What's out there...
... how we learn about it ...
... and why it's awesome.

Astronomy 101
Syracuse University, Fall 2016
Walter Freeman

August 29, 2016

Welcome!

The size and age of the Cosmos are beyond ordinary human understanding. Lost somewhere between immensity and eternity is our tiny planetary home. In a cosmic perspective, most human concerns seem insignificant, even petty. And yet our species is young and curious and brave and shows much promise. In the last few millennia we have made the most astonishing and unexpected discoveries about the Cosmos and our place within it, explorations that are exhilarating to consider. They remind us that humans have evolved to wonder, that understanding is a joy, that knowledge is prerequisite to survival. I believe our future depends powerfully on how well we understand this Cosmos in which we float like a mote of dust in the morning sky.

–Carl Sagan, from *Cosmos*

Welcome!

Today:

- Who we are
- Who you are
- What this class will be

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- Who you are
- What this class will be
- What the Universe is, too
  (and how we measure it)

Introduction

Course website: `https://walterfreeman.github.io/ast101/`

- Professor: Walter Freeman
- Lead TA: Scott Bassler
- Other TA's...
- Undergraduate coaches...

My email: wafreema@syr.edu
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Clickers

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We're using an extremely high-tech, state-of-the-art clicker system in this class. Make sure you get one, and bring it to class every day.

Who are you?

What academic year are you?

A: Freshman
B: Sophomore
C: Junior
D: Senior
E: Graduate student / non-degree

Who are you?

What's your primary field of study?

A: Science / engineering
B: Social sciences / Maxwell
C: Management / business / accounting
D: SUNY ESF
E: None of these

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What's your primary field of study?

A: Visual / performing arts
B: Liberal arts / philosophy
C: Communication / Newhouse
D: The iSchool
E: Something else

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Someone threw a gauntlet at you...

"With more knowledge comes deeper, more wonderful mystery... with pleasure and confidence we turn over each new stone to find unimagined strangeness leading on to more wonderful questions and mysteries–certainly a grand adventure!

Our poets do not write about [this]; our artists do not try to portray [it]. I don't know why. **Is nobody inspired by our present picture of the universe?** [Science] remains unsung by singers, so you are reduced to hearing not a song or poem, but an evening lecture about it. Is no one inspired by our present picture of the universe? **This is not yet a scientific age.**"

–Richard Feynman, from *The Value of Science* (1955)

Do you agree with Feynman?

... are we not yet living in a "scientific age"? Were we in 1955?

A: No, we don't live in a scientific age

B: We didn't then, but we do now

C: We did then, and we still do!

D: What a silly question!

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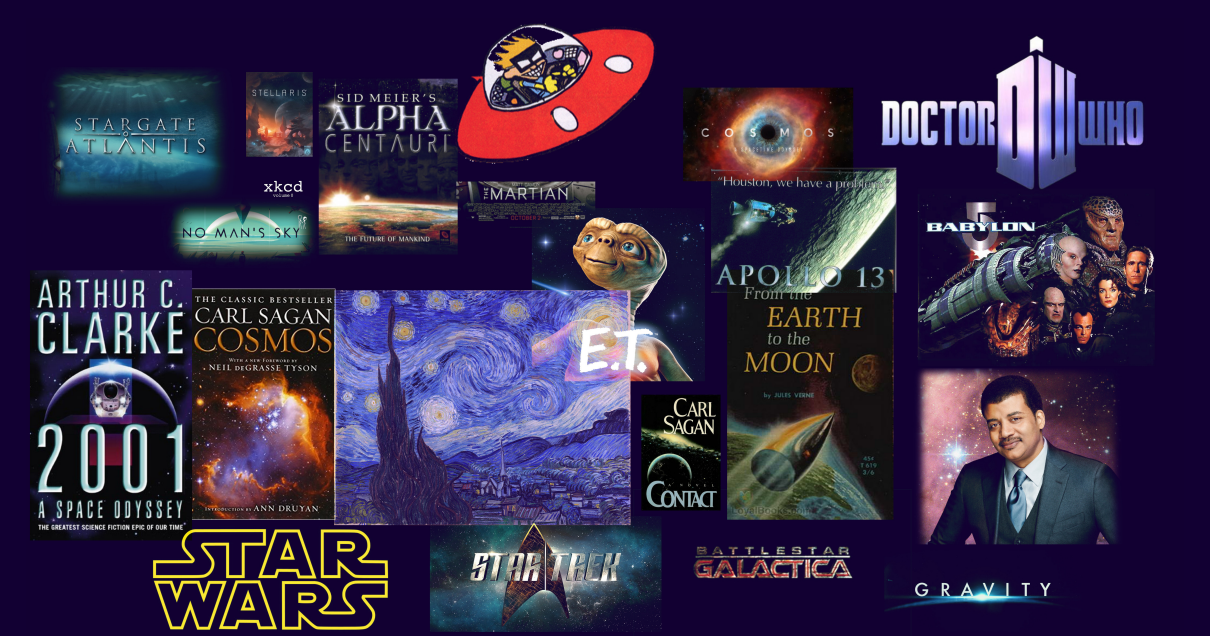
My answer...

Our poets and writers have (always) been busy...



Astronomy's broader impact on human thought

Astronomy has been inspiring art, philosophy, music, and literature since those things have existed.

Why is the fourth planet named Mars?

We're going to spend much of our class looking up ... but we'll spend a bit of time looking back down, too, to see how astronomy has influenced so many fields of human endeavor.

Course organization: four units

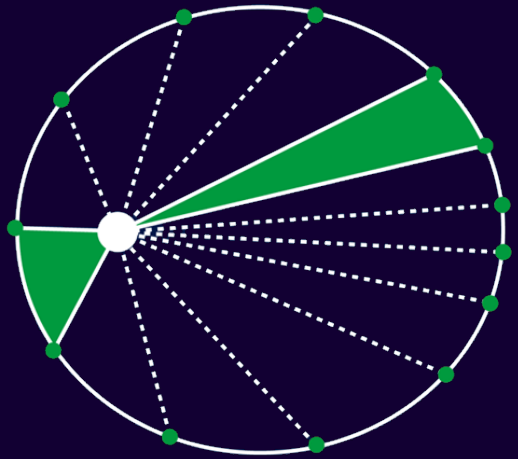
- Naked-eye astronomy
- Astromechanics
- The science of light
- Humanity and the cosmos

Naked-eye astronomy

- What can we see from Earth?
- What changes do we see in the sky?
- How are they explained by Earth's motion?

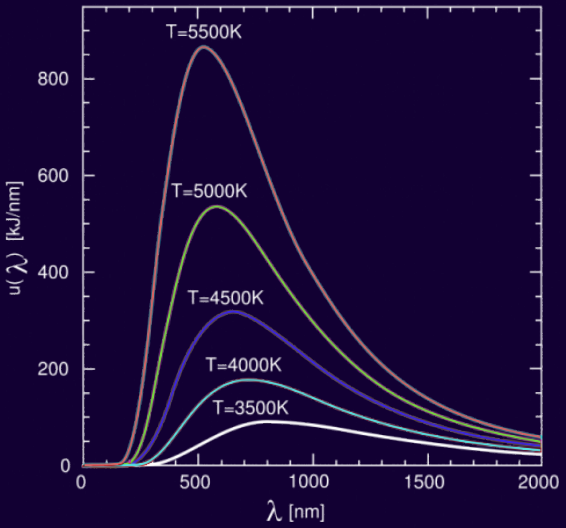
Astromechanics

- How does scientific thought work?
- How do we know the planets orbit the Sun?
- What do the motions of the planets really look like?
- How do the laws of physics cause them to move this way?



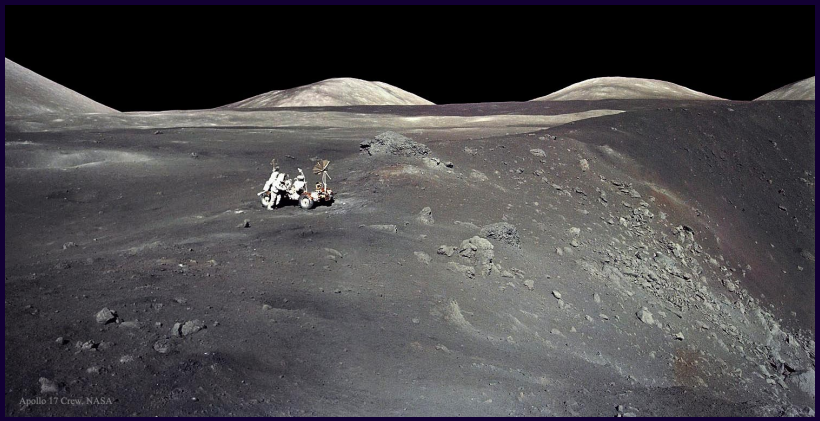
Light and the electromagnetic spectrum

- What is light?
- Where does light come from, and what does it do?
- How do we use light to study the sky?
- What has this taught us about the Sun?



Humanity and the cosmos

- What are the past and present of spaceflight?
- ... what might its future be in our lifetimes and beyond...
- ... and where else in the Universe might we find life, and what might it look like?



Course components: the labs

- Labs start on the **third week of class**
- Take-home labs assigned next week
- Labs meet in Holden Observatory, led by TA's

Course components: Mastering Astronomy homework

- Online homework system, at `https://masteringastronomy.com`
- You should have gotten a code with your book; if not, you can buy one
- Stuff you need to do
  - Go to `https://masteringastronomy.com`
  - Register an account, using course ID SUASTRO101FALL2016
  - Enter an access code, or buy one
- The first homework assignment isn't graded, but is a dry run to get you familiar with the system
- It's due next Tuesday and should take less than a half-hour

Course components: other things

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- Lots of details in the syllabus
- Observing the stars...
  - At Holden Observatory?
  - ... out in the Adirondacks?

I'm here to help you!

My full-time job is to help you all (and my other students). This is your class, not mine.

This means:

- Interrupt me any time in class if you have a question
- Yell at me if you have a question and I don't see your hand
- Email me and ask for help: suastronomy101@gmail.com
- Come to help sessions: Tuesdays, 4:30-6:30, and Fridays, 9:30-11:30
- Come bang on my office door (room 215)
- If you have questions you'd like addressed ("ask the physicist!"), or course suggestions, please send them to me!

"Baltimore is about five hours away."

Does this statement make sense as a way to describe the distance to Baltimore?

A: Yes
B: No
C: Yes, if I give you some other information...

The cosmic perspective: measuring distance

"China is about 1/15 of a second away."

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(This is something anyone who's tried to play a video game with someone across the ocean knows about!)

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→ We can measure long distances by *how long it takes light to get there!*
... if China is one-fifteenth of a light-second away, then a *light-year* has to be a pretty long way...

Three measures of distance...

Inside the Solar System, it's also useful to measure distances with a different yardstick: the distance to the Sun. This is called an astronomical unit, or AU.

We have:

- 1 kilometer
  - (good for measuring Earth-size things)
- 1 AU = 150 million km (1.5×10^8 km) = about 9 light-minutes
  - (good for measuring distances to the planets)
- 1 light-year = 60,000 AU = 9 trillion km (9×10^{12} km)

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- 1 universe = 14 billion light-years!

Another Freeman can explain it better than me!

https://www.youtube.com/watch?v=vRjGarICal4

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... where are we in all this?

Physics: Everything here is all the same!

It's no accident this class is in the physics building!

Everything in the Universe is made of the same sort of stuff.

- Those distant billions of galaxies, and their billons of stars each...
- ... the planets that we now know orbit many of those stars...
- ... the atoms that make up our own sun...
- ... the matter here on Earth...
- ... and even the atoms that make up you and I...

... are all made of the same sort of matter, doing the same dance they've been doing since the beginning.

By studying a few dancers, we learn about them all..

https://youtu.be/PrIk6dKcdoU

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This is a computer simulation of a collision that will happen in a few billion years.

Using a few principles you'll learn about in this class, and a computer, you can make this!

We, on our little rock, can actually *understand* how this all works!

Next time: the night sky

Thursday: How does the night sky move each night?

Stuff to do:

- Go find the course website and read the syllabus
- Register for Mastering Astronomy
- Bring your colored cards *and Lecture Tutorials* on Thursday
- If we have a clear night, look up!

Summary

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https://walterfreeman.github.io/ast101/galaxy-song.mp3