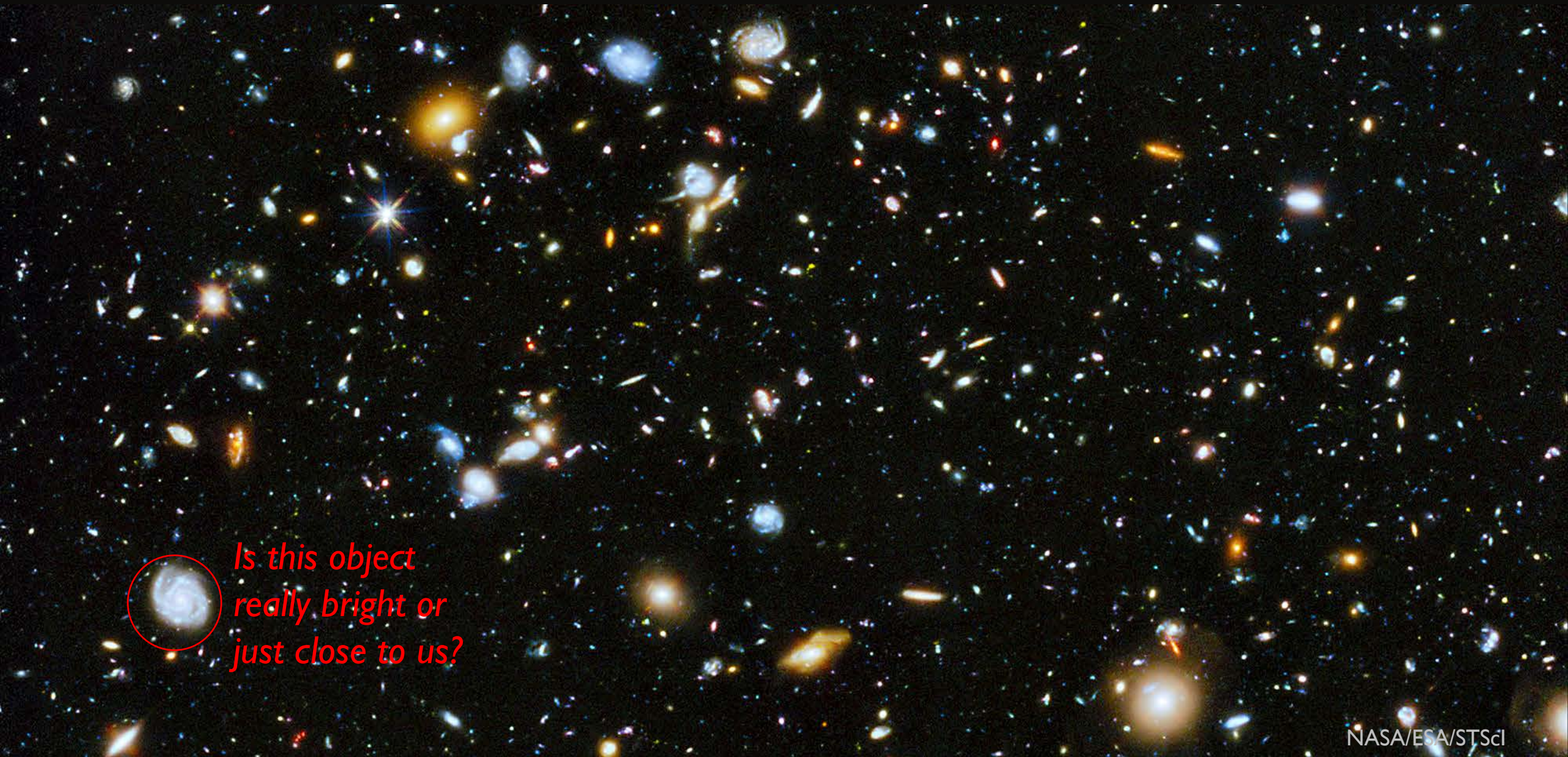
An introduction to

Galactic Distances

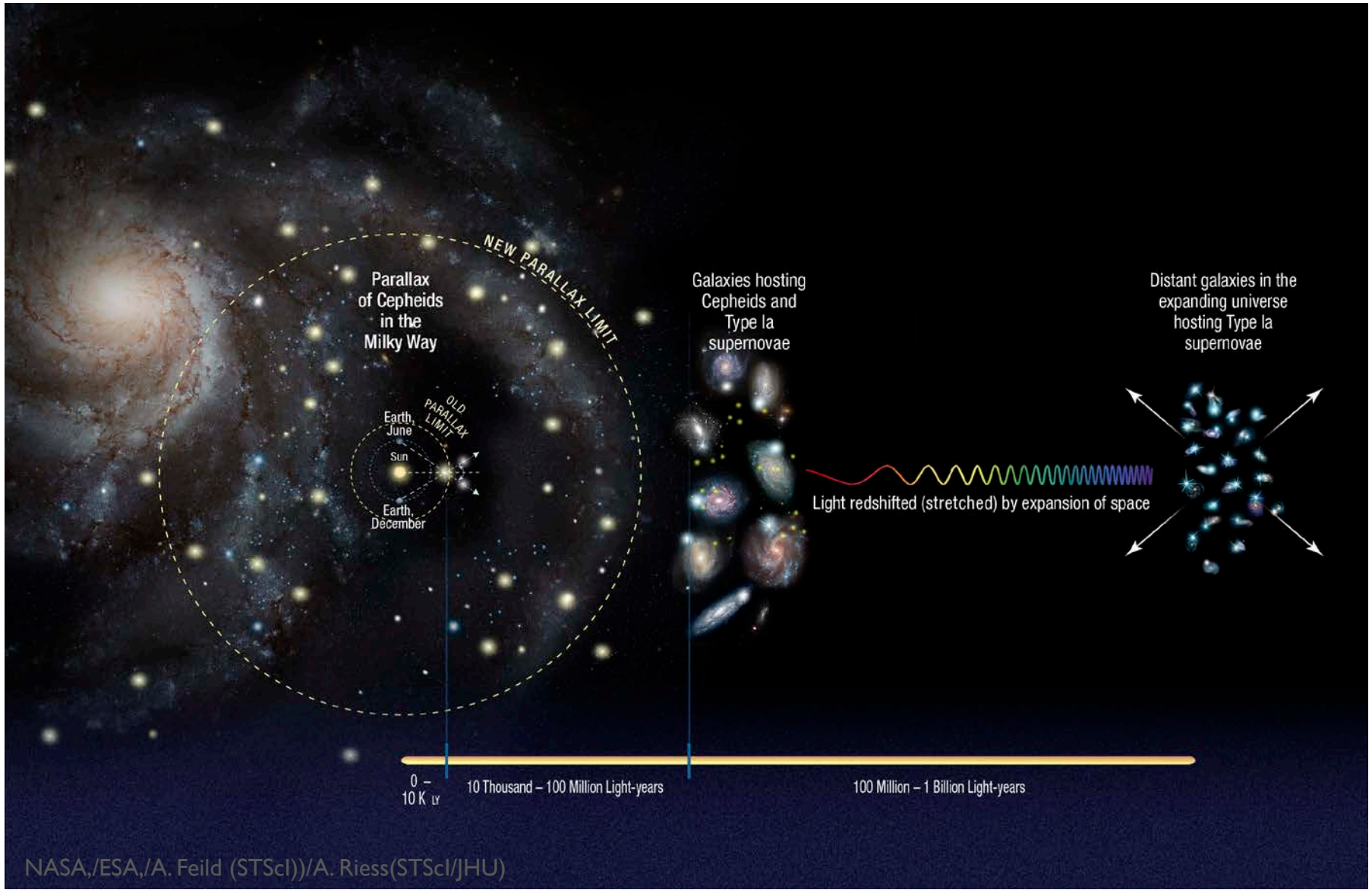
Zach Meisel

Ohio University - ASTR1000

How do we know how far away each of these is?

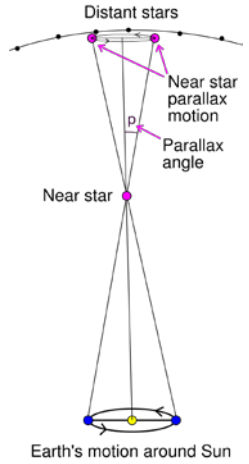


The Cosmic Distance Ladder:
distances to galaxies



NASA,/ESA,/A. Feild (STScI))/A. Riess(STScI/JHU)

- Parallax:
  - solve for missing side of triangle, using known side & measured angles



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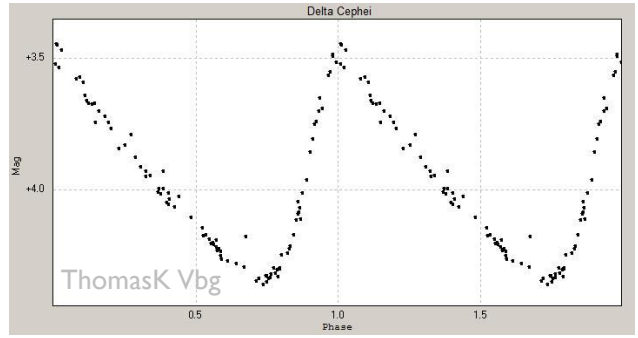
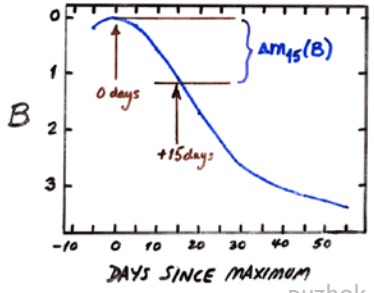
- Variable stars:
  - Intrinsic brightness is directly related to period of brightness



- Standard candles:
  - Type Ia supernova Phillips relation



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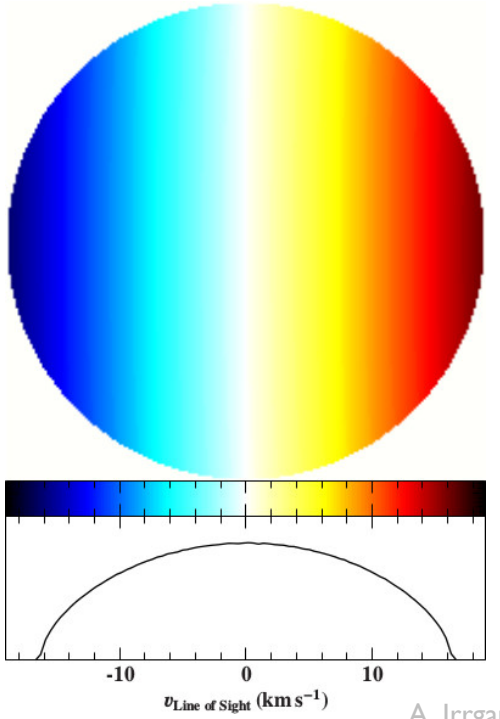
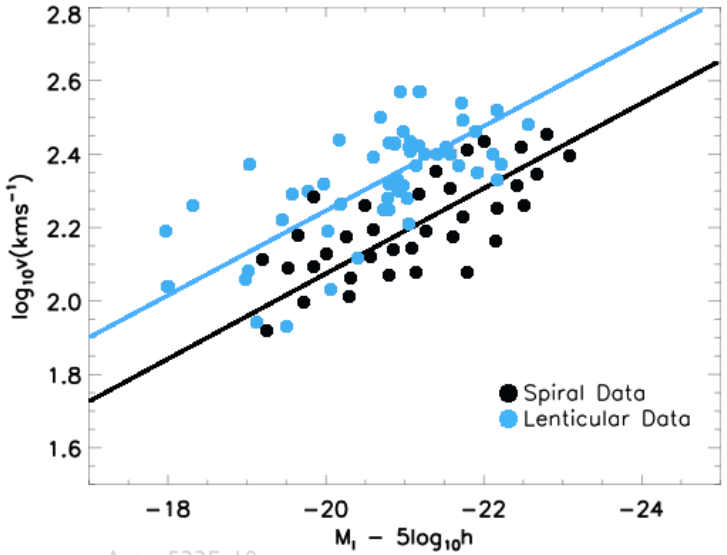
The Cosmic Distance Ladder: *distances using galaxies*

- Consider two opposing forces: gravity and centripetal acceleration
  - $F_{cent} = F_{grav} \rightarrow \frac{mv^2}{r} = \frac{GmM}{r^2} \rightarrow v \propto M$
  - The orbital velocity of stars is proportional to the mass of the galaxy
- Recall from Intro to Redshift lecture, that rotation leads to spectral line broadening
  - So a galaxy's intrinsic brightness is directly related to the line broadening, which is the Tully-Fischer relation
  - This works for spirals, but not for ellipticals



A. Irrgang



Hubble's law

- Using spectral lines from galaxies,
  - broadening gives the velocity,
    which gives the mass,
    which gives the brightness,
    which gives the distance
  - redshift gives the velocity
- The further away an object is,
  the faster it is moving away from us
  - This is Hubble's law, $v = Hd$,
    where $H \approx 20 \frac{km/s}{Mly}$ is the Hubble constant
    (right now! It's not "constant" at all)
  - Recall the discussion in the Intro to Cosmology lecture
  - Therefore redshift can be used for distance determination

E. Hubble PNAS 1929

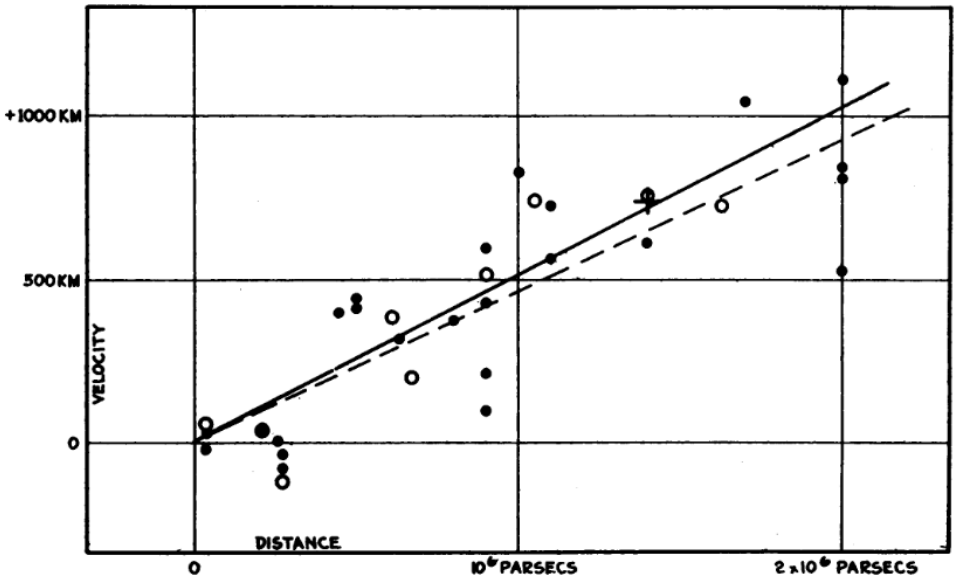


FIGURE 1

Velocity-Distance Relation among Extra-Galactic Nebulae.