Physics 171

Planetary & Stellar Astronomy

Fall 2019
William & Mary

[Peter Komka, MTI, AP]

Instructors

Prof. Seth Aubin

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CeeCee Bishop

Office: room 258, grad student lounge, Small Hall
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Office hours:

Aubin: T & Th noon-1 pm, or by appointment
Bishop: Th 8:30-10:30 am or by appointment

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→ Concepts, Methods, and Science.

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- Main sequence stars, stellar evolution.
- Specials stars: dwarfs, Cepheids, 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.), 2018]

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

Note: There are 2 hardcopies on reserve at Swem Library.

Course materials will be posted on:

- Blackboard course site
- Prof. Aubin website:
https://saaubi.people.wm.edu/TeachingWebPages/Physics171_Fall2019/Physics171_Fall2019.html

Course Work

- **Problem sets:** weekly.
- **Participation:** class attendance, classroom discussion, quizzes (PollEv).
- **Papers and presentations** for the 2 interludes.
- **Midterm:** 3 midterm tests.
- **Final** covers all course material with emphasis on end of semester.

Participation:	10%
Problem sets:	20%
Papers & Presentations:	20%
Midterms (3):	30%
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**.
- 5-ish problems, mostly quantitative.
- Turn in as hard copy (handwritten) … neatness will graded.
- A random sample of 1-3 problems will be graded.
- Source for some midterm test problems and in-class **quiz questions**.

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.
- Physics SPS tutoring (free): Thursdays at 6pm in Small Hall 122.
- Consultation of written references (and internet).

Not Allowed (i.e. honor code violation)

- Collaborative effort with other students.
- Consultation of solution manual.

PollEv

Usage

- Class discussion questions (ungraded).
- Participation gauge.
- In-class quizzes.
- Starts next week (September 2-6).

Sign-up

- Free
- Use mobile device (tablet, phone) or laptop.
- Sign-up instructions (see syllabus for details):

https://www.wm.edu/offices/it/services/academicsupport/studentresponsesystem/index.php

- Course username: sethaubin

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

Some lecturing, readings, with strong **student-led** component.

Course work (tentative)

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

Schedule (I)

Week 0: 8/28-30 **Intro to Astronomy [Ch. 1, 2]**
Overview, units, distance scales, time, past concepts of the stars and planets, constellations.

Week 1: 9/2-6* **Basic Physics I: Motion and Gravity [Ch. 3, 4.6]**
Galileo, Newton's laws, gravity, orbits, Kepler' laws, escape velocity.

Week 2: 9/9-13 **Basic Physics II: Light and Matter [Ch. 5, 16.1-2]**
Electromagnetic radiation, photons, blackbody radiation, spectroscopy, elements, fusion.

Week 3: 9/16-20 **Astronomy Instruments [Ch. 6]**
Telescopes (optical, infrared, radio, x-ray, gamma), resolution, space probes.

Week 4: 9/23-27 **Solar System I: Overview [Ch. 7, 8]**
MIDTERM #1. Composition, structure, and origin of our solar system, Earth as a planet.

***Add/drop deadline: Friday, September 6, 2019**

Schedule (II)

Week 5: 9/30-10/4 **Solar System II: Earth & Earth-like Planets [Ch. 8, 9, 10]**
Earth, Moon, Mercury, Venus, Mars.

Week 6: 10/7-11 **Solar System III: Gas Giants, etc … [Ch. 11, 12, 13]**
Jupiter, Saturn, Uranus, Neptune, rings, moons, dwarf planets, asteroids, and comets.

---------- Fall Break ----------

Week 7: 10/16-18 **Our Sun [Ch. 15, 16]**
Structure of the Sun, thermonuclear fusion energy, space weather.

Week 8: 10/21-25 **Interlude I: Humanity in the Solar System**
MIDTERM #2. "Colonizing" Earth orbit, Moon, Asteroids, nearby planets. Astro-biology.

Week 9: 10/28-11/1** **Stars I: Stellar Properties [Ch. 17, 18]**
Brightness, color, size, rotation, composition, stellar distribution.

****Withdraw deadline: Monday, October 28, 2019**

Schedule (III)

Week 10: 11/4-8 **Start II: Distances & Interstellar Space [Ch. 19, 20]**
Measuring distance, Cepheid stars, H-R diagram, interstellar gas and dust.

Week 11: 11/11-15 **Stars III: Star Formation & Exo-Planets [Ch. 21]**
Stellar birth, planets outside our solar system, prospects for life outside Solar System.

Week 12: 11/18-22 **Stars IV: Stellar Evolution [Ch. 22, 23]**
MIDTERM #3. Main sequence stars, stellar death, dwarfs, novae, supernovae.

---------- Thanksgiving Break ----------

Week 13: 11/25 **Stars V: Extreme Stars [Ch. 24]**
Neutron stars, black holes, curved space, Einstein's general relativity, gravitational waves.

Week 14: 12/2-6 **Interlude II: Space Art**
(Extreme stars continued.) Imagining other worlds: space in still art and movies.

Dec 17, 2019, 9am-noon **Final Exam**

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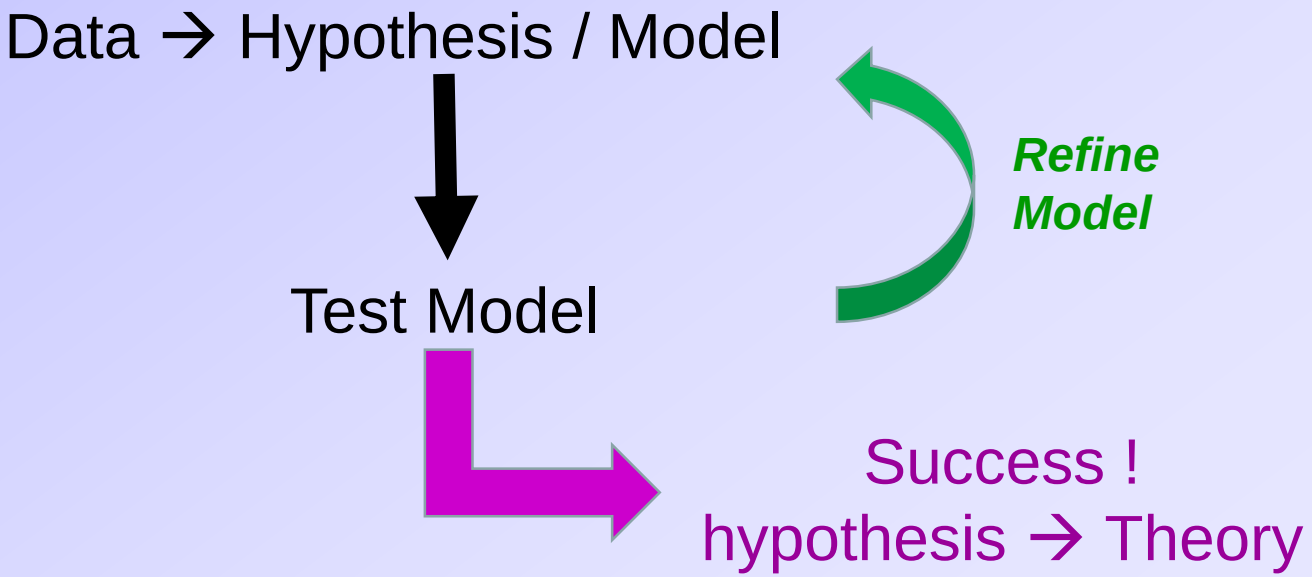
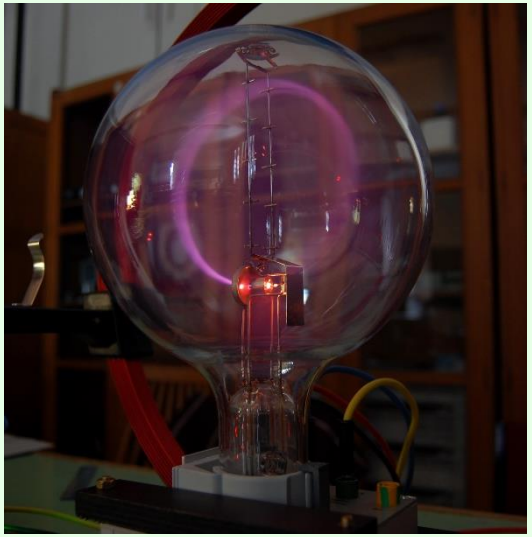
"Scientific method":



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