I calculated the Hamiltonian in the inertial barycentric coordinate system as:

where – radius vector of the spacecraft from the barycenter, – radius vector of the Earth and – radius vector of the Moon.

I also will be showing plots of the Moon-centered radius-vector and the velocity of the spacecraft.

First, the results from ODE113 function for circular and non-circular Moon orbits.

**1. ODE113, circular Moon orbit:**

Hamiltonian:

Chart, histogram

Description automatically generated

Moon-centered r and v:

Histogram

Description automatically generated

a(t) and e(t):

Chart, line chart, scatter chart

Description automatically generated

**2. ODE113, non-circular Moon orbit:**

Hamiltonian:

Chart, histogram

Description automatically generated

Moon-centered r and v:

Chart, histogram

Description automatically generated

a(t) and e(t):

Chart, scatter chart

Description automatically generated

Both cases with ODE113 look similar with strange *r* and *v* behavior and the leaps in *a*.

Now the same plots with Runge-Kutta.

**3. Runge-Kutta, circular Moon orbit:**

Hamiltonian:

Chart, histogram

Description automatically generated

Moon-centered r and v:

Histogram

Description automatically generated

a(t) and e(t):

Chart, histogram

Description automatically generated

**4. Runge-Kutta, non-circular Moon orbit:**

Hamiltonian:

Chart, histogram

Description automatically generated

Moon-centered r and v:

Histogram

Description automatically generated

a(t) and e(t):

Chart, histogram

Description automatically generated

**5. Results:**

In all cases the Hamiltonian is not constant (if I calculated it right). Also, it seems that the Moon orbit being circular or not doesn’t change much (but you can clearly see the difference in semi major axis with the Runge-Kutta method in paragraphs 3 and 4). Both cases with ODE113 functions look incorrect (you can see strange behavior in r and v after a certain amount of time and compare it with Runge-Kutta).