios: core accretion and disk gravitational instability, observations testing these scenarios
– Planet Migration in Gaseous Disks: type I and II migration and their role in interpreting the properties of giant planets, neptunes, and super-Earths

– Planetary Systems vs Stellar Masses: stellar-mass-dependent disk properties imprinted in planetary architectures and planet properties. Discussion on the potential of forming terrestrial planets in the habitable zone of A- down to M-dwarf stars

Pre-requisites: All students enrolled in the astronomy, physics, planetary science, and optical science PhD programs can take this class. Students in other PhD programs should contact the instructor for approval. Undergraduate students who have taken two upper division science classes are also eligible to take this class.

Grades will be based on homeworks (60%) and one final exam (40%). Extra points will be given based on participation. This course uses absolute grading. If your final percentage falls within the following ranges, you are guaranteed at least the corresponding letter grade

A:87.5-100%; B: 75-87.5%; C: 62.5-75%; D: 50-62.5%; E<50%

Homework (graduate vs undergraduate)

Homework assignments will be announced in class and will be posted on the d2l website after the class. Most assignments will contain one or more advanced questions for graduate students only. Homework assignments are typically graded on a 10-point scale. Late homework that are turned in the day after the due date will receive a 25% penalty while homework submitted later will receive a 50% penalty. Any homework submitted later than the first class after the due date will not be accepted. You are encouraged to work together but the work that you submit MUST be your own.

Exam (graduate vs undergraduate)

There will be a final exam covering material discussed in class and in the homework. The exam will contain a few advanced questions for graduate students only.

Makeup Exams

Makeup exams are only allowed for the following reasons and must be taken within 2 weeks of the exam date:

1. University approved activity (dean's approval required);
2. Religious holidays (you must provide information on the holiday);
3. Medical emergency, for which you can provide a doctor's note;
4. Jury duty.

Suggested textbooks:

There are no required textbooks for this class. The following textbooks are suggestions as to where students might look for extra information on the topics covered in class. These books will be put on reserve at the LPL library (Space Sciences 409):

"Accretion Processes in Star Formation" by L. Hartmann (Cambridge Astrophysics)
"Astrophysics of Planet Formation" by P. Armitage (Cambridge University Press)
"Protoplanetary Dust" by D. Apai and D. Lauretta (Cambridge University Press)
"Planetary Sciences" by I. de Pater and J. Lissauer (Cambridge University Press)

Absence and class participation policy: Participating in the course and attending lectures and other course events are vital to the learning process. As such, attendance is required at all lectures and discussion section meetings. Although attendance will not be formally taken in this class, extra points will be given based on participation (see **Grades**) and will affect a student's final course grade. If you anticipate being absent, are unexpectedly absent, or are unable to participate in class activities, please contact me as soon as possible. A student's request for reasonable religious accommodations will be granted, please see http://policy.arizona.edu/human-resources/religious-accommodation-policy for details.

Subject to Change Statement: Information contained in the course syllabus, other than the grade and absence policy, may be subject to change with advance notice, as deemed appropriate by the instructor.

Students with Disabilities

If you anticipate barriers related to the format or requirements of this course, please meet with me so that we can discuss ways to ensure your full participation in the course. If you determine that disability-related accommodations are necessary, please register with Disability Resources (621-3268; drc.arizona.edu) and notify me of your eligibility for reasonable accommodations. We can then plan how best to coordinate your accommodations.

Academic Integrity

It is strongly recommended that all students read the University of Arizona's Code of Academic Integrity. Details can be found at http://deanofstudents.arizona.edu/codeofacademicintegrity. All students in this course are expected to abide by this code, which will be strictly enforced. Primary things you need to be aware of are:

- ***Cheating is not tolerated in any form.*** If a student is caught cheating on an exam, the penalty will be failure in the course. ***A letter will be sent to the Dean of Students describing the incident.*** If you are aware that someone else is cheating, it is your obligation to inform the instructor.

- ***Collaboration among students is encouraged BUT*** you must always write the final version of an assignment yourself, and use your own words to describe what you have concluded. If we receive verbatim answers from more than

one person we will divide the credit received among all those with identical answers. This holds for math as well as text.

- It is fine to make use of reference books or web sites. But if you do so ***make sure to put in quotes what is taken verbatim from a different source***, otherwise make sure to rewrite things in your own words, and **list the source of your information**. Plagiarism is strictly prohibited. If you are uncertain as to what constitutes plagiarism see: http://deanofstudents.arizona.edu/codeofacademicintegrity. Note that we will be using the software Turnitin within d2l to automatically check all assignments for plagiarism.

- ***Threatening Behavior:*** Check http://policy.arizona.edu/threatening-behavior-students

- ***UA anti-harassment policy :*** The University is committed to creating and maintaining an environment free of discrimination; see http://policy.arizona.edu/human-resources/nondiscrimination-and-anti-harassment-policy. Our classroom is a place where everyone is encouraged to express well-formed opinions and their reasons for those opinions. We also want to create a tolerant and open environment where such opinions can be expressed without resorting to bullying or discrimination of others.

- ***Late Arrival – Early Departure:*** Late arrivals and early departures can be very disruptive for the class. They can be accepted as an exception, but if for whatever reason a student needs to do so on a regular basis, he/she should contact the instructor ahead of time, and try to sit near the exit doors.

- ***Cell Phones and Laptops:*** The use of cells phones is not allowed inside the class and it is strongly suggested that they are turned off before getting to class. If you accidentally forget to turn your cell phone off, I expect that if the cell phone rings you will turn it off immediately. ***Talking on the phone during class is not allowed***. Failing to observe this rule will be considered poor class participation and affect the overall grade. Phone usage is strictly forbidden during exams.

- ***No Food/Drinks:*** The Lunar & Planetary Laboratory does not allow food and drinks other than bottled water in the classroom, Space Science Room 312. Also, if you find a problem with a seat or its writing table, please let us know, so that the problem can be addressed as soon as possible.

- ***Study Room:*** Space Science Room 330 is dedicated for general use by students and TAs. The room is open to students Monday through Friday from 8:00am through 5:00pm. Besides work/study tables, the room includes several Macintosh and PC computers connected to the internet, and 1 printer. Students are encouraged to take advantage of this facility. However, keep in mind that these computers are shared among all the undergraduate students, so if you use them make sure to take your work with you when you leave. The Planetary Sciences Department is not responsible for any file left by students in the computers of SS-330. There may be times when the room will be used for a laboratory-type class, and will be unavailable for a limited amount of time.