HOMEWORK #3
Due date: Feb 4, 2015

1. Mike is sent off to a city at $\lambda = 163°14'\,\mathrm{E}$ to determine the hour angle of the Sun at exactly $8^{\mathrm{h}}46^{\mathrm{m}}22^{\mathrm{s}}$ local time on March 10, 2015. The time zone there is that of the closest meridian (165° E). At the same time, Valery has a Nautical Almanac at hand, and she reads off that the equation of time on March 9 is $-0^{\mathrm{h}}10^{\mathrm{m}}45^{\mathrm{s}}$ (no, 9 is not a typo; why?). While Mike is off in a faraway land (where, exactly?) measuring the hour angle, Val can compute it. And so can you. Even if you're Mike. So let's see it.

2. Globular cluster M13 is one of the most impressive clusters in the northern sky. We can find it in the Hercules constellation, its coordinates are $\alpha = 16^{\mathrm{h}}41^{\mathrm{m}}42^{\mathrm{s}}$ and $\delta = 36°27'37''$. On what day in 2015 should Connor observe it if he wants to catch it around 10pm local time as it crosses the local meridian? How high above the horizon will it be? How long will it still be observable? We are observing from Villanova ($\varphi = 40°02'14''\,\mathrm{N}$, $\lambda = 75°20'57''\,\mathrm{W}$). Use the ephemerides from the Nautical Almanac.

3. On April 9, 2015, Griffin and Amanda set out to observe the Cygnus constellation from Villanova ($\varphi = 40°02'14''\,\mathrm{N}$, $\lambda = 75°20'57''\,\mathrm{W}$). The brightest stars in that constellation are Deneb ($\alpha = 20^{\mathrm{h}}41^{\mathrm{m}}26^{\mathrm{s}}$, $\delta = 45°16'49''$) and Albireo ($\alpha = 19^{\mathrm{h}}30^{\mathrm{m}}43^{\mathrm{s}}$, $\delta = 27°57'35''$). They plan to start observing at the time of Albireo rising. When is that? At what altitude and what azimuth will they see Deneb at Albireo's culmination? How long will the two stars both be visible? Sidereal time at 0^{h} UT is $13^{\mathrm{h}}10^{\mathrm{m}}11^{\mathrm{s}}$.

4. Where on Earth do Cole and Jeff need to be to catch the Geminid meteor shower radiant (Dec 14, 2015 at 10^{h} UT; $\alpha = 4^{\mathrm{h}}$, $\delta = 40°$) in zenith? What will be the local time there? Estimate sidereal time instead of looking it up in the Almanac.

5. Rob wants to figure out when to plan on harvesting the crops. He remembers that ancient Egyptians used an astronomical event to figure it out: when Sirius rises with the Sun, that is when they started their harvest. The coordinates of Cairo are $\varphi = 30°03'00''$ and $\lambda = 31°14'00''$. Hint: derive an expression for equatorial coordinates of the (mean) Sun ($\alpha_\odot$, $\delta_\odot$) as a function of time. Hint for the hint: this is a simplified version of problem #6.

6. *Extra credit:* A "fun" one to wrap up: using spherical trig, derive the expressions for ecliptic latitude β and longitude λ from known equatorial coordinates α and δ. Googling for these transformations is

cheating. ;p Trust in yourselves and do it yourselves. Yes, it'll take a while, so better start soon. The calculations are straight-forward, but plotting a bunch of spherical triangles (until you recognize the useful ones) takes time. Hint: don't give up.