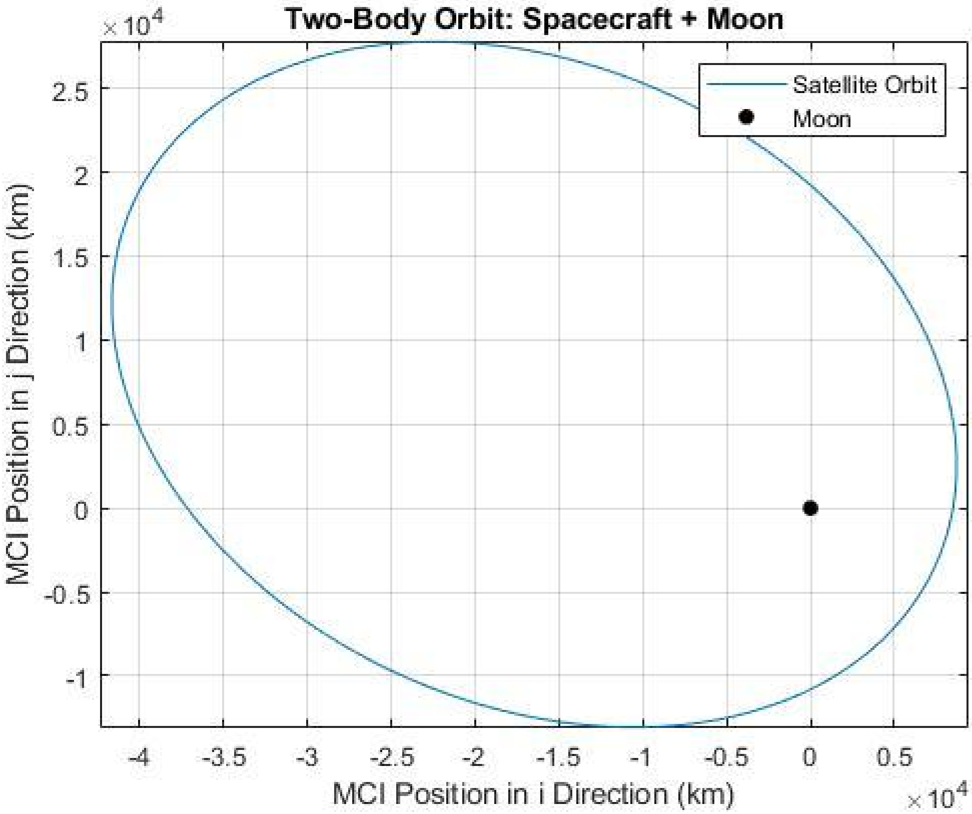
Computational Assignment # 2 Results and Discussion

Variable Descriptions

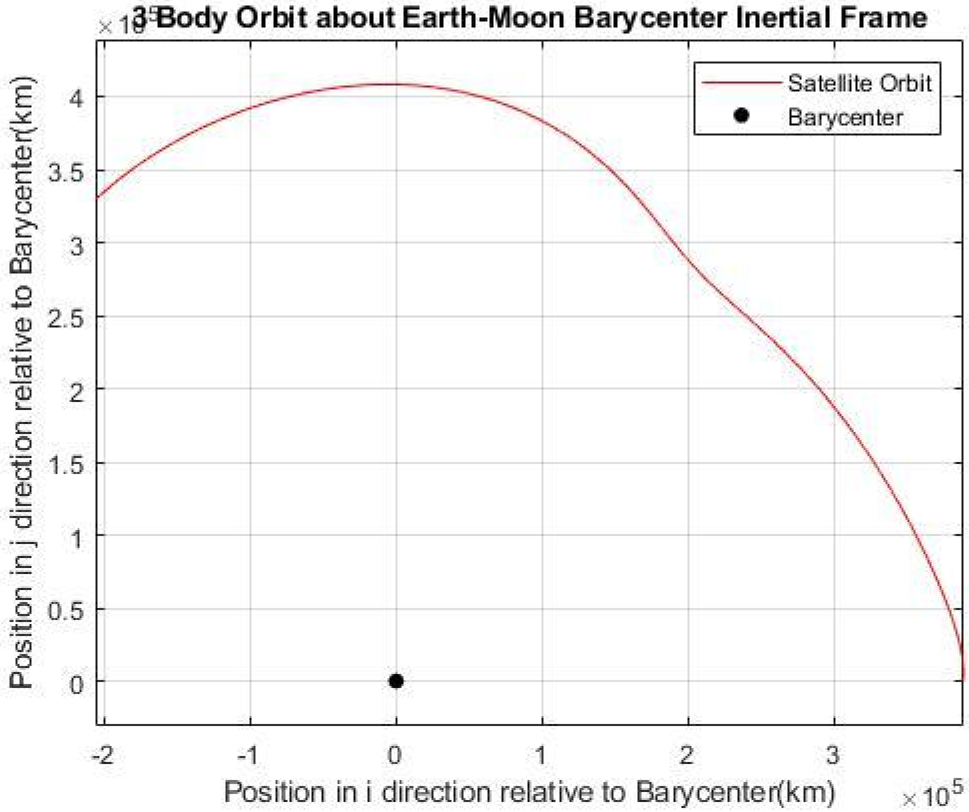
- r_SOI_moon - Size of moon's sphere of influence
- E - Energy of moon-centered orbit
- a - semi-major axis of moon-centered orbit
- T_circular - period of moon-centered orbit
- r - propagated position vector of spacecraft relative to Moon using two-body
- r_SB - the position of the spacecraft at t0 relative to the Earth-Moon barycenter
- v_SB - inertial velocity of the spacecraft at t0 relative to the Earth-Moon barycenter
- r_SE - position of spacecraft at t0 relative to Earth center
- v_SE - velocity of spacecraft at t0 relative to Earth center
- time4 - 5,000x1 time vector with t0=0 and tf=2P
- rB4 - propagated position vector of spacecraft using N body equation in an inertially aligned frame centered at the Earth-Moon barycenter
- rB5 - propagated position vector of spacecraft using N body equation in an inertially aligned frame centered at Earth.
- EC2EMB_shift - origin shift from Earth centered inertial frame to E-M barycenter frame
- error - difference between E-M barycenter and transformed Earth-centered position vectors (Part 6)
- EC2MCI_shift - origin shift from Earth centered inertial frame to Moon-centered inertial frame
- r0_CR3BP - spacecraft position and velocity at t0 in the rotating CR3BP frame.
- v0_CR3BP - spacecraft velocity at t0 in the rotating CR3BP frame.
- rB9 - propagated position vector of spacecraft in the rotating CR3BP frame
- P4_pos_CR3BP - Transformed spacecraft position vector from an inertially aligned frame in part#4 into the CR3BP frame
- error10 - difference between propagated position vector in the rotating CR3BP frame and the transformed barycenter spacecraft position vector in the rotating CR3BP (Part 10)
- C - Jacobi constant for the CR3BP

Part 2

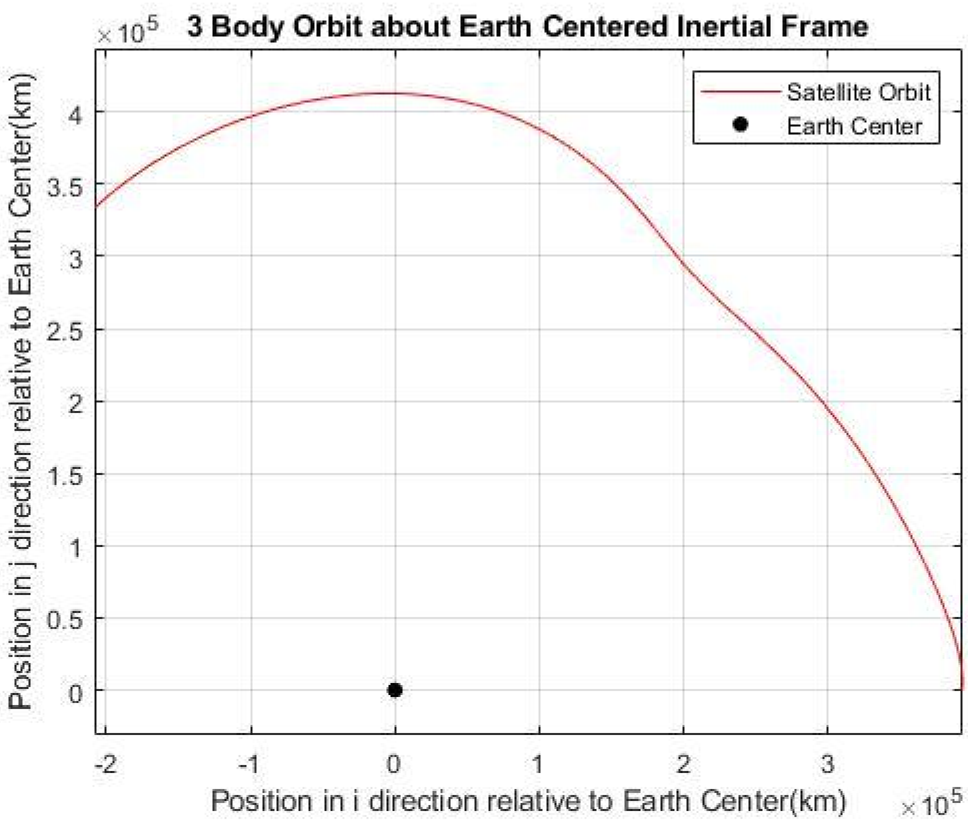


Two-Body Orbit: Spacecraft + Moon
Satellite Orbit
Moon
MCI Position in j Direction (km)
MCI Position in i Direction (km)
×10^4
2.5
2
1.5
1
0.5
0
-0.5
-1
-4
-3.5
-3
-2.5
-2
-1.5
-1
-0.5
0
0.5
×10^4

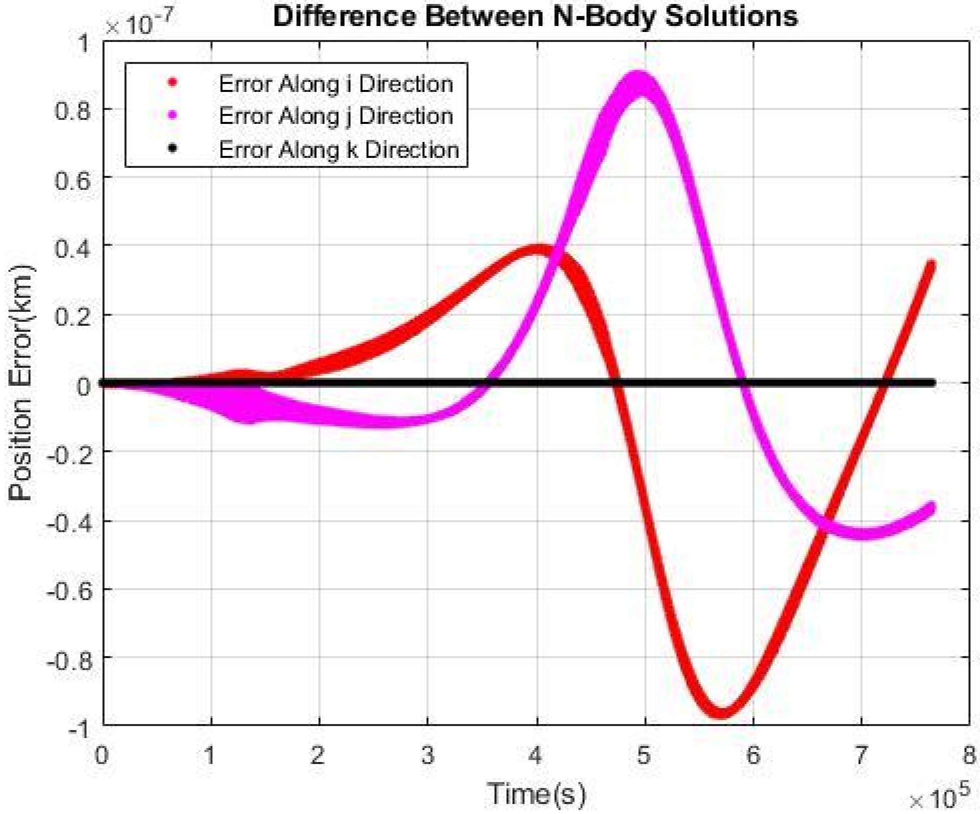
Part 4


3 Body Orbit about Earth-Moon Barycenter Inertial Frame
×10^5
Satellite Orbit
Barycenter
Position in j direction relative to Barycenter(km)
Position in i direction relative to Barycenter(km)
×10^5

Part 5

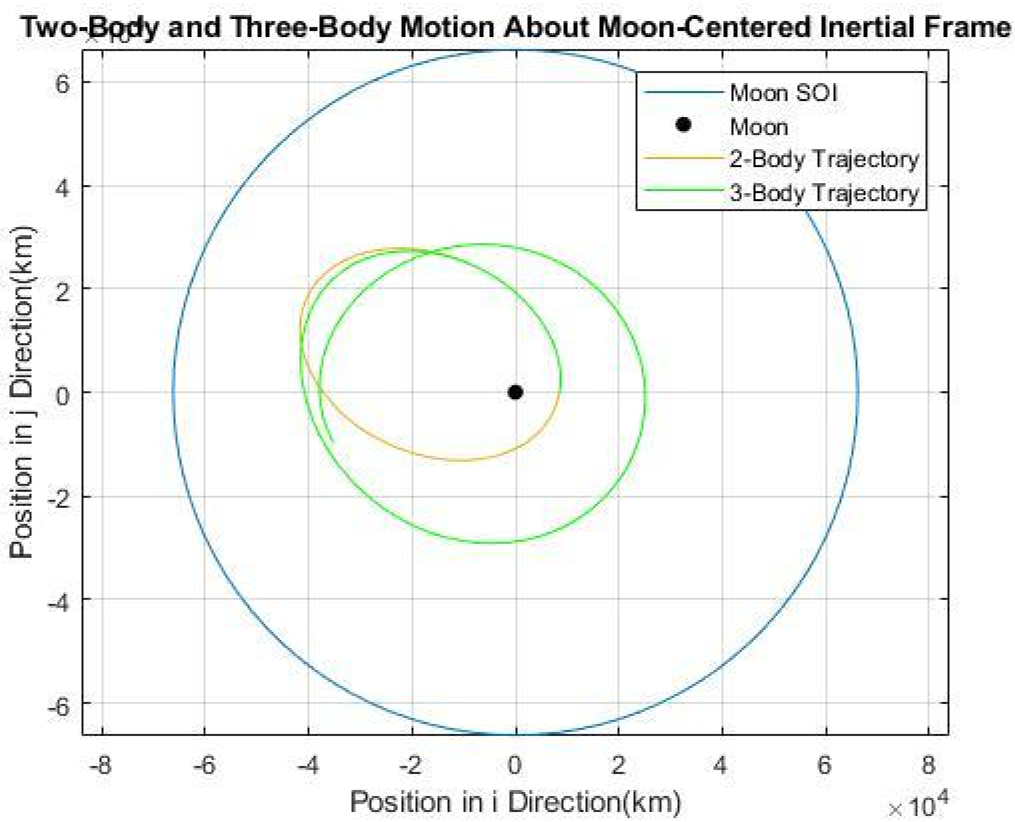

×10^5
3 Body Orbit about Earth Centered Inertial Frame
Satellite Orbit
Earth Center
Position in j direction relative to Earth Center(km)
Position in i direction relative to Earth Center(km)
×10^5

Part 6



Difference Between N-Body Solutions
Error Along i Direction
Error Along j Direction
Error Along k Direction
Position Error(km)
Time(s)
$\times 10^{-7}$
$\times 10^{5}$

Part 7

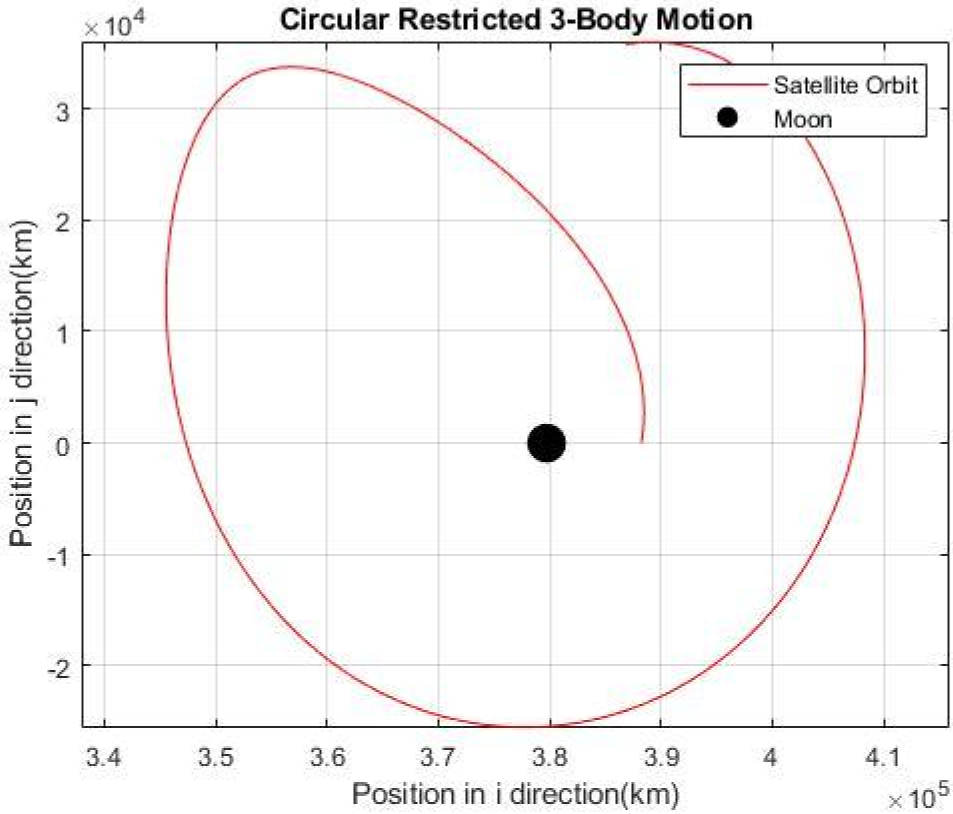


Two-Body and Three-Body Motion About Moon-Centered Inertial Frame
Moon SOI
Moon
2-Body Trajectory
3-Body Trajectory
Position in j Direction(km)
Position in i Direction(km)
$\times 10^{4}$

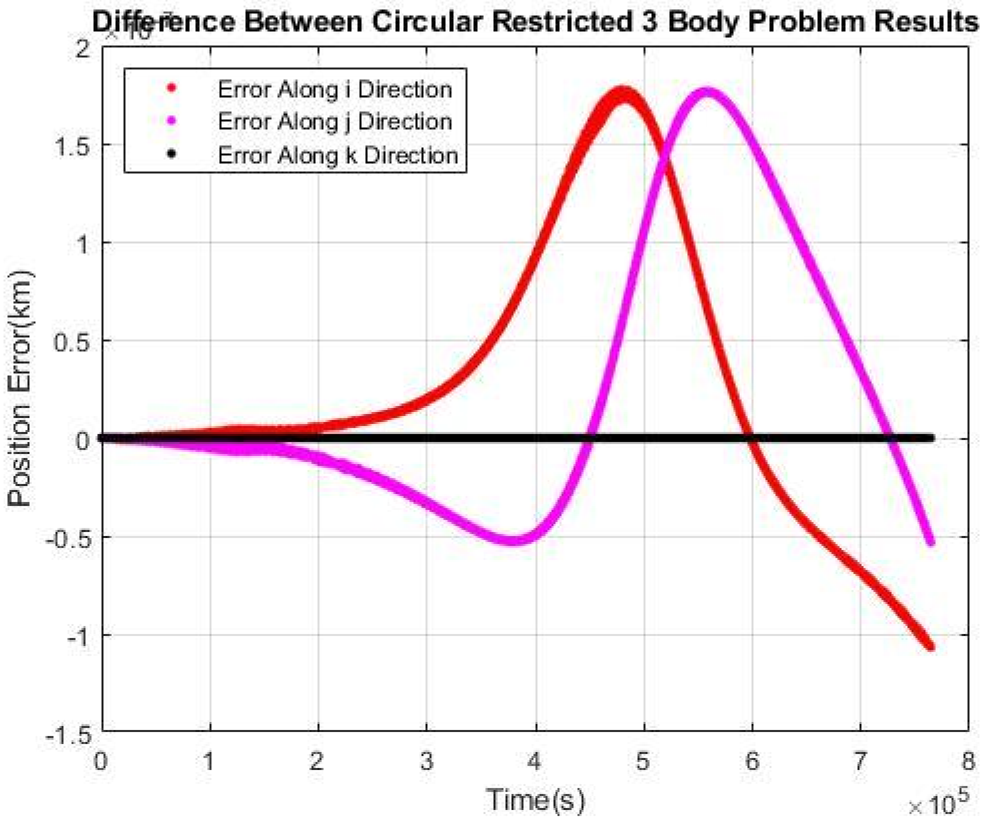
The two-body trajectory is a good approximation of the three-body trajectory for about 1.1059 days. ((T_circular/4)*1.15741e-5).

The three body problem is more appropriate than the two body problem in this case because the 3 body motion has greater influence on the accuracy of the trajectory

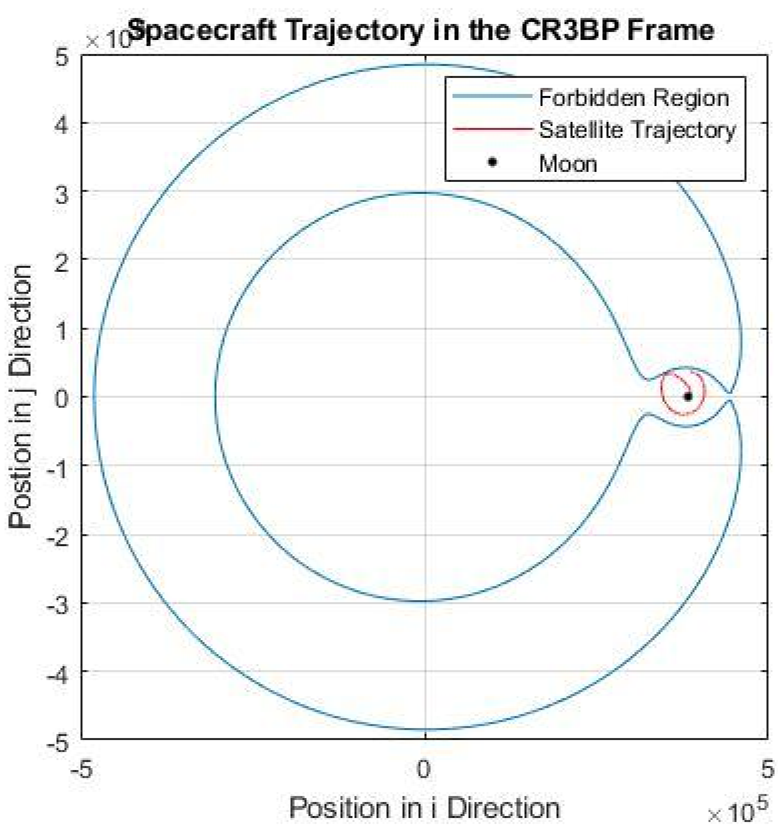
Part 9



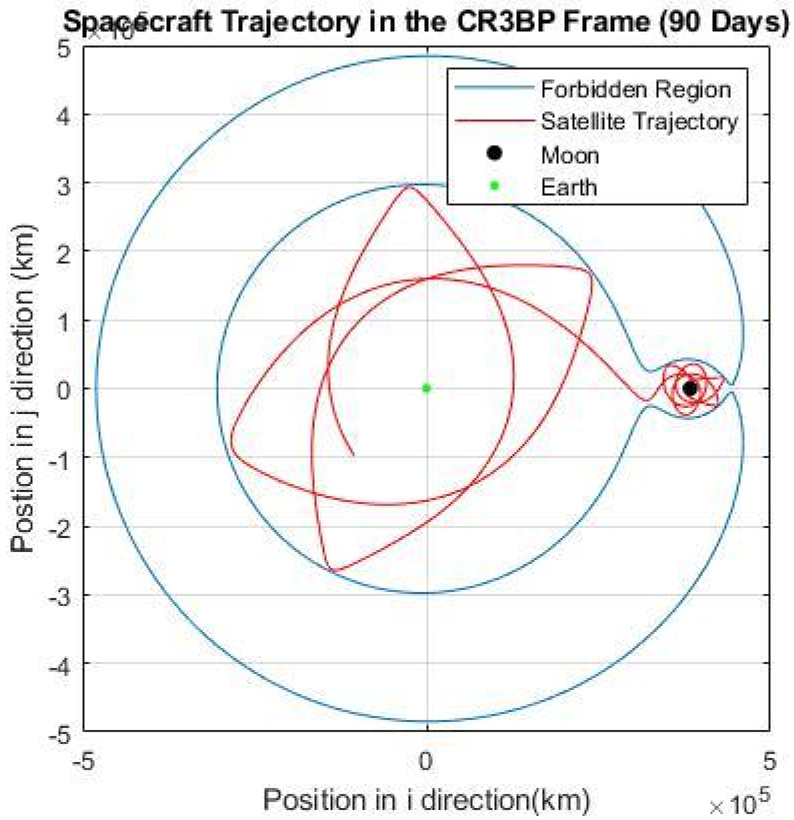
Part 10



Part 11



Part 12



The spacecraft makes about 4 revolutions about the moon before it departs the vicinity of the moon.

The complexity of the gravity field of this three-body problem is something that needs to be taken into account when launching lunar satellites.

It's possible that at some point the presence of gravitational influences will result in the spacecraft re-entering the moon's orbit.