

ASTR-, PTYS-450/550 — Fall 2021

The Origin of the Solar System and Other Planetary Systems

This class is scheduled to be taught in the in-person modality.

Meeting time: Tuesday & Thursday 11am – 12.15pm

Location for in-person classes: Space Sciences 312

Instructor: Dr. Ilaria Pascucci (ilariapascucci.com)

Office hours (initially on Zoom) : Tue 1–2pm & Thu 2–3pm

Zoom link for office hours: <https://arizona.zoom.us/j/82215769245>

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, disk gravitational instability and pebble accretion, 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 homework (70%) and one final exam (30%). 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 is expected to take place in Space Sciences 312. 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)

Classroom Participation Policy and Attendance: 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.

However:

– If you feel sick, or may have been in contact with someone who is infectious, stay home. Except for seeking medical care, avoid contact with others and do not travel.

If you will be missing a course meeting or an assignment deadline, notify me immediately. Non-attendance for any reason does not guarantee an automatic extension of due date or rescheduling of examinations/assessments. If you must miss the equivalent of more than one week of class, you should also contact the Dean of Students Office DOS-deanofstudents@email.arizona.edu to share documentation about the challenges you are facing.

Note that voluntary, free, and convenient [COVID-19 testing](#) is available for students on Main Campus. COVID-19 vaccine is available for all students at [Campus Health](#). Please visit the [UArizona COVID-19](#) page for regular updates.

Class Recording: For lecture recordings, which are used at the discretion of the instructor, students must access content in D2L only. Students may not modify content or re-use content for any purpose other than personal educational reasons. All recordings are subject to government and university regulations. Therefore, students accessing unauthorized recordings or using them in a manner inconsistent with [UArizona values](#) and educational policies ([Code of Academic Integrity](#) and the [Student Code of Conduct](#)) are also subject to civil action.

Statement on compliance with COVID-19 mitigation guidelines: As we enter the Fall semester, your and my health and safety remain the university's highest priority. To protect the health of everyone in this class, students are required to follow the university guidelines on COVID-19 mitigation. Please visit www.covid19.arizona.edu.

Academic advising: If you have questions about your academic progress this semester, please reach out to your academic advisor (<https://advising.arizona.edu/advisors/major>). Contact the Advising Resource Center (<https://advising.arizona.edu/>) for all general advising questions and referral assistance. Call 520-626-8667 or email to advising@arizona.edu

Life challenges: If you are experiencing unexpected barriers to your success in your courses, please note the Dean of Students Office is a central support resource for all students and may be helpful. The [Dean of Students Office](#) can be reached at (520) 621-2057 or DOS-deanofstudents@email.arizona.edu.

Physical and mental-health challenges: If you are facing physical or mental health challenges this semester, please note that Campus Health provides quality medical and mental health care. For medical appointments, call (520) 621-9202. For After Hours care, call (520) 570-7898. For the Counseling & Psych Services (CAPS) 24/7 hotline, call (520) 621-3334.

Nondiscrimination and Anti-harassment Policy

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. For more information, including how to report a concern, please see: <http://policy.arizona.edu/human-resources/nondiscrimination-and-anti-harassment-policy>

University Policies

For other university policies, including academic integrity, please see: <https://academicaffairs.arizona.edu/syllabus-policies>.

Subject to Change Notice

Information contained in the course syllabus, other than the grade and absence policies, may be subject to change with reasonable advance notice, as deemed appropriate by the instructor of this course.

Graduate Student Resources: <http://basicneeds.arizona.edu/index.html>