Astro 210

Lecture 2

Aug 25, 2010

Announcements

- URL course webpage (handout available)

  http://courses.atlas.uiuc.edu/fall2010/ASTR/ASTR210/

  Compass site is for grades only; has link to course page
- iClickers *required* starting next time
- **register** your iClicker; link on course webpage

Last time: Overview and Appetizer

Today: Start your engines

Leftover Business

Prerequisites:

Credit in Phys 211–i.e., mechanics

Credit in Calculus

Physics 212 very helpful, especially for physics of light & waves
   not required **if** you are willing to pick these up on your own
   from my class notes, texbook, etc.

iClicker Poll: Homework Printout

By Friday I will post HW1. 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

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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:

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* iClicker 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 <mark>**data**</mark>

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

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

$\star$ **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

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

direct information about distance

$\rightarrow$ 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., $\pm 10° NS$, longitude

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

How might these be classified?

can classify celestial objects into
"fixed" stars, sun, moon, planets

"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

   $\rightarrow$ not just stars in "connect the dots" patterns

constellations fill sky like states on a US map

$\Rightarrow$ 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

science: to test prediction, do experiment! *Q: how?*

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 "**celestial sphere**" − this is geometry of the sky

(at any moment, see only hemisphere−Earth hides half)

diagram: small Earth globe, enclosed by cel sph globe, cel eq,
NSP,SCP

daily cycle → celestial sphere spins with period $P = 1$ day

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