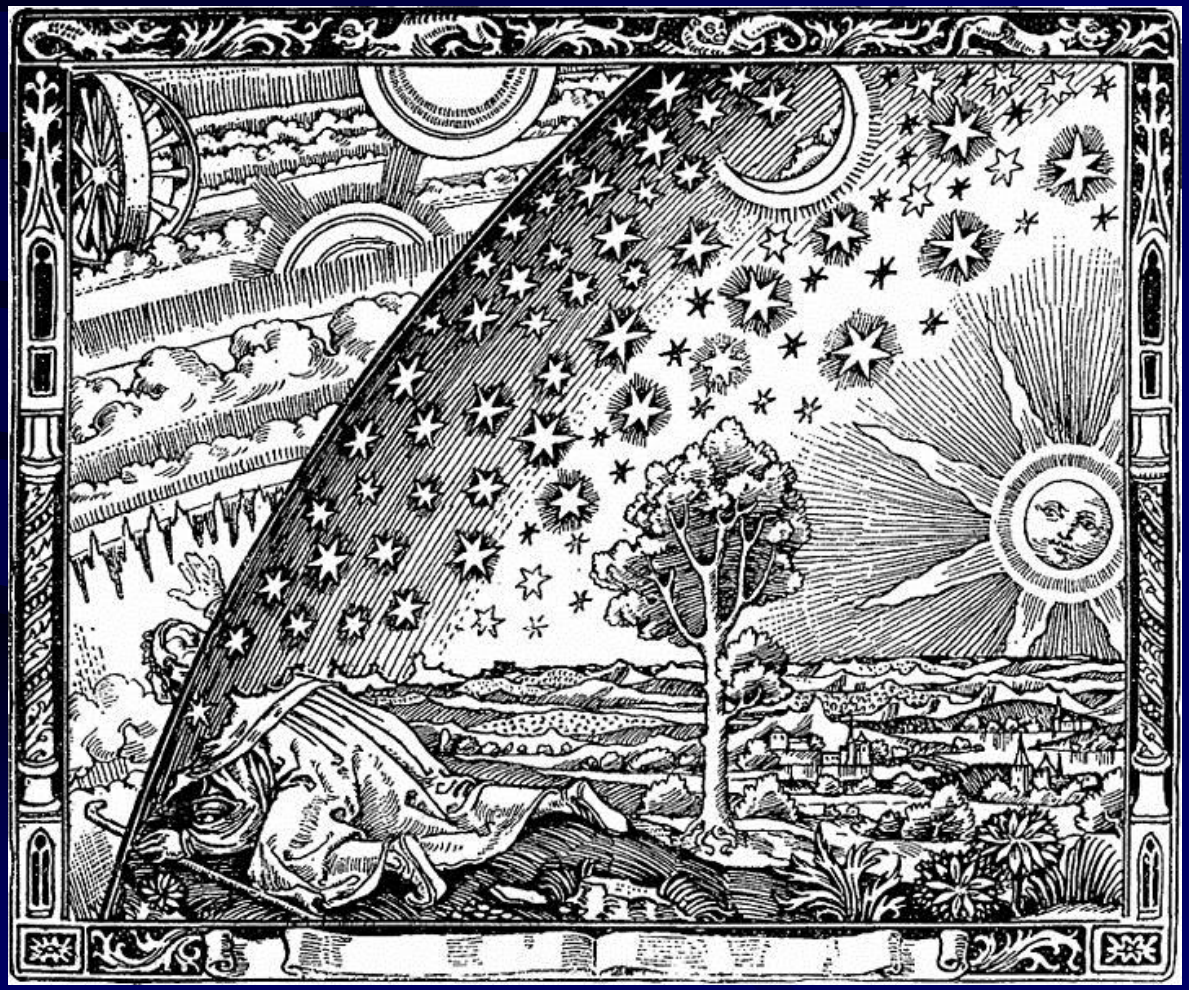
Astronomy as a Science & Angles



Timezones: What time is it?

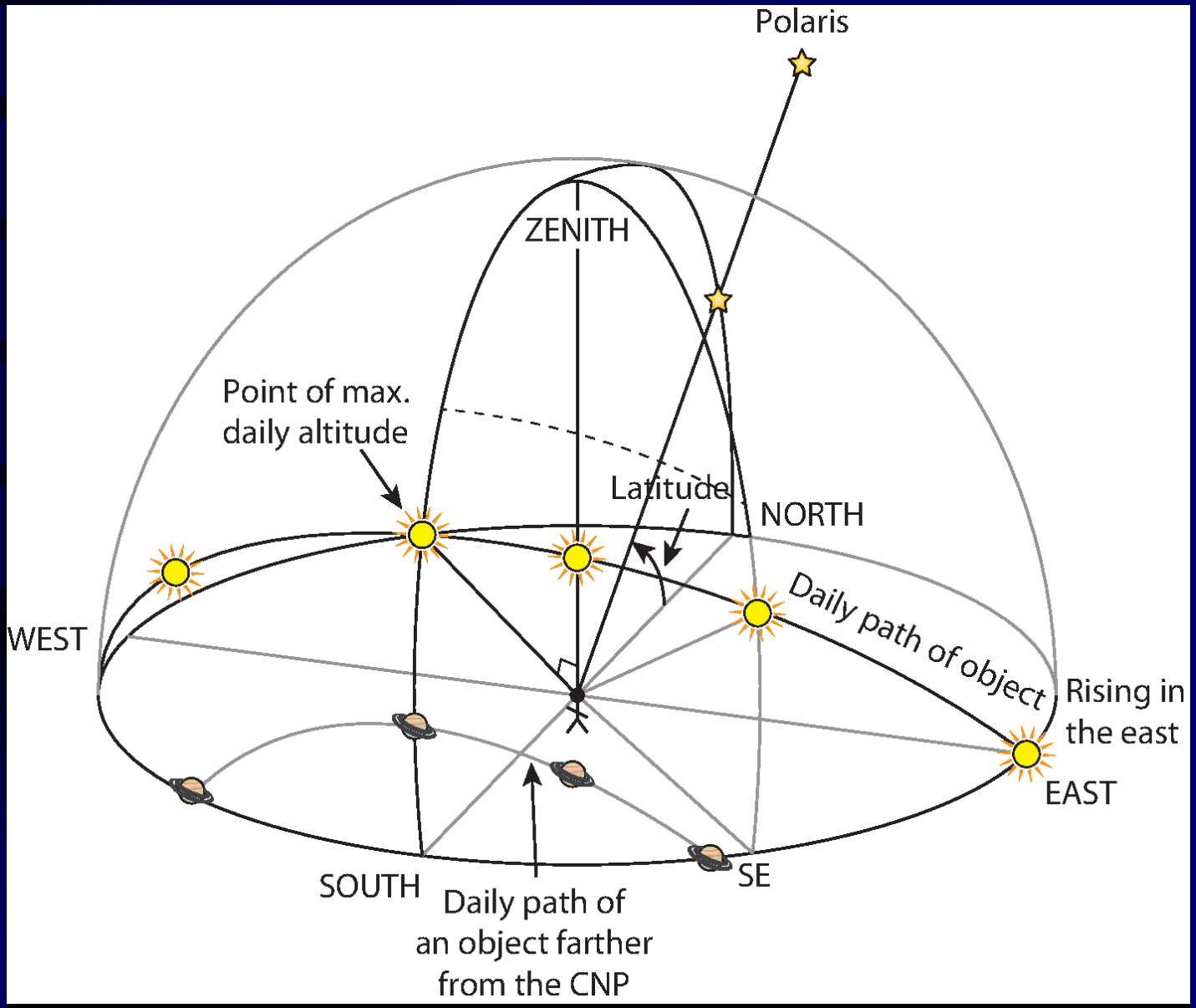
- Depends on where you are on the Earth!
- Time zones ensure that the noon is really noon, i.e. sun is at highest point
- To avoid confusion, use universal time (UT), the time at the meridian in Greenwich

  UT = EST + 5 hrs
- Daylight savings adds one hour in spring, so UT = EDT+ 4 hrs

You are in Sydney, Australia. The Sun is at its highest point in the North. What time is it?

- 12:00, Midnight
- 12:00, Noon
- Depends on the time in the year (season)
- The sun never reaches its highest point in the North

Path of Daily Motion



Define Noon

- I.e. agree on the word "noon" meaning (being equivalent to) "time when the sun reaches the highest altitude in the observer's sky"
- Note that this time is
  - different when you are further east or west
  - the same when you are further north or south
- Note that the sun *culminates* in the North in the southern hemisphere!

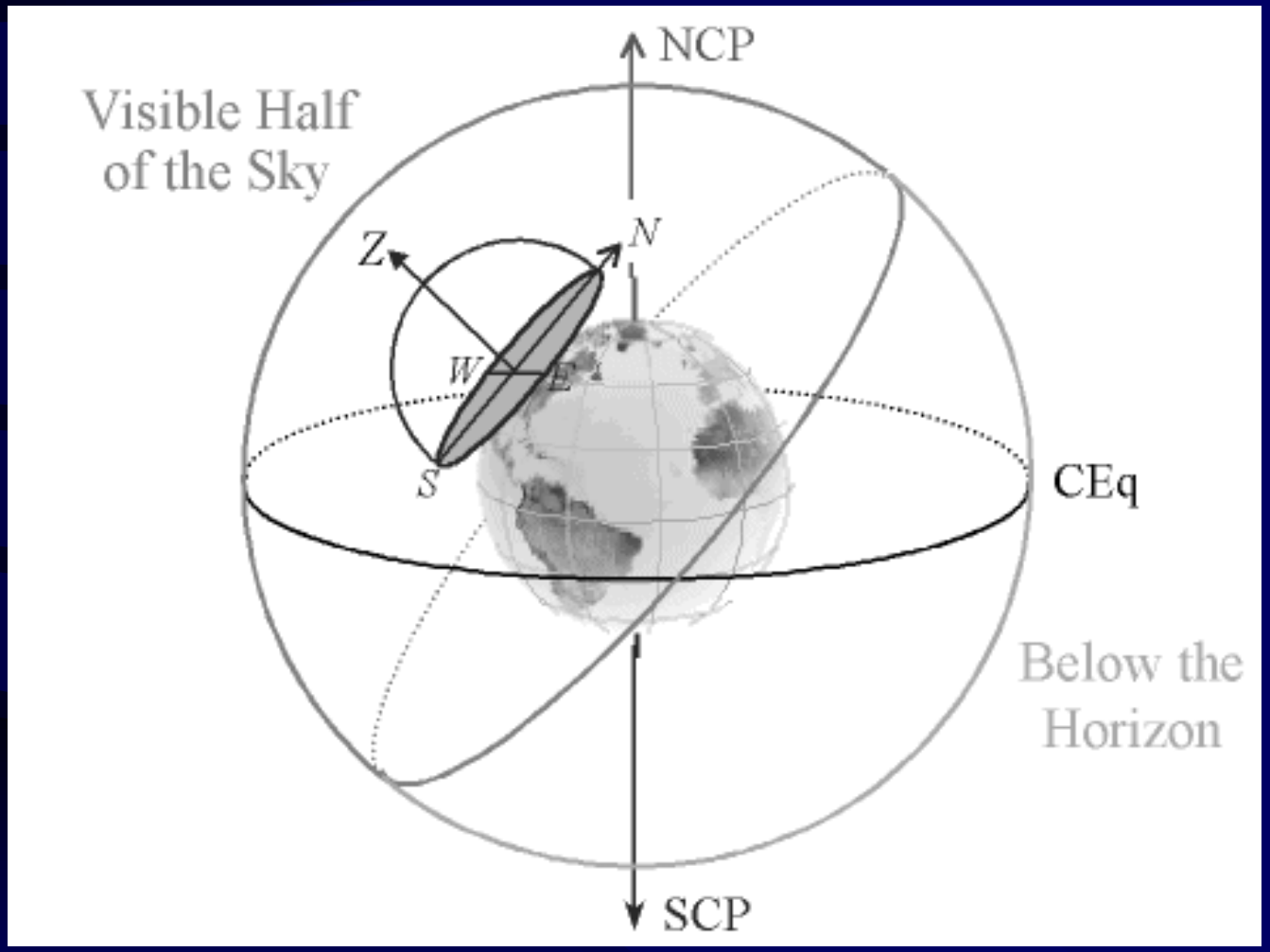
Define South

- Either opposite of direction to the North Star
- Or: direction in which the sun culminates

Why are Polaris and the Sun in opposite directions?

- They are not exactly, because “the north direction” and “the south direction” do not exist
- Their positions are related because
  - the direction of Polaris defines the rotation axis of the celestial sphere
  - The sun is somewhere on the sphere
  - From a “skewed” perspective everything on the sphere culminates on the *meridian*

What you see depends on where you are!



- Your **local sky** –
  your view depends on your location on earth

Pete at the Pole

- Can we forensically determine the date and time this photo was taken?

You're stranded on a desert island. You locate the pole star. It is 17 degrees above the northern horizon. What is your latitude?

- 73 degrees south
- 17 degrees north
- Depends on the time of the day
- Depends on the time in the year

Revisit Sun's Shadow and Position

- Observed: Aug 23, 2017
  - at 10:15: L= 1.2m → 39.8º
  - At 12:00: L = 0.7m → 55º

- To evaluate quality of measurement, draw a simplified (2D) diagram of the observer's sky at a specific latitude

Is this good or bad or what?

- Compare to expected value:
  - Westerville location 40° N latitude
  - Celestial equator 90° off of that
  - Sun's celestial (not observer!) coordinates on August 23: 11°, i.e. south of Celestial Equator (see YourSky) at noon (max!)

    40° – 90 °+11 ° = 61° above S horizon
- Observed: Aug 23, 2017
  - at 10:15: theory 38º, obs: L= 1.2m → 39.8º
  - At 12:00: theory 54º, obs: L = 0.7m → 55º

Astronomy as a Science

- The science dealing with all the celestial bodies in the Universe
  - Cosmology is the branch of astronomy that deals with the cosmos, or Universe as a whole
- The medieval list of the Liberal Arts: grammar, rhetoric, logic (trivium); arithmetic, music, geometry and astronomy (quadrivium)
- Is an "exact science" for ~5000 yrs
  - Most rapid advancements in astronomy have occurred during the Renaissance and the 20th century
  - Success has been a result of development and exploitation of the ***scientific method***

Astronomy and Culture

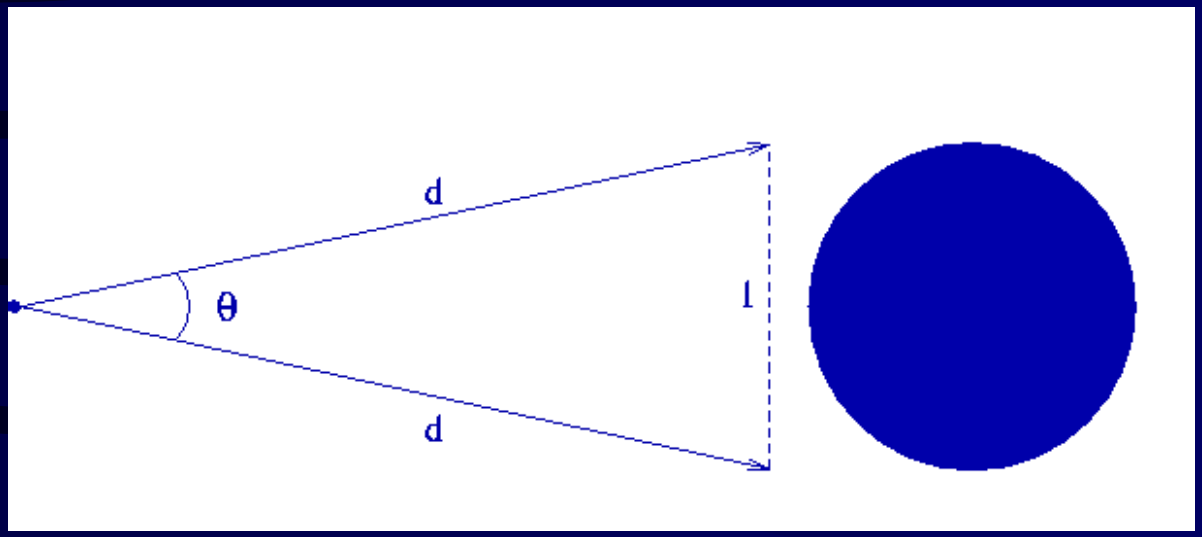
- Astronomy had and has an enormous influence on human culture and the way we organize our lives
- For example:
  - The year is the rotation period of the Earth around the Sun
  - The year is subdivided into months, the period of the Moon around the Earth
  - The weeks seven days are named after the seven bodies in the solar system known in antiquity: Sunday, Monday, Saturday (obv.), Tuesday=Mardi, Wednesday = Mercredi, Thursday=Jeudi, Friday=Vendredi

Position: Angles vs. Distances

- Locations in the sky are easy to measure: 2 angles
- Distances from observer are hard (one length)

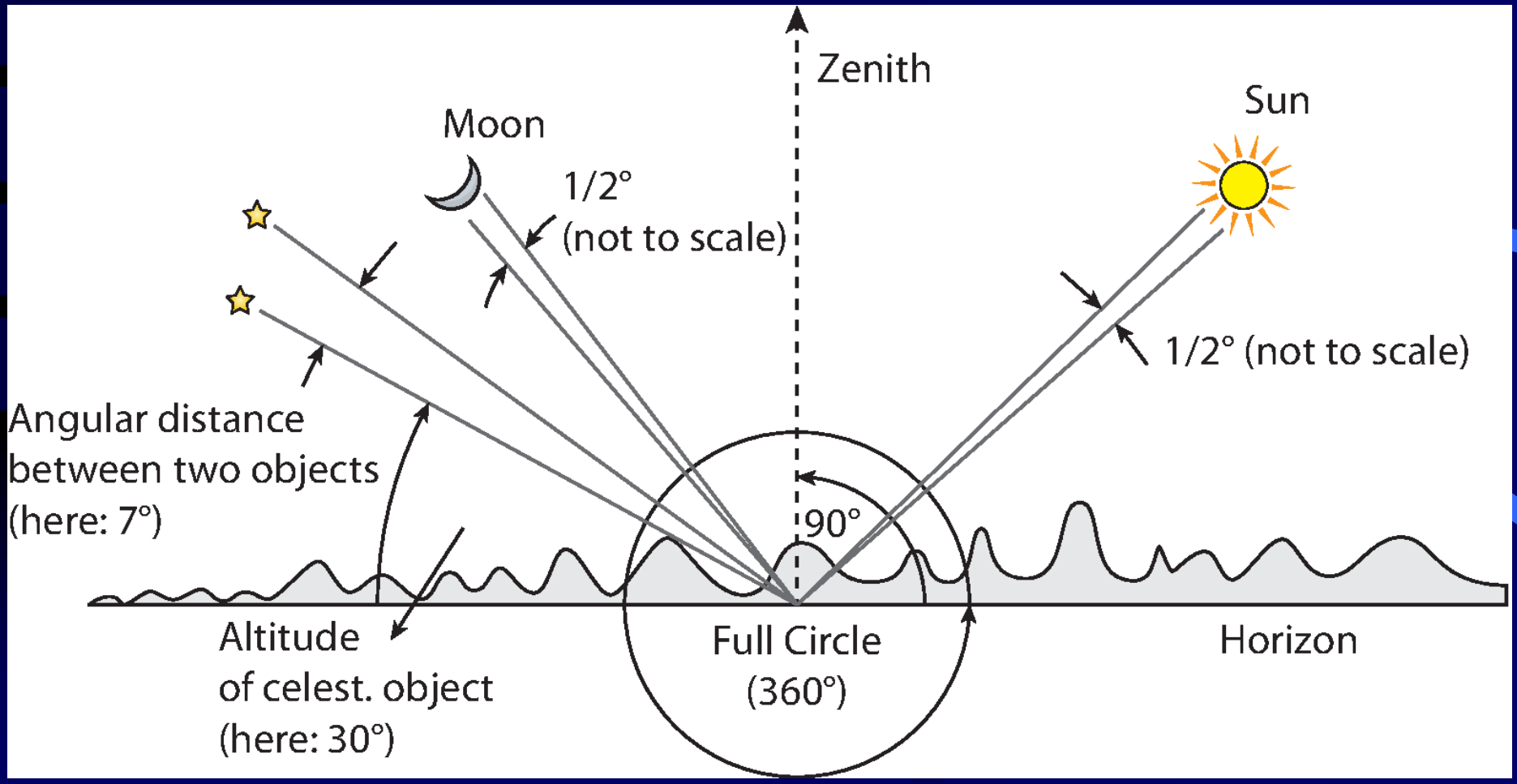
➔ Together they give the location of an object in three-dimensional space

Angles and Angular Size



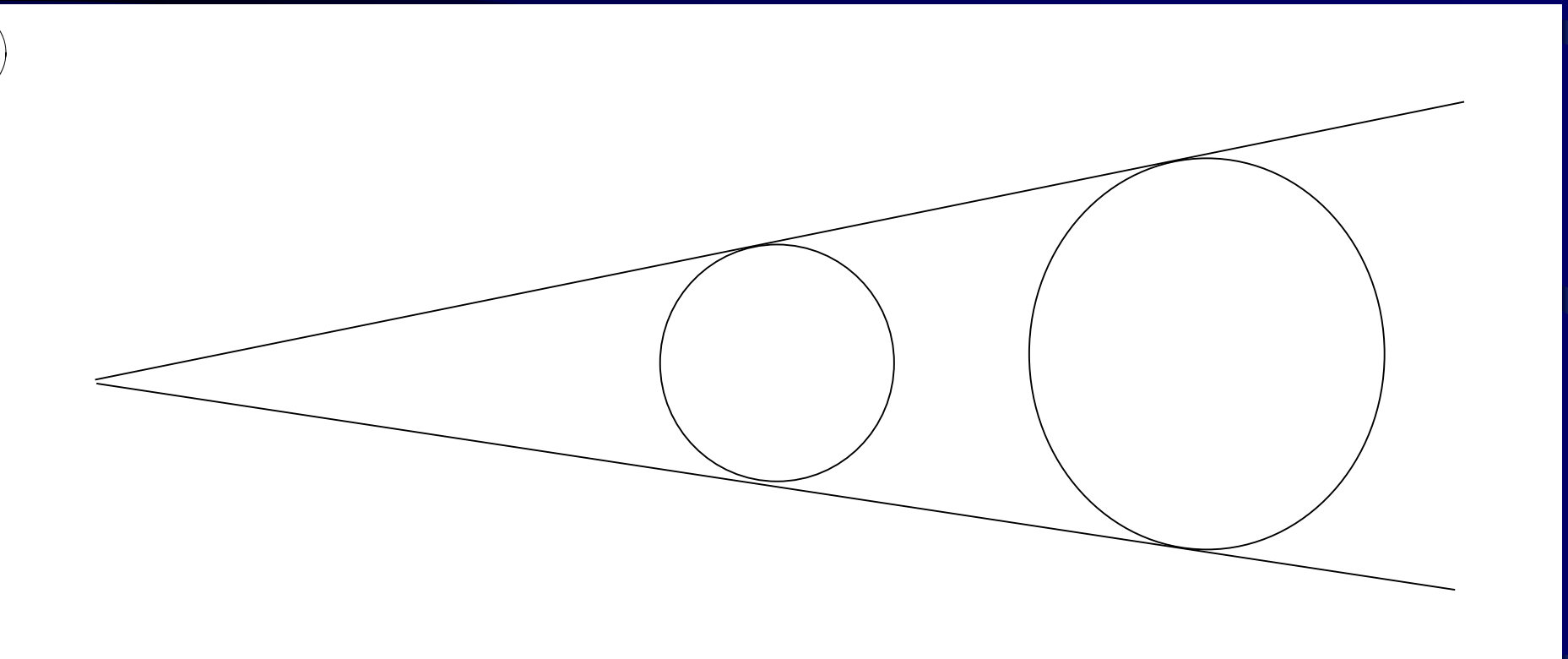
- Angles measured in *degrees*
  - full circle = 360°; right angle = 90°
  - 1° = 60' (***minutes of arc*** or ***arc minutes***)
  - 1' = 60" (***seconds of arc*** or ***arc seconds***)
  - **Typical angular sizes:**
  - Moon 0.5°, Sun 0.5°, Jupiter 20”, Betelgeuse (α Ori) 0.05”

Typical Values for Angles in the Sky

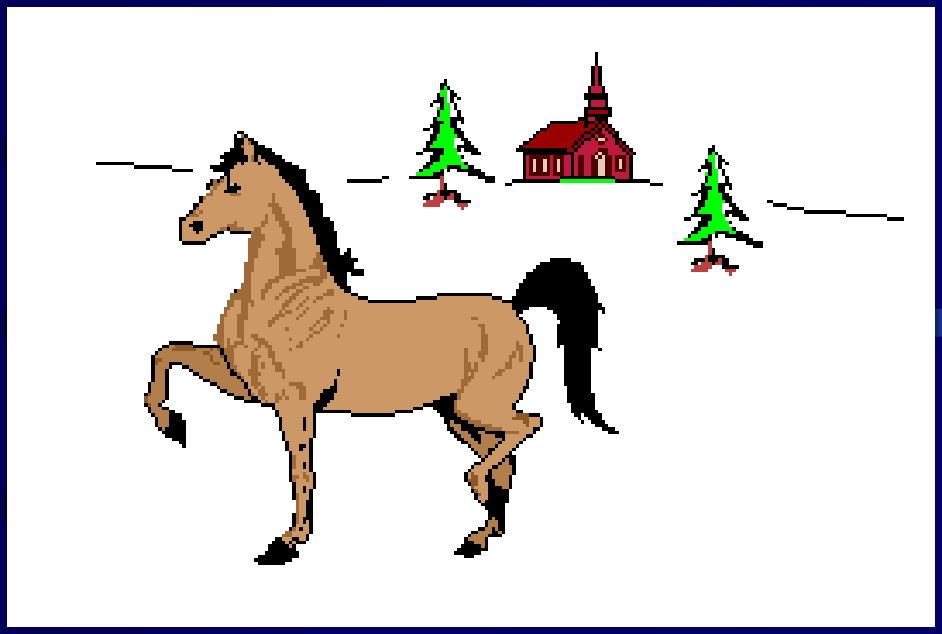


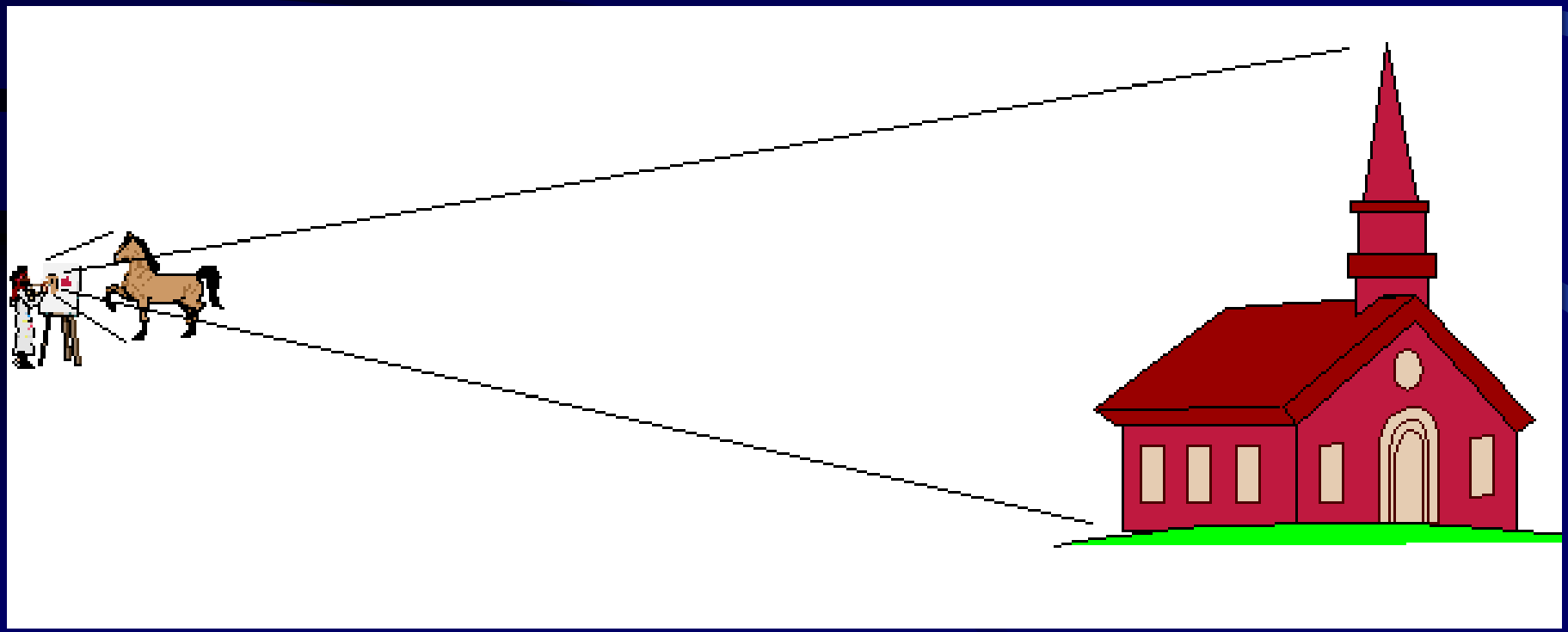
The Trouble with Angles

- Angular size of an object cannot tell us its actual size – depends on how far away it is
- Sun and Moon have very nearly the same angular size (30' = ½°) when viewed from Earth



Angles and Size





Without Distances …

- We do not know the size of an object
- This makes it hard to figure out the “inner workings” of an object
- We can’t picture the structure of the solar system, galaxy, cosmos

The most important measurement in Astronomy: Distance!

- The distances are astronomical!
- The distance scales are very different
  - Solar system: light minutes
  - Stars: light years
  - Galaxies: 100,000 ly
  - Universe: billions of ly
- Need different “yardsticks”

Activity: Angular Sizes and Distances

- Please pick up a work sheet.

Science Speak

- Approximation
- Assumption
- Extrapolation
- Goes up/falls off like/with
- Models/Theories

Scaling

Measurement & Uncertainty

Daily Motion of the Sun