

Astro 210
Lecture 2
Jan 21, 2011

Announcements

- pick up HW1; due in class next Friday
- **register** your iClicker; link on course webpage
- pick up Syllabus if you didn't get one last time
- If this is your first time to class:
 - ▷ Welcome!
 - ▷ talk to instructor after class
 - ▷ read syllabus

Last time: Overview and Appetizer

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Today: Start your engines

iClicker Poll: Homework Printout

HW1 is posted online; printouts also available. I am happy to give printouts if you will use them; but no sense in wasting paper for the paperless readers among you.

Would you like a printout of the homework and other assignments?

A yes

B no

Online Notes

Class notes will be posted online and available all semester

Astro-Tip:

Each class meeting has a webpage and notes like these

They will remain on the course website throughout the semester

So no need to write what's in this file...

also: when printing out pdf notes, you may find 2 or 4 slides per page is legible, saves paper

Notes are posted right before each class

but best to wait about 1 hour after class:

ω updated/corrected notes posted

Class Notes Online: A Good Thing?

Pros:

- you are not a stenographer—can use your brain to think and not transcribe
- don't have to read my bad handwriting

Cons:

- tempting to be astro-hypnotized
so: I'll ask questions and iCliker polls throughout
- might give incorrect impression that there's no reason to come to class
but: I'll give extra pearls of wisdom verbally
...and you'll miss the *required & easy* iCliker participation points
not to mention demos, music, and movies

Bargain:

- ↳ • I'll avoid railroading you
- you pay attention, ask questions when confused/interested

Building a Scientific Cosmology: The Night Sky

Cosmologies

Cosmology: study of/ideas about the big picture
→ origin and nature of “the world/the universe”

A big subject! And many possible ways to approach it...

ASTR210: *Scientific or Physical* Cosmology

Q: *what does this mean?*

Q: *what other kinds could there be?* [turtle story]

Observing the Sky

Science begins with collection of **data**

Astronomy began with naked-eye observations
of day and night sky

The Shape and Contents of the Sky

Q: What is geometry of the sky as observed from Earth's surface?

...recalling that the eye can't tell
depth/distance to celestial objects

*Q: What coordinate system(s) might be useful
to describe the sky?*

Geometry of the Sky

In reality: celestial objects arranged in 3-D space

But: your eye can't tell distance to these objects

no "sense of depth"

So observationally: the sky "flattened" into a 2-D surface

★ **Crucial fact of life in science:**

have to connect

(a) what you can actually *observe/measure: data*

(b) with what is "really" going on—*models/theory*

In astronomy: observe objects in sky

can measure position = direction on sky

→ 2-number "address" \Leftrightarrow 2-dimensional sky but sky gives *no*

direct information about **distance**

∞

→ observed sky flattens the 3-dimensional arrangements

down to **2-D sphere** projection: "cosmic roadkill"

Geometry problem: have to always go between

- ▷ observed 2-D sky view: projected
- ▷ underlying arrangement in 3-D space

Mapping the Sky: Coordinates

local coordinates (*observer*-centered):

diagram: horizon, zenith, nadir, altitude angle, meridian, NSEW

compare to *global* coordinates, origin at *Earth's center*

diagram: NP, SP, latitude—e.g., $\pm 10^\circ$ NS, longitude

Q: What are the main *naked-eye* “citizens” of the sky?

How might these be classified?

can classify celestial objects into
sun, moon, planets, “fixed” stars

what changes and what doesn't:

- “fixed” stars—same patterns relative to one another
- sun, moon, planets move w.r.t. stars, each other

ancients: “seven wanderers”—days of week (Sun, Mon...)

The Fixed Stars

grouped in “constellations”; e.g., Orion

constellations: *regions* in the sky

→ not just stars in “connect the dots” patterns

constellations fill sky like states on a US map

⇒ any point in the celestial sphere lies in

exactly one constellation

Big Dipper (subgroup = “asterism” of Ursa Major):

diagram: big dipper, ‘pointer stars’, Polaris

Q: how quantify constellation size, star spacings on sky?

Q: do the stars move at all relative to each other? Do they move

⇔ on the sky (i.e., relative to the horizon)? is change noticeable

daily? yearly?

can't say anything (yet) about *distances*
only can measure **angles** between objects
label: pointer stars: 5° apart; to Polaris: 25° separation

Don't seem to move w.r.t. each other
i.e., constellations don't morph – move as if
rigid structure on sky

Daily motion w.r.t. horizon: rise in east, set in west

In more detail:

Imagine a dark night sky in Chambana
and an expensive, magic machine:

makes each star leave a “*trail*” behind as it moves

iClicker: Star Trails

Imagine you could see all trails made by all stars over one night, as seen from Champaign-Urbana.

What pattern would you see?

- A arcs of circles
- B arcs of ovals
- C parallel line segments
- D none of the above

The Experiment

fix a camera on a tripod, open lens and expose to night sky
as each star moves, leaves “trail” on film

Many such images exist online:

www: image of star trails

Q: why do we get this pattern?

Q: what does it mean that it repeats daily?

Q: what does it tell us? special points/regions?

Q: why do telescopes have motors on them?

Celestial Sphere

stars seem to be attached to surface
of enormous “**celestial sphere**” – this is geometry of the sky
(at any moment, see only hemisphere—Earth hides half)

*diagram: observer on globe, enclosed by cel sph globe
celestial equator, poles, typical star path*

daily cycle → earth spins with period $P = 1$ day
but Earth-based observer sees celestial sphere spin with **period**
 $P = 1$ day

circumpolar stars: never set (=never below horizon)
Q: do these exist? where are they on diagram?

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www: Mountaintop star trail

Q: what is latitude at which these were taken?

iClicker: Star Trail Exposure Time

www: image of star trails

About how long was the image exposed?

- A 2 hours
- B 4 hours
- C 6 hours
- D 8 hours
- E no way to tell from this image alone