ASTR2013 Problem Set 3 - due **1 Sep 2019**

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August 20, 2019

As this tutorial is mostly prep for the field trip, I've made it due the day before. However, I suggest you do it before the Friday and have a weekend! Magnitudes in all questions below are Vega magnitudes (not AB magnitudes).

1. On September 2, 2019, Minor Planet 136199 Eris (originally designated Xena by Mike Brown and team) has a right ascension of 01h46m55s, and a declination of -1d42m18s.

   (a) Using either `astropy.coordinates` or `http://catserver.ing.iac.es/staralt/` or a different tool, find how many hours this is observable for, assuming that it has to be above 30 degrees elevation and the sky has to be darker than 18 degree twilight.

   (b) What is its right ascension in degrees?

   (c) Eris has an apparent magnitude of 18.7. If the sky has a brightness of 21 magnitudes per square arcsec and the seeing is 2 arcsec, how bright in magnitudes is the sky in an aperture with diameter equal to the seeing disk diameter? How many times brighter is Eris than this light from the sky?

   (d) Use `astropy.coordinates` to compute the Geocentric ecliptic coordinates of Eris. Include the line of `python` you used to compute the coordinates. How many degrees is Eris from the ecliptic plane?

2. Horizontal branch stars have an approximate absolute magnitude of +0.7.

   (a) An imaging observation with a particular camera, telescope, filter and exposure time has a magnitude limit of 23 to achieve a signal-to-noise ratio of 5. With this observing setup, how far away could you detect a horizontal branch star with a signal-to-noise ratio of 5?

   (b) A spectroscopic observation is made of a horizontal branch star with a magnitude of 15. How much closer is this star? What is its distance modulus?

   (c) A 15 minute exposure of this star is made and the exposure is limited by target shot noise, with a signal-to-noise ratio of 20. How much longer would you have to integrate to achieve a signal-to-noise ratio of 40?

3. Without using complex spherical trigonometry formulae, compute the approximate angular separation between two stars which both have declination -5 degrees, and have right ascensions of 23 and 1 hours. Compute the approximate angular separation between two stars which both have a declination of -85, and have right ascensions of 1 and 3 hours.

4. The total gravitational potential energy of a white dwarf is $\alpha GM^2/R$ as it approaches the Chandrasekhar mass. Approximating $\alpha(M)$ of 1.0 (you can get a more accurate value in the next tutorial if you like), compute the minimum value for R where the fusion of C to Fe can power the explosion of the white dwarf as a SN Ia. The atomic mass of ^{12}C is 12.0000 u and the atomic mass of ^{56}Fe is 55.9349 u.