Physics 171


Planetary & Stellar Astronomy
Fall 2020
William & Mary
[Peter Komka, MTI, AP]

Instructors

Prof. Seth Aubin

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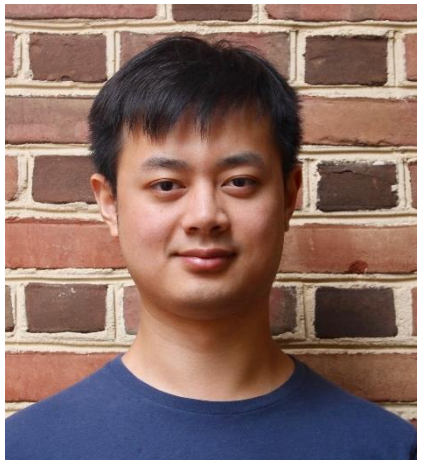
web: http://www.physics.wm.edu/~saubin/index.html



Peiwen Liu

Office: On-line, Zoom
e-mail: pliu01@email.wm.edu

Office hours:

Aubin: MWF 9:20-10:30 am, or by appointment
Liu: by appointment

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Introduce **planetary** and **stellar** astronomy

→ Concepts, Methods, and Science.

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- Main sequence stars, stellar evolution.
- Specials stars: dwarfs, Ceipheids, neutron stars, black holes.
- Exploding stars: novae, supernovae, mergers.

Course Materials

Text: A significant fraction of the course materials and problem sets will be taken from the following required texts for the course:

Astronomy by A. Fraknoi, D. Morisson, and S. C. Wolff
[OpenStax (Rice U.), 2020]

→ Download for free at:
https://openstax.org/details/books/astronomy

Note: Swem Library has 2 hardcopies.

Course materials will be posted on:

- Blackboard course site
- Prof. Aubin website:
https://saaubi.people.wm.edu/TeachingWebPages/Physics171_Fall2020/Physics171_Fall2020.html

Course Delivery Structure

Primarily Remote Asynchronous

All of the lectures will be delivered remotely via short videos posted on the course site.

Synchronous sessions: MWF 9:00-9:15 am

- At the start of each official class period, there will be a short **synchronous problem solving session** (or class announcement/discussion).
- You are expected to have **already viewed the video lecture** for that day.
- **Attendance** is expected.
- Opportunity for **Q&A**.
- These sessions will be recorded and posted on the course site.
- **Official office hours** begin immediately after this problem solving session.

Extra course time

Due to the shortened semester, each “lecture” will be approximately 54 minutes long on average (videos + problem session).

Course Work

- **Problem sets:** roughly every week.
- **Participation:** attendance, questions/discussion, quizzes.
- **Papers and presentations** for the 2 interludes.
- **Midterm:** 2 midterm tests.
- **Final** covers all course material with emphasis on end of semester.

Participation:	10%
Problem sets:	20%
Papers & Presentations:	25%
Midterms (2):	25%
Final Exam:	20%
Total =	100%

Problem Sets (I)

- Important for verifying and deepening understanding of **text chapters** and **lectures**.
- Typically, one week to complete and due on **Fridays**.
- 3-5 problems, mostly quantitative, some qualitative.
- Turn in on Blackboard … we may switch to Gradescope or WebAssign.
- A random sample of 1-5 problems will be graded.
- Source for some midterm test problems (and final exam).

Problem Sets (II)

You should complete the problem sets on your own.

Allowed

- "Verbal" discussion of problems between students.
- Ask for assistance during office hours.
- TBD: Physics SPS tutoring (free): Thursdays at 6pm ???
- Consultation of written references (and internet).

Not Allowed (i.e. honor code violation)

- Equation-based numerical discussions.
- Collaborative effort with other students.
- Consultation of solution manual.

Interludes (COLL 200)

Interlude I: Humanity in the Solar System.

→ reaches out to CSI domain: Cultures, Societies, & Individuals.

Interlude II: Space Art.

→ reaches out to ALV domain: Arts, Letters, and Values.

Interlude Structure

Student presentations, discussions, short papers.

Course work (tentative)

- 2 papers: one for each interlude, 5-ish pages.
- 1 team presentation.

Miscellaneous

Piazza Q&A forum

We will use Piazza.com as a forum for questions & answers.
You will receive an invitation to enroll by e-mail.

HonorLock

The course will use HonorLock for proctoring the midterms and final exam.

Schedule (I)

Week 0: 8/19-21 **Intro to Astronomy [Ch. 1, 2]**
Overview, units, distance scales, time, atoms to galaxies, radius of the Earth.

Week 1: 8/24-28* **Basic Physics I: Motion and Orbits [Ch. 3]**
Constellations, gravity, orbits, Kepler' laws, seasons, precession.

Week 2: 8/31-9/4 **Basic Physics II: Newton and Gravity [Ch. 3]**
Kepler's laws, Galileo, Newton's laws, conservation laws, gravity, circular motion, tides.

Week 3: 9/7-11 **Basic Physics III: Light and Matter [Ch. 5, 16.1-2]**
Electromagnetic waves, blackbody radiation, photons, atoms, fusion, Doppler effect.

Week 4: 9/14-18 **Astronomy Instruments [Ch. 6]**
MIDTERM #1. Telescopes, resolution, adaptive optics, interferometry, space probes.

***Add/drop deadline: Friday, August 28, 2020**

Schedule (II)

Week 5: 9/21-25 **Solar System I: Overview [Ch. 7, 21]**
Structure of solar system, planetary density, formation of solar system, radio-dating.

Week 6: 9/28-10/2 **Solar System II: Earth & Rocky Planets [Ch. 8, 9, 10]**
Planetary structure, magnetosphere, atmosphere, tidal locking, Mercury, Venus, Mars.

Week 7: 10/5-9 **Solar System III: Gas Giants [Ch. 11, 12]**
Planetary structure, Jupiter and Galilean moons, Saturn and rings, Uranus, Neptune.

Interlude I: Humanity in the Solar System (presentation + paper).
Week 8: 10/12-16** **Dwarf Planets, Comets, Exoplanets, Life [Ch. 13, 14, 30]**
Outer solar system, asteroids, comets, exo-planet hunting, exo-life.

Week 9: 10/19-23 **Stars I: Our Sun & Main Sequence Stars [Ch. 15, 16, 17]**
MIDTERM #2. Structure, solar wind, sunspots, fusion, star brightness and temperature.

****Withdraw deadline: Monday, October 12, 2020**

Schedule (III)

Week 10: 10/26-30 **Start II: Stellar Evolution [Ch. 17, 18, 19, 22]**
Luminosity vs mass, H-R diagram, spectroscopy, star types.

Week 11: 11/2-6 **Stars III: Stellar Death [Ch. 22, 23]**
Helium fusion and beyond, red giants, white dwarfs, novae, supernovae, neutron stars.

Interlude II: Space Art (presentation + paper).
Week 12: 11/9-13 **Black Holes & Einstein's Relativity [Ch. 24]**
Special & general relativity, spacetime, gravitational redshift, black holes.

---------- Classes Finish ----------

November 20, 2020, 9am-noon **Final Exam**

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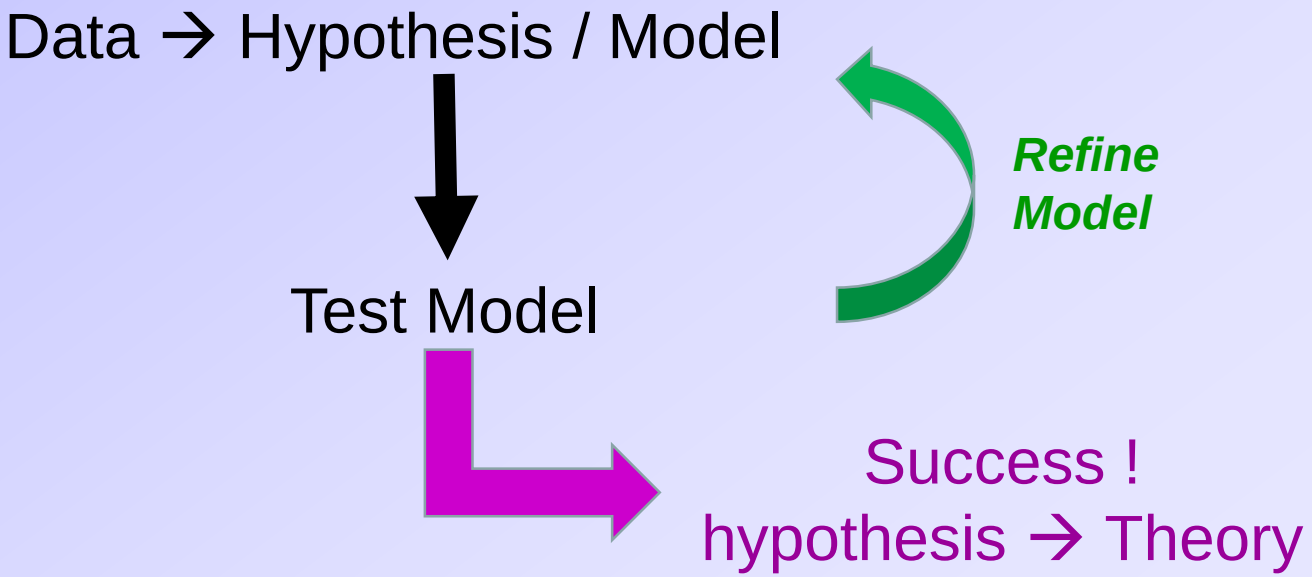
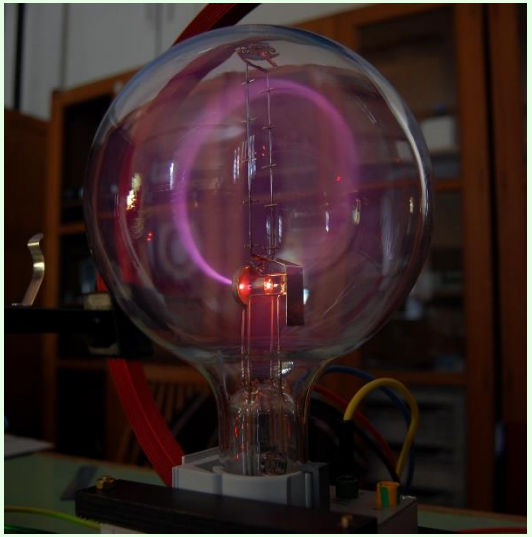
"Scientific method":



How accurate can a Theory be?



[Wikipedia, 2009]

Electron's magnetic "g-factor"

Schrodinger's theory: $g_e = 1.0$

Dirac relativistic theory: $g_e = 2.0$

Present day quantum physics: $g_e = 2.002\ 319\ 304\ 362$

12-digits

Theory and experiment agree to 9 digits !!!

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- Observational science, with physics-based models/theories.

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Answer: As best we can tell, **science/physics** developed from Earth-based experiments **can explain all** observed astronomical phenomena.

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Potential exceptions:
Big Bang, dark matter, and dark energy (… black holes).

Scientific Units

Scientific Notation


Antares
dust & gas clouds
“Astronomy Picture of the Day”
David McGarvey