

Problem Set #1
PHY 300 Observational Astronomy
Throop / Booth

ASSIGNED: MONDAY 9-FEB-2015

DUE: MONDAY 16-FEB-2015, BEGINNING OF CLASS

1. **Magnitudes.** A star cluster has 100 stars in it. Each star has identical brightness of magnitude 18.
 - a) What is the cluster's total integrated magnitude ('apparent magnitude')?
 - b) If the nebula were moved to ten times its original distance, what would happen to its angular diameter? To the magnitude of each stars? To its total apparent magnitude?
2. **Resolving Power.** In class, we showed that NASA's Hubble Space Telescope (HST; diameter = 2.4 meter; wavelength = 0.5 μm) can resolve Pluto (assume 30 AU from Earth, and diameter 2400 km) to roughly two pixels — that is, HST's resolving power is slightly smaller than Pluto's angular diameter. In order to explore Pluto better, in 2006 NASA sent the New Horizons spacecraft toward Pluto, where it will arrive later in 2015. New Horizons has a small telescope ($D = 21$ cm), but it will get very close to Pluto (10,000 km).
 - a) At what distance from Pluto will New Horizons' resolution exceed that of HST?
 - b) New Horizons will fly past Pluto at 10,000 km above the surface. Assuming perfect optics, what are the smallest features it will be able to resolve?
3. **More Magnitudes.** In class, I said that if you took Pluto and the full Moon and placed them each at 1 AU, they would be of similar brightness. That's not quite true, because in reality their sizes and albedos are not quite identical.
 - a) If you were standing on the Sun, what would Pluto's magnitude be if it was at 1 AU from the Sun?
 - b) What about the Moon?

You can assume that Pluto's current distance is 33 AU from both the Sun and Earth, and it has a magnitude $V = 14$ (from Earth or Sun)

For the Moon, assume a distance 400,000 km (from Earth), distance 1 AU (from Sun), $V = -13$ (seen from Earth).

4. **Thermal Balance**
 - a) What would Pluto's temperature be if placed at 1 AU? Assume an albedo 0.5, and radius 1200 km.
 - b) What about the Moon (albedo 0.05, radius 1700 km)?