ASTR 407/507 Assignment 3

Due: Monday Jan 29, 4 PM in class or under Prof's door. NO EMAIL submissions
Late Penalty : -30% if turned in by 4 PM Tuesday. -60% if by 5 PM the following Wednesday

Your answer must be *clearly explained* and *neatly presented*, or points will be deducted. Although you may work with other students to understand, your write-up must be done independently.

1. Near-Earth asteroids have chaotic orbits caused by their gravitational encounters with the terrestrial planets. A typical near-Earth asteroid can be imaged by planetary radar, and due to the light-travel return-time precision, it's position can be known with 10 m accuracy. Taking the Lyapunov time for the NEA's orbit to be 100 years, how long will it be before the uncertainty in the orbit (that is, the distance between the nominal orbit and one that begins 10 meters away) reaches:
a. the radius of the Earth, making an asteroid impact prediction impossible?
b. an astronomical unit, at which point one has no real idea where the asteroid is located around the Sun?

2. A comet apparition. For the purposes of this problem, consider the Earth's orbit to be precisely in the ecliptic plane, with a/e/arg_peri = 1.000 010 au/0.016 733/102.90 degrees, and its 2018 instant of pericenter passage to be T=Jan 3.23194 2018. Note that here arg_peri=ω is measured from the reference direction (to the vernal equinox). Now consider a comet with J2000 ecliptic heliocentric orbital elements:

a=3.501 988 au, e=0.710 432, i=32.008 deg, ω=172.776 deg, Ω=195.413 deg, T= JD 245 8371.82243

a. Find a julian date converter on the internet, and compute the Julian Day (JD) of Earth's perihelion, while confirming that the comet's perihelion date is Sept 10, 2018 at about 7:44 UT. In this problem, you should work with a time unit of Julian days.
b. The comet's orbit pierces the ecliptic plane (Earth's orbital plane) at two points. Draw a rough scale diagram of the ecliptic plane showing a reference circle at 1 AU, the comets 'line of nodes' and the two locations of the ascending and descending node of the comet, computing their heliocentric distances. (hint: what true anomalies are the nodes?)
c. For the node that is *closer to the Sun*, compute the date (JD and calendar) of that nodal passage and the (*x*,*y*) coordinates of the comet at that instant.
d. For that same instant, compute the *x*,*y* coordinates of the Earth, and thus the geocentric distance of the comet at that time. You should either add the relevant information to your previous diagram or create another one. State, and explain, to order of magnitude how accurate you thing your result is.

3. **Text problem 2-10.**
Graduate students will substitute a different problem for this one.