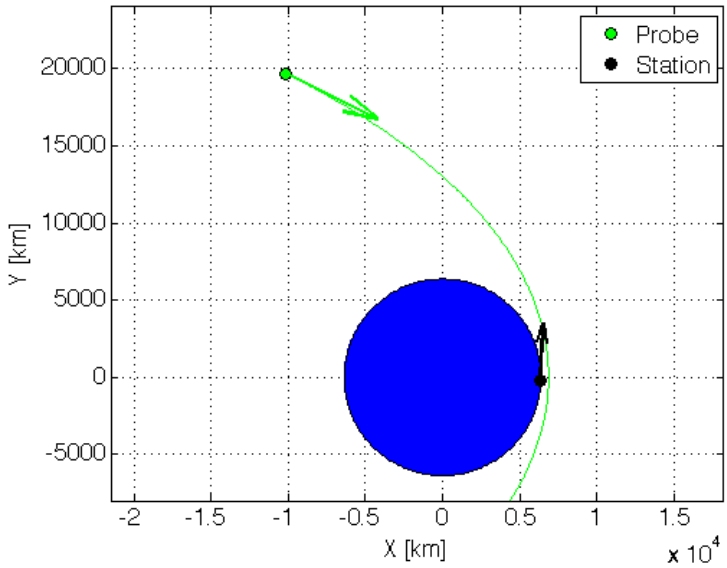
Space Missions and Systems 2018: Home Test #1

A spacecraft is in an eccentric orbit about the Earth, and a tracking station is collecting range and range-rate observables. The orbit is equatorial and coplanar. The estimate of the probe state vector (best guess) at the initial reference time $t_0 = 0$ is:

	Value	Uncertainty
x	-10150.0 km	20 km
y	19680.0 km	20 km
v_x	4.90 km/s	100 m/s
v_y	-2.42 km/s	100 m/s

The motion of the tracking station is perfectly known. At the reference time, the angle between the station position vector and the X-axis of the reference frame is -2.0 degrees (negative Y-component). The figure below illustrates the details of the geometry.



(1) Use the range and range rate observables (accuracy equal to 1 m and 1 mm/s, respectively) provided by the ground station to obtain a new estimate of the probe's state vector at the reference epoch.

(2) Which of the two types of observables is most valuable for the determination of the probe state? Justify your answer.

(3) Compute the beginning and end times of the next tracking window of the ground station. Comment on the difference with the given tracking session.

(4) What are the period and eccentricity of the orbit?

(5) At what time will the closest approach with the Earth occur? Compute the uncertainty on the altitude.

Additional information:

- The observables are provided in file the “GS1.txt”: the first column contains the observation time (in sec after t_0), the second column is the corresponding observed range value (in km), and the third column is the corresponding observed range-rate value (in km/s).
- Standard Earth GM: 398600 km^3/sec^2
- Sidereal Earth rotation period: 23 hours, 56 min, 4 sec
- Earth equatorial radius: 6370 km

Email a working computer code (Matlab is recommended) and a short note (a pdf file) with the mathematical procedure, results, comments, and figures by Sunday April 15th 23:59:59 UTC to luciano.iess@uniroma1.it **AND** daniele.durante@uniroma1.it.

In the first page of your pdf indicate your **first name**, **last name**, and **student id** (a.k.a. “numero di matricola”).

Tips on Matlab:

- Rather than ode45, use ode113, which excels in orbital dynamics problems (just replace ode45 with ode113 in your setup);
- For integration purposes, use at least RelTol=1.0E-13, AbsTol=1.0E-13;
- ALWAYS put labels and units on the plot axes!