

The stars and the Earth

Astronomy 101
Syracuse University, Fall 2016
Walter Freeman

September 1, 2016

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 .



If you missed class Tuesday:

- Course website: `walterfreeman.github.io/ast101/`
- The syllabus, the *Mastering Astronomy* info, etc. is all there
- Course email: `suastronomy101@gmail.com`
- Extra colored cards will be available each class
- No labs until the third week of class

On the textbooks:

- Yes, you need the books
- Any edition, paper or electronic, is fine for the text
- You need a paper copy of the *Lecture Tutorials*
- I know the Bookstore's out; I will bother them
- If you don't have the *Tutorials*, share with a (new) friend today

On *Mastering Astronomy*:

- The course code is on the website: SUASTR0101FALL2016
- Access codes: either from the bookstore or purchased separately
- Please give me your feedback about the software

I will be out of town on Friday; no help session hours. Sorry!

I will only have a few minutes a day to answer email over the weekend. If you email me and it's not extremely urgent, I will answer next week.

Lab section changes are tricky because things are very full.

I can't process these (I don't have access). Talk to Patty Whitmore (pawhitmo@syr.edu); her office is room 111.

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 night 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*, virtual planetarium software.

It's available for free on Linux, Mac OSX, and Windows.

- Ubuntu users: `sudo apt install stellarium`
- Windows users: see links on stellarium.org

Light pollution

What do you think about this picture?



Light pollution

This is what we could have instead!



Our disappearing heritage: the night sky

The previous image is from the *New York Times*: see
<http://www.nytimes.com/interactive/2013/02/03/magazine/look-stars.html>.

We *can*, if we try, reclaim this heritage for all of us!

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 13th century. The glow is light pollution from Tehran, 100 km away.

Let's look at the planetarium software again...

How do these stars move?

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How do these stars move?



The “celestial sphere” model of Ptolemy:

- All the stars are attached to a sphere, very far away
- This rotates around the Earth, once per day

A question for you...

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

A: All of it

B: More than half

C: Half of it

D: Less than half

E: It depends on your latitude

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

A: It's completely wrong; we know it's not like that!

B: It's pretty close to correct, with a few exceptions

C: It's correct, just look at the sky!

D: It explains a lot of things, so it must have *some* use

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E: I thought Dr. Freeman was supposed to tell *us* this stuff?

Problems with the celestial sphere: I

Discuss with your neighbors: what's wrong with the celestial sphere?

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

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Is it really true that all the stars are stuck to a sphere, all at the same distance from us?

No; we just don't have any “depth perception” of things this far away.

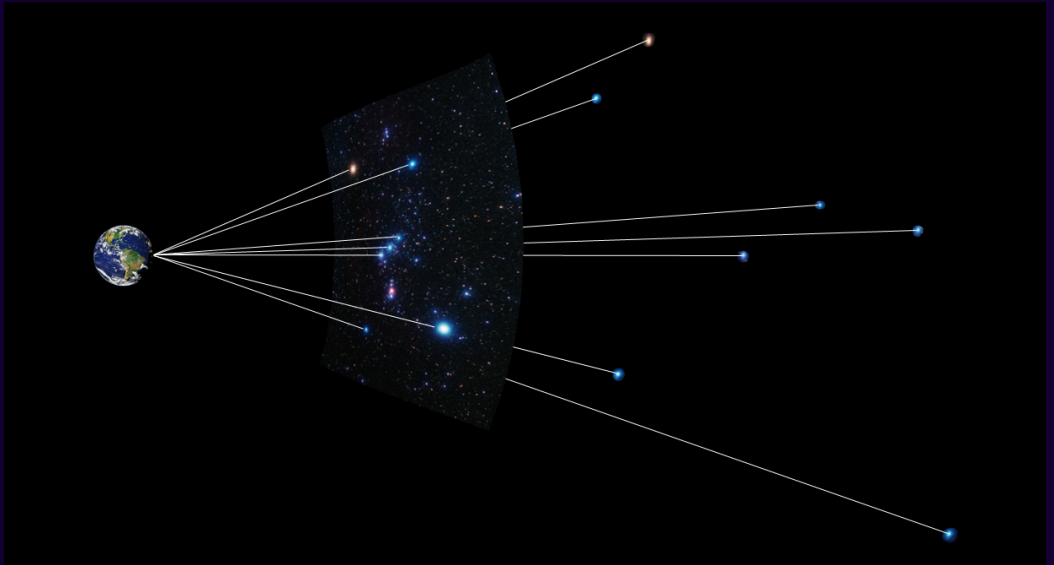
The constellation of Orion:



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The reality:



Why the celestial sphere still explains a lot

Key idea #1: the stars are **very far away** compared to the Earth's motion!

- Parallax experiment: try it!

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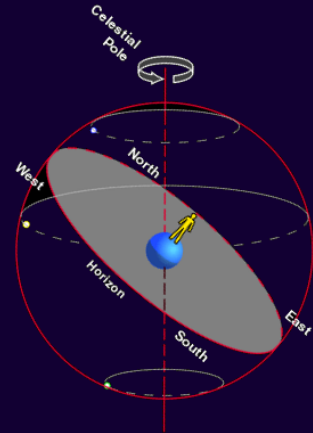
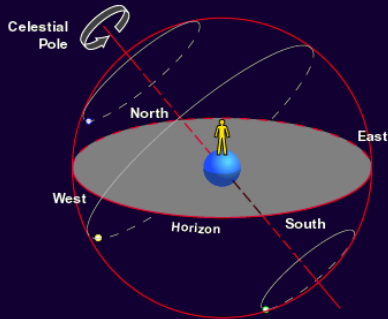
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Key idea #2: It doesn't matter if Earth rotates or the celestial sphere rotates: **relative** motion controls what we see!

- The celestial sphere model is just dizzy!

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”
- 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



How many celestial poles are there?

A: One

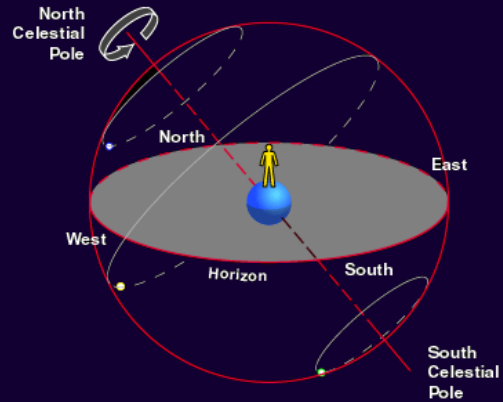
B: Two

C: Three

D: Four

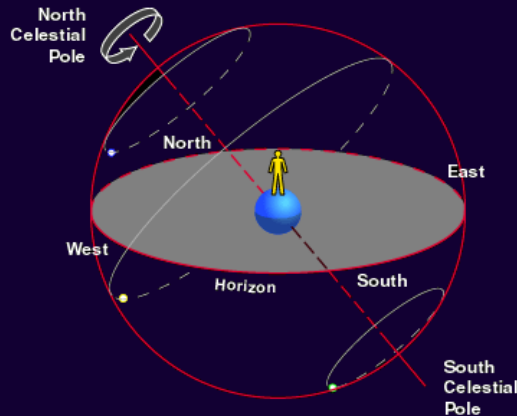
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Complete pages 1-4 (“Part I”)

Which are true in Syracuse?

- I: Some stars are always visible (at night).
- II: Some stars are only visible sometimes; they rise and set during the night
- III: Some stars are never visible

A: I only

B: II only

C: III only

D: I and II

E: I, II, and III

What is this?



What is this?



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

For next time:

- Visit the course webpage
- Complete the first Mastering Astronomy assignment
- Read pp. 25-32 of your text if you haven't already
- Look up!