An introduction to

Astronomy

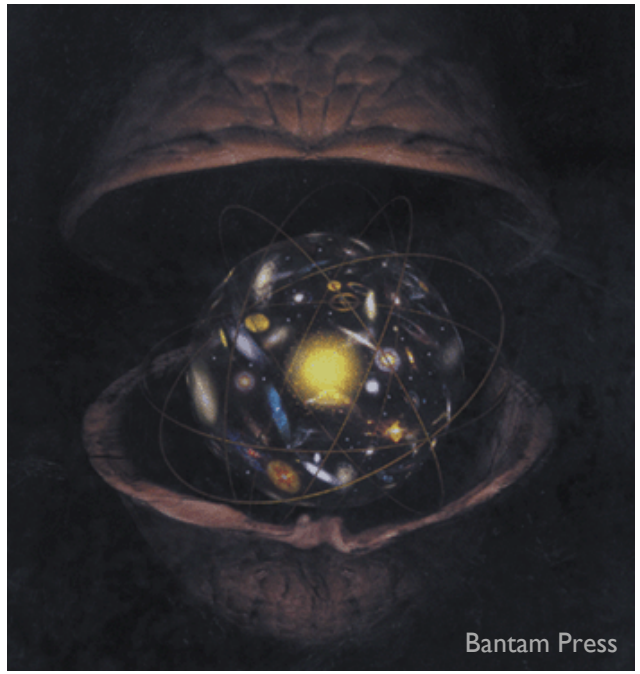
Zach Meisel

Ohio University - ASTR1000

What is astronomy?

"The cosmos is all that is, or ever was, or ever will be." – Carl Sagan

- Astronomy is:
  - **the study of everything** outside the extent of the Earth …but also including Earth in terms of it's properties as a planet.
  - an observational science (for the most part). We can't conduct astronomical experiments, though experiments in astrophysics (computational, nuclear, chemical) can be performed.
  - an evolving field. The major items we cover in this course are unlikely to change (probably!), but details may be not be solidified.



Units and Scales

- Vast difference in time and spatial scales, so need scientific notation
  - More compact way of writing very large or small numbers, placing significant digits out front and moving zeroes to an exponent
  - The exponent indicates how many positions the decimal place needs to shift, where negative means shift to the left.
  - Large number example: 310,000,000 = 3.1×10^{8}
  - Small number example: 0.0000000013 = 1.3×10^{-10}
  - See textbook Appendix C

- Commonly used system of units is the international system (SI), though many special units also exist
  - Distance = meters (m), time = seconds (s), mass = kilogram (kg)
  - Common SI prefixes: ---------->
    - See textbook Appendix D

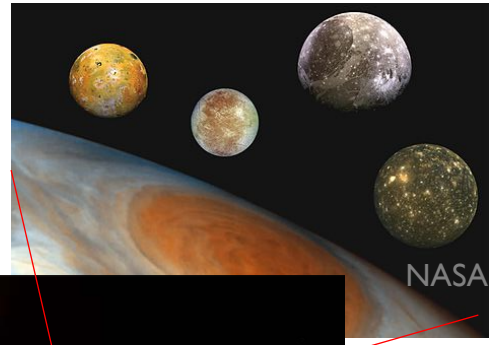
giga (G): 10^{9}
mega (M): 10^{6}
kilo (k): 10^{3}

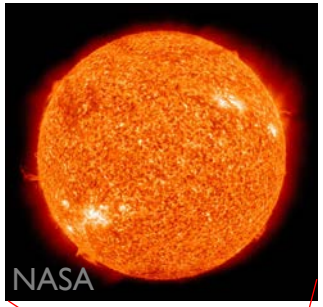
centi (c): 10^{-2}
milli (m): 10^{-3}
micro (μ): 10^{-6}
nano (n): 10^{-9}
femto (fm): 10^{-15}

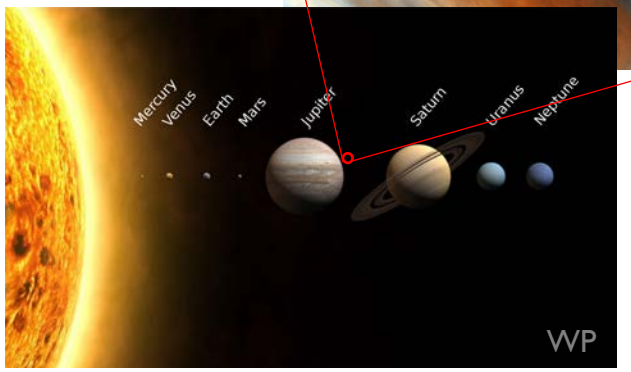
  - Common special units:
    - Astronomical Unit (AU) = earth-to-sun distance= 1.496×10^{11} m
    - Lightyear (ly) = distance light travels (at 2.998×10^{8} m/s) in a year = 9.46×10^{15} m
    - Parsec (pc) = 3.26 light years

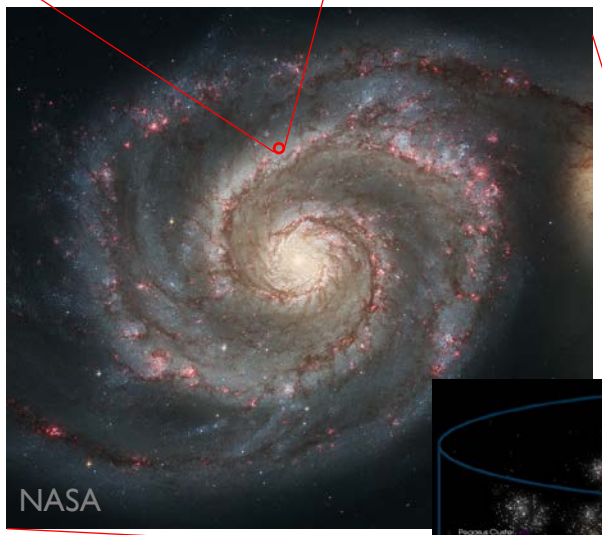
The Universe in a Nutshell: *Major components*

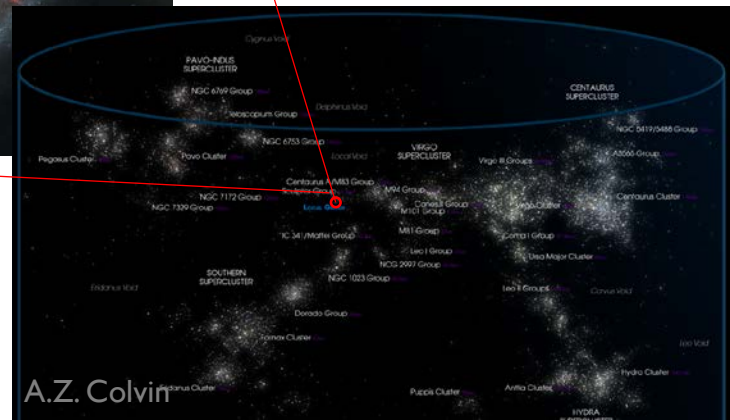
- Moons, like the Moon, are (relatively) cold rocks and/or oceans that orbit a host planet, which are hundreds to thousands of kilometers in diameter
- Planets, like the Earth, are (relatively) cold rocks and/or fluid clouds that are large enough to be spherical and to clear their orbital path around a host star, which are thousands to tens of thousands of kilometers in diameter
- Stars, like the sun, are hot balls of gas, most of which are powered by nuclear fusion and tend to be light-seconds in diameter
- Galaxies, like the Milky Way, are collections of 100's of billions of stars bathed gas clouds, most of which are thousands of light years in diameters
- Galaxy clusters are collections of galaxies into large scale structures. Superclusters are clusters of clusters









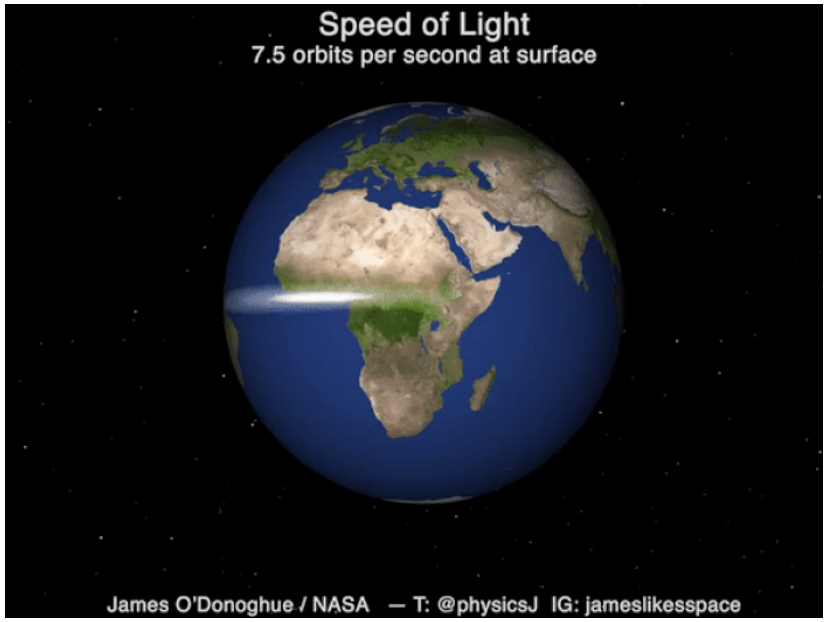


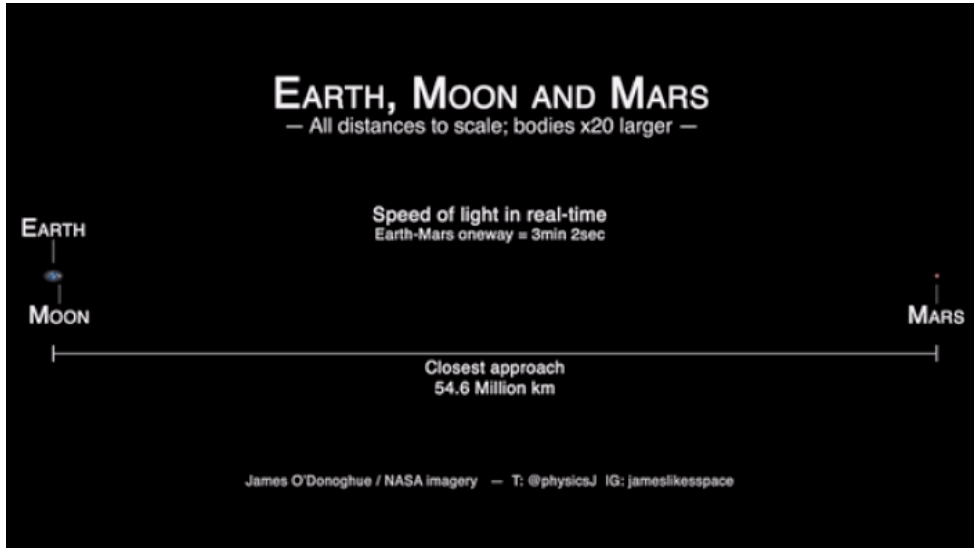
Vastness of space

- Space is big ... really, really big
- "Lightspeed" may sound fast, but "fast" is relative to the distance that will be covered

- It takes _____ for light to travel _____
  - 8 min — from Earth to the Sun
  - 4.25 yr — to the nearest star
  - 100 kyr — across the Milky Way
  - 2.5 Myr — to the nearest Galaxy
  - 13.8 Gyr — across the visible universe

Looking far away means looking back in time!





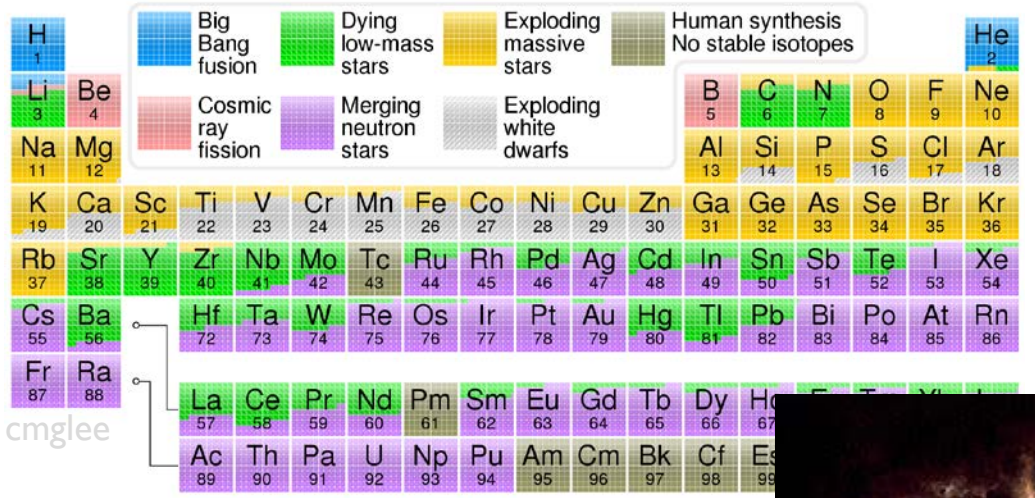
- When two galaxies collide, the respective stars will not collide (though the gas in between will)

- Space is mostly nothing (<1 atom/m^3 in intergalactic space)

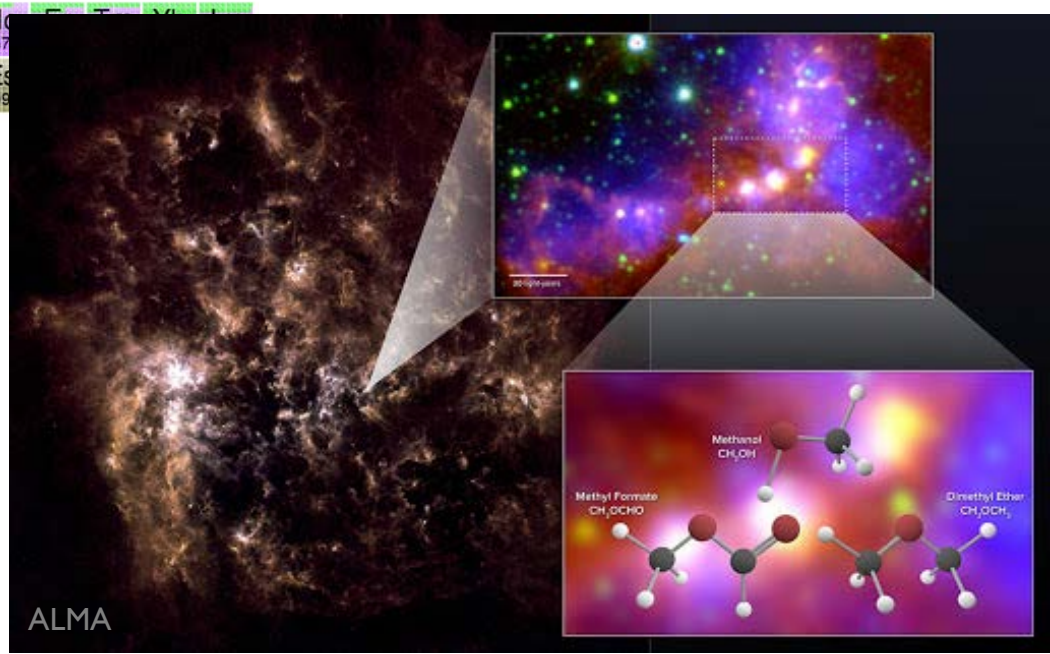
So, astronomy is the study of everything and nothing. .... very Zen.

Connecting very small and very large scales

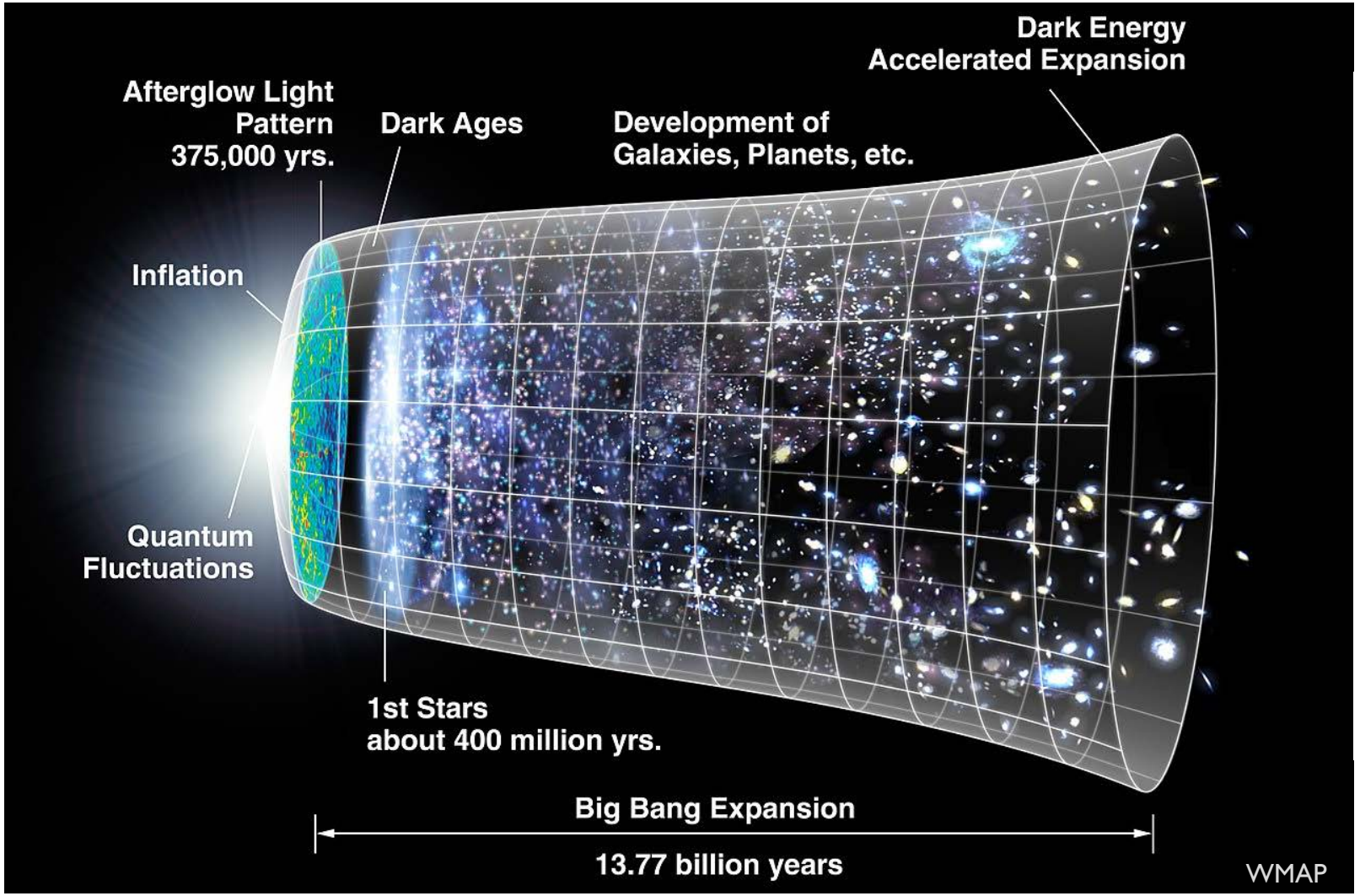
- Stars are powered by the fusion between atomic nuclei (~10^{-15} m)
  - Nuclear reactions produce energy and transmute elements

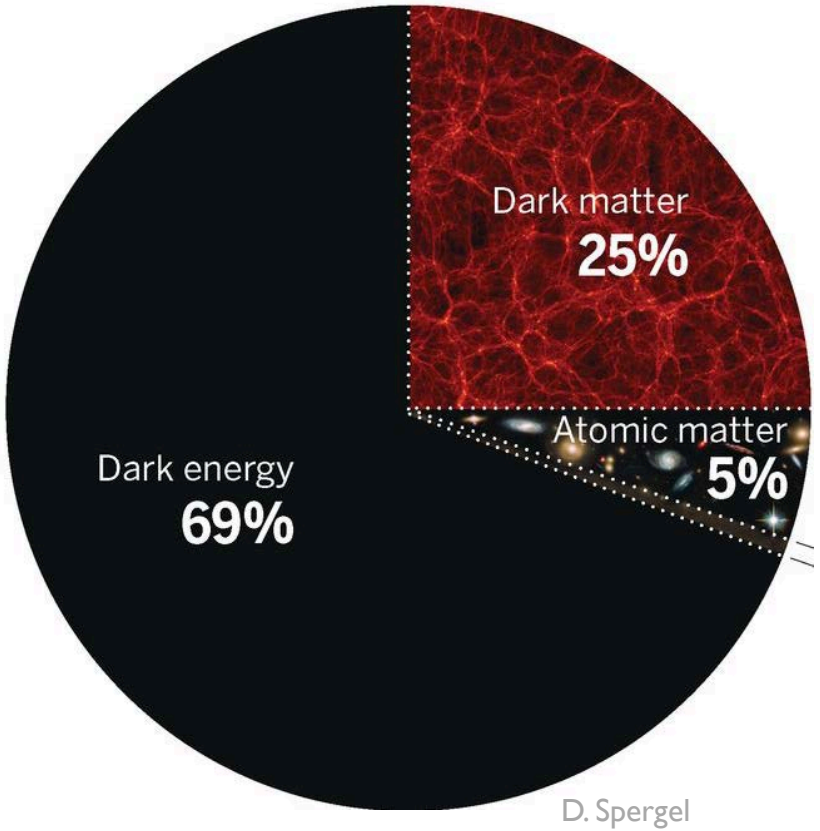


- Interstellar chemistry leaves an imprint on astronomical data and gives insight into the conditions of astronomical environments



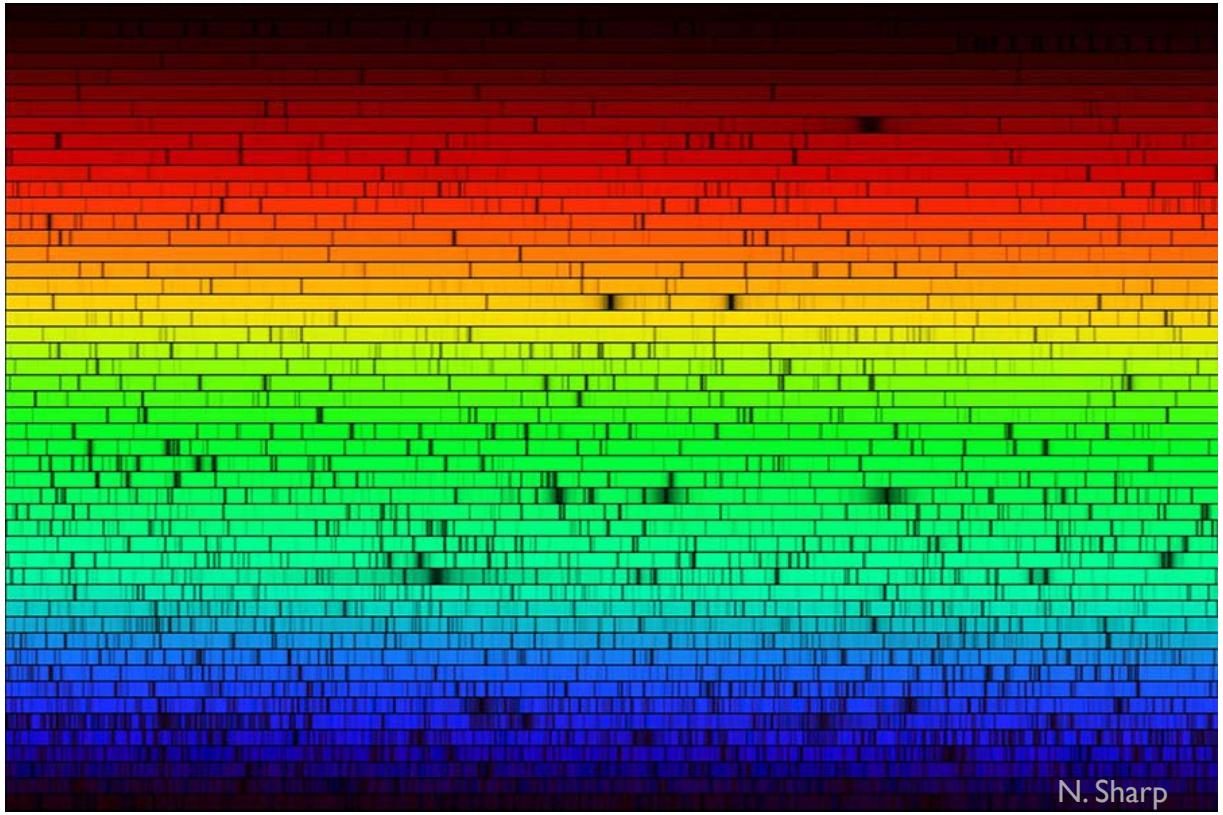
The Universe in a Nutshell: *Big-picture Evolution*



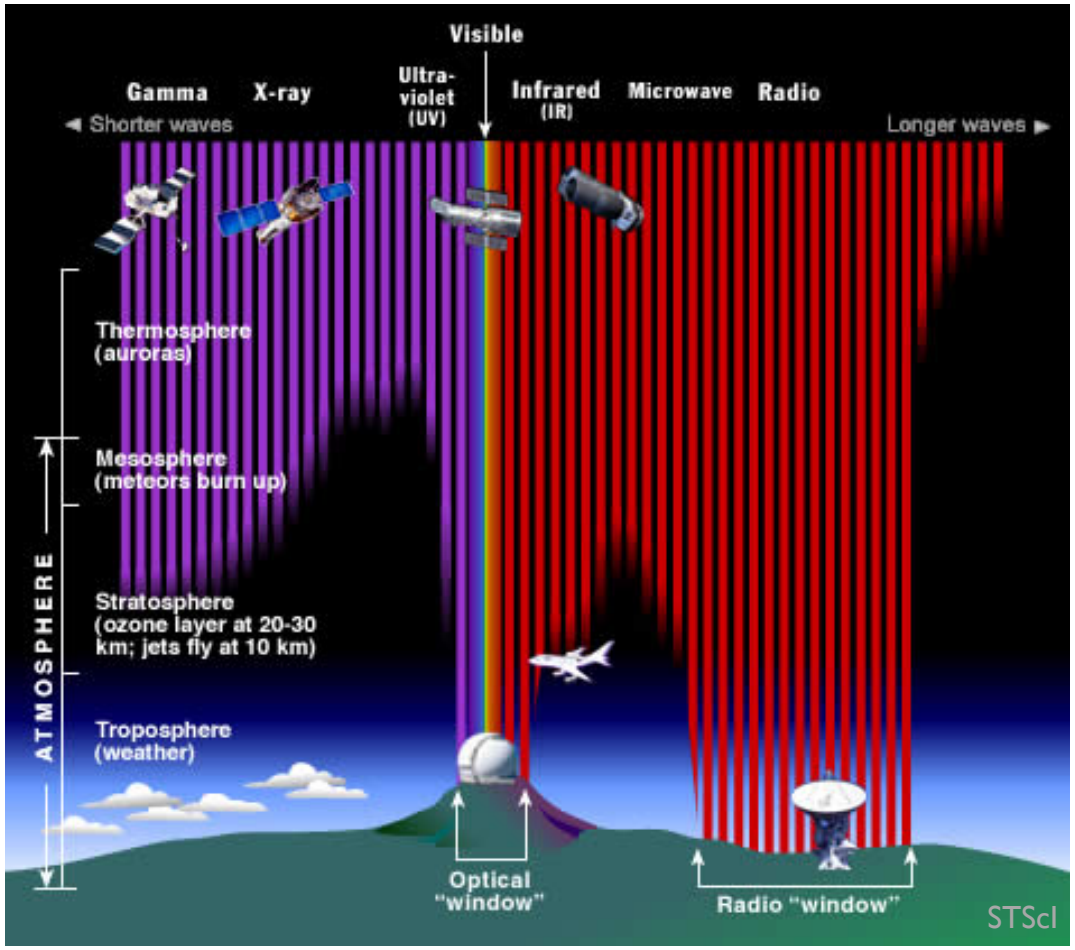


How do we know what we know?

- Mostly from light collected by telescopes
  - *Spectra:* amount of light versus wavelength
  - *Light curve:* amount of light versus time



- Telescope types span the electromagnetic spectrum, often requiring a satellite



- *Exceptions:* neutrinos, gravitational waves, meteorites, rocks collected in space