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% Galileo flew to Jupiter by means of a VEEGA trajectory (Venus-Earth-Earth Gravity Assist).
% Assuming that the trajectory to Venus was ballistic, determine the parameters of the interplanetary
% orbit knowing that the Earth departure was on October 8, 1989 and the arrival to Venus was on
% February 10, 1990. Assume that the departing vâˆž was parallel to the Earthâ€™s velocity. Use JPL
% Horizon to determine the positions and velocities of the planets for those dates.
% Marc C
% Based on Pi method

clc
close all
clear all

r1_v = [1.353683421048372E+08 6.236351063675036E+07  1.616180081151426E+03];
r2_v = [-9.694952181127319E+07 4.610774545357175E+07 6.225620771722047E+06];
mu = 1.33e11;
time_expected = 115; %days

p = 1.2e8;

% Trial example values
%mu = 3.964016e-14;s
%r1_v = [0.473265 -0.899215 0]; To check with example code
%r2_v = [0.066842 1.561256  0.030948];
%time_expected = 207; %days
%p = 1.250633;
 r1 = norm(r1_v);
r2 = norm(r2_v);

delta_theta =  acos (dot(r1_v,r2_v)/(r1*r2));
 k = r1 * r2 * (1 - cos(delta_theta) );
l  = r1 + r2;
m = r1*r2*(1+cos(delta_theta));
p1 = k/(l+sqrt(2*m));
p2 = k/(l-sqrt(2*m));
 error_cons = 1; %days
error = error_cons+1;
 %%Starting the trial
while (error>error_cons)
a = m * k * p / [(2*m - l*l)*p*p + 2*k*l*p - k*k];
f = 1 - (r2/p)*(1 - cos(delta_theta));
g = r1*r2*sin(delta_theta)/sqrt(mu*p);
E = acos(1 - r1 / a * (1 - f) );
t =  g + sqrt(a*a*a/mu)*(E - sin(E));
tdays = t/(3600*24)
error = abs(-tdays+time_expected);
p = p + 10000;
end
f_p = - sin(E)*sqrt(mu/a)/(r1*r2);
g_p = 1-(1-cos(E))*a/r2;
v1_v = (r2_v-f*r1_v)/g
norm(v1_v)
v2_v = f_p*r1_v + g_p*v1_v
norm(v2_v)
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