Astro 3, Section 8084: Stellar Astronomy

Please pick up a voting card and sign in on the roster at the front of the room.

About Me

• My office is in Lark Hall 2023
• Come say hello!
• Best way to contact me is email
  – jfielder@santarosa.edu
  – put the words “Astro 3” in the subject line of your email so it won’t be marked as spam

Goals For This Class

Help you understand:

• What astronomy is
• The role of astronomy in history
• How astronomy is connected to you

I expect you to:

• Come to class prepared to learn & participate
• Communicate with me about your progress in the class
• Respect everyone’s learning environment

I do NOT expect you to:

• Turn into a “Math-aholic” (or Math-ophobe!)
• Understand everything after seeing/hearing/reading it once
• Memorize equations

Course Website:

http://www.physics.sfsu.edu/~jfielder/3Sum10.html
Participation
• 15% of your final grade is class participation
  – Short writing assignments
  – Group activities
  – Voting
• If you miss class, you cannot make up the participation credit
• If you miss more than 2 classes, you may be dropped without warning or fail the class.

Voting
• During class, we will sometimes have multiple choice questions
• Preview of exam day!

Why does the Sun rise and set every day?
A. Because the Earth spins on its axis
B. Because the Earth orbits the Sun
C. Because the Sun spins on its axis
D. Because the Sun orbits the Earth
E. None of the above

Homework
• 6 assignments:
  – Review questions from textbook
  – Ranking Tasks from Lecture-Tutorials
• Working in groups is encouraged!
  Homework assignments will be posted on the website.

Exams
• 2 midterms and a final
• multiple choice, fill-in-the-blank
• You will need 3 882-E Scantron forms, a pencil, and an eraser
• Exam dates are not flexible

• DO NOT MISS EXAMS! THERE ARE NO MAKEUPS!

Grades
• Homework
• Participation (15 x 1% each) 15%
• Midterms (2 x 20% each) 40%
• Final Exam 25%

If you need to talk about your grade in detail, email me to make an appointment.
The Montillation of Traxoline

It is very important that you learn about traxoline. Traxoline is a new form of zionter. It is montilled in Ceristanna. The Ceristannians gristerlate large amounts of fevon and then brachter it to quasel traxoline. Traxoline may well be one of our most lukized snezlaus in the future because of our zionter lescelidge.  

(Attributed to the insight of Judy Larier)

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Directions: Answer the following questions in complete sentences. Be sure to use your best handwriting.

1. What is traxoline?
2. Where is traxoline montilled?
3. How is traxoline quaselled?
4. Why is it important to know about traxoline?

Astronomy in a nutshell...

Astronomy is all of science (physics, chemistry, and biology) applied to what we can see in the sky

Some Examples...

• Physics + Observations of planet positions = How to planets move around the Sun?
• Chemistry + Observations of stars = Why do stars shine?
• Biology + Observations of extrasolar planets = Is life outside Earth possible?

The Scientific Method

1. Form hypothesis
2. Design experiment to test hypothesis
3. Perform experiment/observations
4. Do the data support the hypothesis?
5. Revise or reform hypothesis based on results

Science is not...

• A list of previously known facts about nature
• A list of equations handed down from ancient times
• A set of laws that were discovered by Dead White Guys a long time ago and are kept hidden from the general public
Science Is...

- a continuing process that
  - seeks to understand the rules and laws of nature
  - uses systematic observations
  - uses mathematical models
  - experimentally tests ideas
- subject to independent verification

The Hard Part

Astronomy has no "test tube", we're stuck with whatever's going on in the Universe

1. Hypothesis
2. Experiment
3. Observations
4. Revise

Astronomers often have to start at #3!

This course covers the basics:

- How astronomers make observations (telescopes, photometry, spectroscopy)
- What astronomers see: stars, star clusters, galaxies, and what these things are doing
- Why astronomers think things are the way they are.

Dealing with large numbers

1. Give them Names
   - 1,000 = thousand (kilo-)
   - 1,000,000 = million (mega-)
   - 1,000,000,000 = billion (giga-)
   - 1,000,000,000,000 = trillion (tera-)
   - 1,000,000,000,000,000 = quadrillion (peta-)

1 googol =

Dealing with large numbers

2. Use Scientific Notation

- $1,000 = 10^3$
- $1,000,000 = 10^6$
- $1,000,000,000 = 10^9$
- $1,000,000,000,000 = 10^{12}$
- $1,000,000,000,000,000 = 10^{15}$

Dealing with large numbers

3. Calculations

Scientific notation makes calculations easier:

- $1,000 \times 1,000,000,000 = 1,000,000,000,000$
- Add exponents to multiply:
  - $10^3 \times 10^9 = 10^{12}$
- Subtract exponents to divide:
  - $10^{10} / 10^3 = 10^7$
Units of Length

- **British**
  - Miles, feet, inches
- **Metric**
  - Based on the meter
- **Astronomical Unit (AU)**
  - Based on the Earth-Sun distance
- **Light-Years**
  - Based on the speed of light

Metric System

- Everything is based on the meter (m)
  - 1 kilometer (km) = 1000 m = 10³ m
  - 1 centimeter (cm) = 0.01 m = 10⁻² m
  - 1 millimeter (mm) = 0.001 m = 10⁻³ m
  - 1 nanometer (nm) = 0.000000001 m = 10⁻⁹ m
- Good estimates:
  - 1 meter is about 3 feet
  - 1 inch is about 2.5 centimeters
  - 5 miles is about 8 kilometers

The Astronomical Unit (AU)

1 AU = 9.3 x 10⁷ miles (93 million miles)

- The average distance between the Earth and the Sun
- Good for characterizing distances within the solar system
  - Jupiter is about 5 AU from the Sun
  - Neptune is about 30 AU from the Sun

The Light-Year (ly)

1 light year = 5.8 x 10¹² miles (5.8 trillion miles!)

- Derived from the speed of light
- We can also talk about light-minutes, light-weeks, or light-seconds
  - The Sun is 8 light-minutes away
  - Neptune is about 4 light-hours away

Finding your way around the sky

Ancient Observers

- Ancient humans observed the sky
- They noticed that the Sun rises every day in the eastern half of the sky and sets in the western half.
- Same for the Moon & stars!

Stonehenge in England

Ruins of a Mayan temple and/or observatory
But our goal is still the same: to understand why things move, change, appear, and exist in the night sky.

Today, we use different instruments to keep track of the sky...

Constellations

- In ancient times, people saw patterns in the stars.
- They named these **constellations** for things that were important to their culture.

Different cultures saw different patterns.

Sagittarius, the Centaur & Scorpius, the Scorpion

**Constellations Redefined**

- Modern astronomers needed a more specific definition of a constellation.
- The sky was divided up into 88 semi-rectangular regions.
- Familiar, useful patterns are kept, now called "asterisms":
  - Big Dipper
  - Summer Triangle
  - Orion’s Belt

**Constellations: the 88 semi-rectangular regions that make up the sky**

- Northern constellations have Latinized Greek-mythology names:
  - Orion, Cygnus, Leo, Ursa Major, Canis Major, Canis Minor
- Southern constellations have Latin names:
  - Telescopium, Sextans, Crux

**Orion: The Hunter**

(Actual photograph)
Orion: The Hunter

Stars were given names by ancient people.

We use Arabic names in addition to ranking stars using Greek letters:

\(\alpha\) - Alpha, the first Greek letter, designates the brightest star in a constellation.

Finding the North Star

The Winter Hexagon

The Summer Triangle

Finding other bright stars using the Big Dipper

The Celestial Sphere

The ancients believed that all the stars were stuck to the surface of an invisible sphere that rotated around Earth.
Distances to Stars

- Stars were once thought to be fixed in a dome (The “Celestial Sphere”) above the Earth.
- We now know that the stars are scattered through space at great distances.

The stars in a constellation are not close in space. They are just along a similar “line of sight.”

Imagining a spinning Celestial Sphere surrounding Earth aids in thinking about the position and motion of the sky.

Celestial Sphere vs. Horizon Demo

Earth’s rotation causes the Sun, Planets, Moon and stars to appear to move when viewed from Earth.

Position Lecture Tutorial: Pg. 1-2

- Work in groups of 2-3
- Read the instructions and questions carefully.
- Discuss the concepts and your answers with one another. Take time to understand it now!!!!
- Come to a consensus answer you both agree on and write complete thoughts in your workbook.
- If you get stuck or are not sure of your answer, ask another group.
- If you get really stuck or don’t understand what the Lecture Tutorial is asking, ask me for help.
Nightly Motion of the Stars

- Imagine looking toward the North. What do stars appear to do over the course of an evening?
- What about stars in the South? East? West? Directly overhead?

Rising and Setting Stars

- The Earth’s eastward rotation causes stars to appear to move westward.
- Stars near the North Celestial Pole move in small circles, and are called circumpolar.
- Stars far from the pole move in long arcs.

Nightly Motion of the Stars

For stars (and Moon and planets) that appear in the southern sky: Stars first rise near the eastern horizon, move upward and toward the south, and then move down and set near the western horizon.

Nightly Motion of the Stars

- Looking North: Stars appear to move counterclockwise around the stationary North Star (Polaris) – we call these circumpolar stars.