

# The consequences of the rotating Earth

Astronomy 101  
Syracuse University, Fall 2020  
Walter Freeman

August 27, 2020

# The celestial sphere of the stars

“I know that I am mortal by nature and ephemeral, but when I trace at my pleasure the windings to and fro of the heavenly bodies, I no longer touch earth with my feet. I stand in the presence of Zeus himself and take my fill of ambrosia.”

–Claudius Ptolemy, from the *Almagest* (c. 150 CE)

Schema huius præmissæ diuisionis Sphærarum.



“Ooh, the wheel in the sky keeps on turning // I don’t know where I’ll be tomorrow...”

–Journey, “Wheel in the Sky” (1978)

# What is this?



## Announcements: if you need to catch up

- Course website: [walterfreeman.github.io/ast101/](https://walterfreeman.github.io/ast101/)
- The finished syllabus and other information is posted there
- Other information will be added quickly in the days to come
- Make sure you join the Piazza page (you got an invite by email, or use the link on the website)
- Class will be streamed on both Zoom and Twitch for the foreseeable future

# Announcements: I need to catch up!

We had a *ton* of glitches that I've had to fix with various things. (I've been working until midnight and I'm still behind!)

Even so, I think I have something really cool to show you today – stay tuned!

The consequence of all of this is that I have been working long days and still haven't had a chance to answer all your email and questions on Piazza. I'm sorry!

So what all has gone wrong, and how will we recover from it?

# Recovering from glitches: Blackboard is a hot mess

Blackboard dumped the results of the lab time survey on the ground. (Aaaargh! It's a bug in Blackboard that bit another Physics prof as well this week.)

This means that you will need to fill out a new one. This one says it's a "test". (You'll get free credit for filling it out). Sorry to make you do this again...

On this one, though, there's an option for choosing your groups if you want to work with friends.

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Because we are late getting the groups together because of Blackboard, **we won't have labs next week either**. Don't worry – we'll start the next week!

You *will* have a group homework assignment, though – something to do next week during the time you have put down for lab.

# Recovering from glitches: Dealing with trolls

We had issues with people trolling both Zoom and the Twitch stream last time.

We now have people monitoring chat in both places with a banhammer, so I don't have to do it.



## Recovering from glitches: Kaltura died

I was going to post our recordings to SU's video service "Kaltura". But it died today.

If Kaltura isn't reliable for us, I'll post recordings to YouTube and Bilibili instead. I'll let you know when those are posted and put them on the course website.

(YouTube is not accessible in China, where some of our students are. Bilibili is a Chinese version of YouTube.)

I can keep trying to use Kaltura, too, but it has been dead more than it's been alive since Tuesday.

Could I get a volunteer from the class to start a Bilibili channel for us? (I don't speak Chinese, sadly.) It is likely that this will turn into a *paid job* if you want!

What do you think about this picture?

# Some announcements

I am really far behind answering questions and email. I will catch up ASAP!

Do you have any questions for me now?

# The night sky and the celestial sphere: overview

- What's the night sky look like?
- How have we affected the night sky?
- How does the sky move each night?
  - The celestial-sphere model
  - Why it works, and when it doesn't
  - The first *Lecture Tutorial*

We can simulate the night sky tonight using *Stellarium*. You will download and get to know this program for your first homework assignment, which you will do next week with your groups.

It's available for free on Linux, Mac OSX, and Windows. There is also a web version.

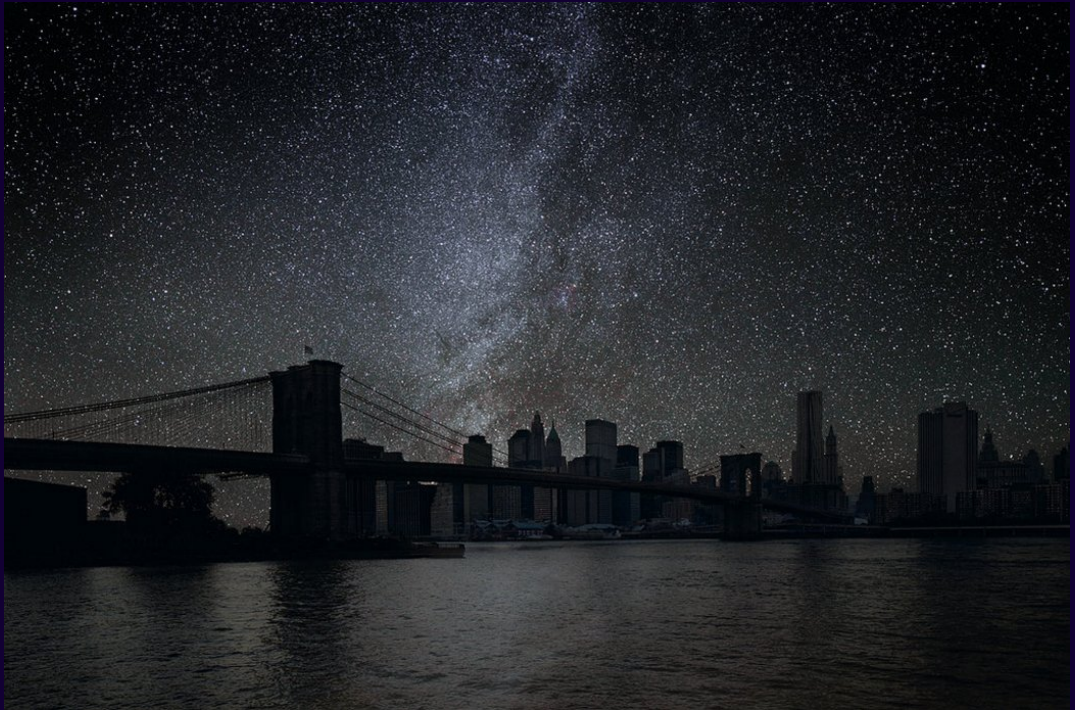
# Light pollution

What do you think about this picture?



# Light pollution

This is what we could have instead!



*(Thierry Cohen, published in the New York Times)*

# Alamut, Iran



Photo by Babek Tafreshi. Alamut was the home of Nasir al-Din al-Tusi, the first to surmise that the Milky Way was made of many stars in the 13<sup>th</sup> century. The glow is light pollution from Tehran, 100 km away.



# Motion and time

Last time we talked about the **distance scales** involved in astronomy:

- We measure distances on Earth in kilometers (1 Earth = 10,000 km; distance to Moon = 400,000 km)
- We measure distances in the Solar System in AU (Sun to Earth = 1 AU, Earth to Moon = 1/400 AU, Sun to Neptune = 30 AU)
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  - (It takes between a few months and a few decades for the other visible planets to orbit the Sun.)
- **In one year** the Earth orbits the Sun.
- **It takes tens or hundreds of thousands of years** for the stars to move appreciably relative to us.

In one day, about how much does the Earth move around the Sun?

Tell me in chat – let's have a conversation here!

In one *hour*, how much does the Earth move around the Sun?

Again, type your thoughts in chat.

The kind of math I just did is the sort of thing you'll use in this class.

I didn't do anything fancy – just “back-of-the-envelope” estimation.

This kind of math is quite important in astronomy (and physics!)...

... and it's not difficult.



In one *hour*, how much does the **Moon** move around the Earth?

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In one *hour*, how much does the *Moon* move around the Earth?

In the course of a day, the only significant motion that happens is that  
the Earth turns on its axis!

# What do you think about this picture?

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## The Student-Blaming Has Begun

Is it fair to fault college students for Covid-19 outbreaks?

WALTER FREEMAN

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*(I think the idea of “blame” is overrated. I am not interested in blaming anyone for things. We’re all in this together.)*

What do you think about *this* picture?





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*There hasn't been any transmission of COVID-19 in Wuhan since May! These people are safe.*

# While this was going on...

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... I was filming the night sky – pointed the other way. What does the sky look like from the Quad?



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- This rotates around the Earth, once per day

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How much of the celestial sphere can we see at a time?

All of it? More than half? Less than half? Does it depend on where on Earth you are?

How good is this “celestial sphere” model, anyway?

What is right about this model? What is wrong about this model?

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Actually, (——) rotates, and (——) doesn't move much at all.

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Is it really true that *every* star in the sky moves in the same way, all together?

Actually, (——) rotates, and (——) doesn't move much at all.

Let's see how this works with a demo. (I spent much of yesterday building this!)

# Why the celestial sphere still explains a lot

Key idea: It doesn't matter if Earth rotates or the celestial sphere rotates: **relative** motion controls what we see!

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The celestial sphere model explains how the Earth's rotation affects the sky.

It should thus explain the changes in the sky pretty well over **one day**.

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## Problems with the celestial sphere: II

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No; we just don't have any "depth perception" of things this far away. Type in chat: what about our eyes lets us see how far away things are?

We can only perceive depth for things close to us, where we can use *binocular parallax*.

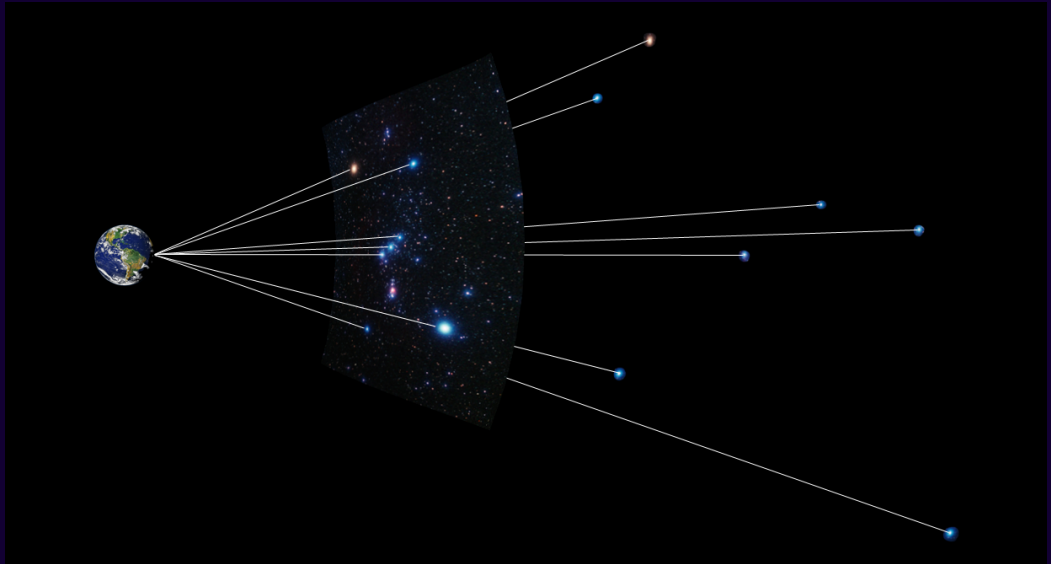
## The constellation of Orion:



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The reality:





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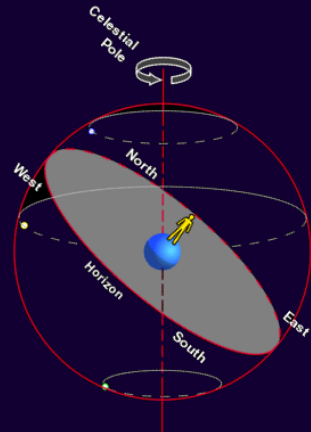
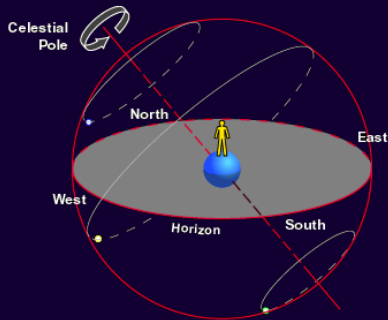
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- How much will the Moon's motion affect how it looks?

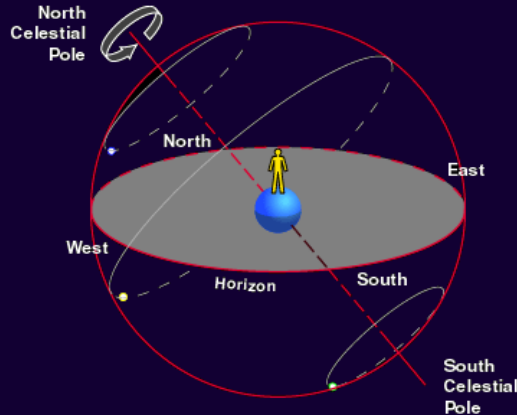
# Summary

- We can treat the stars as all rotating together, on an invisible sphere far away
- We expect this to get the stars “right” and the planets and Sun “wrong” over longer times
- The axis of rotation is the same as the Earth’s, and it rotates once per day
- Only half of the sphere is visible, because the Earth is in the way
- **Horizon**: a plane lying along the Earth at our location
- **Zenith**: the point directly overhead
- **Celestial pole**: the point about which the stars appear to rotate



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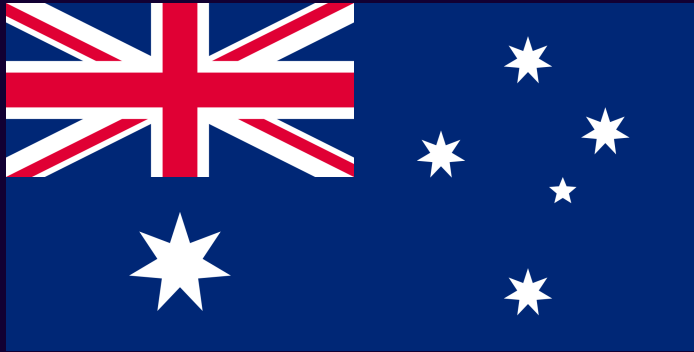
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# What is this?



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The Australian flag, with a pattern of stars called the Southern Cross.  
These stars are only visible in the Southern Hemisphere!



## For next time...

- Fill out the “lab time test” (again – sorry!)
- Watch for a document from us telling you about your groups
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- Fill out the “lab time test” (again – sorry!)
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- We’ll send out your first homework assignment this weekend or early next week
  - It’s a brief “get to know your group” assignment
  - You’ll be answering a few brief questions about the night sky, too
  - This is a bit of a “test run” of how the group work will go – it will be graded but you should get 100% if you do it
- Answer each other’s questions on Kaltura – help me out!
- I’ll be having “online office hours” Friday from 10am to 12pm. I’ll send out the Zoom link tomorrow night.