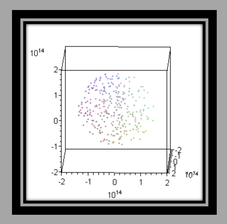
The Effect of Tidal Forces on the Distribution of Planetesimals in the Early Solar System

Ryan Gengler ❖ Faculty Mentor : Lyle Ford ❖ Department of Physics and Astronomy ❖ University of Wisconsin-Eau Claire

The purpose of this project was to determine the influence of the galactic tidal force on planetesimals in the early solar system. We were specifically interested in the comparison of the tidal force compared to earlier simulations performed without this force. We compared the calculations of the semi-major axis and eccentricity between the two simulations.

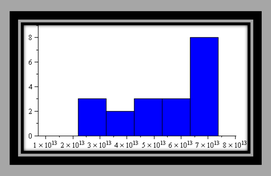
The way we would be able to tell if the tidal force played a major role is that in our spherical solar system, a high percentage of planetesimals would be pulled towards the middle of the solar system, compared to what would happen without the tidal force



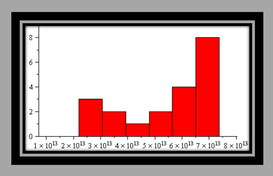
The picture to the left represents the original set-up of our solar system. Every dot within the system represents 1 of 301 planetesimals within the system.

Semi-major Axis graphs

45 degrees

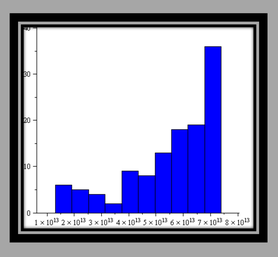


The graph to the left shows the final count of planetesimals for the initial simulation without the tidal force between the region of 0 and 45 degrees. The X-coordinate represents the semi-major axis of the planetesimals.

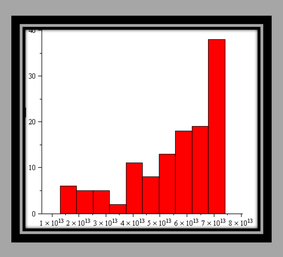


This graph represents the count of planetesimals of the tidal force simulation between 0 and 45 degrees.

90 degrees

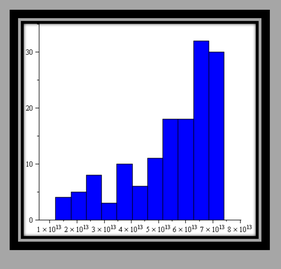


The graph to the left is the count of planetesimals in the initial simulation without the tidal force between the region of 46 and 90 degrees. As you can see there is a greater concentration near the middle region of the spherical arrangement.

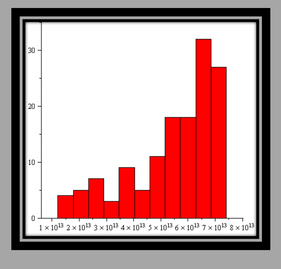


This graph is the same region but with the tidal force simulation, the concentration can also be seen in this graph.

135 degrees

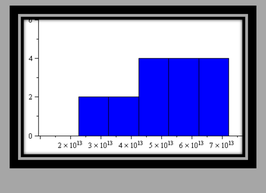


This graph represents the region between 91 and 135 degrees. This is still part of the middle region of the sphere. This represents the simulation done with the initial equation.

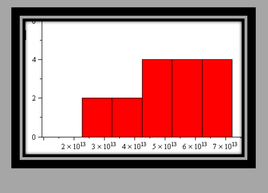


This picture represents the same region but done with the tidal force.

180 degrees



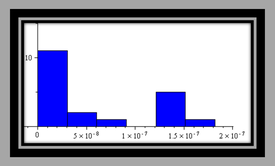
As we get back out of the middle region the count has decreased. This represents between 136 and 180 degrees.



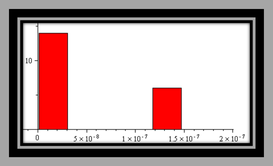
The same region done with the tidal force program shows the same kind of results.

Eccentricity graphs

45 degrees

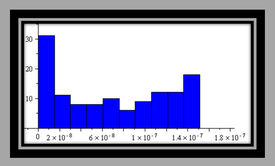


The graph to the left shows the final count of planetesimals for the initial simulation without the tidal force between the region of 0 and 45 degrees. The X-coordinate represents the eccentricity of the planetesimals.

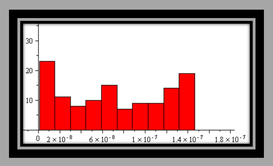


This graph represents the count of planetesimals of the tidal force simulation between 0 and 45 degrees.

90 degrees

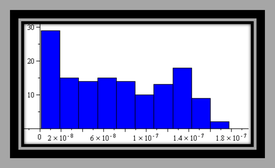


The graph to the left is the count of planetesimals in the initial simulation without the tidal force between the region of 46 and 90 degrees. As you can see there is a greater concentration near the middle region of the spherical arrangement.

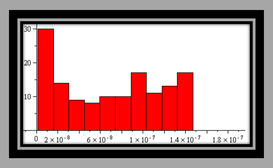


This graph is the same region but with the tidal force simulation, the concentration can also be seen in this graph.

135 degrees

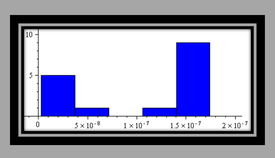


This graph represents the region between 91 and 135 degrees. This is still part of the middle region of the sphere. This represents the simulation done with the initial equation.

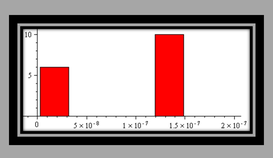


This picture represents the same region but done with the tidal force.

180 degrees



As we get back out of the middle region the count has decreased. This represents between 136 and 180 degrees.



The same region done with the tidal force program shows the same kind of results.

Conclusion:

After comparing the two simulations, with the same initial set-up, the data shows no significant difference. Although there is a little difference between the initial simulation and the tidal force simulation, the difference is not significant enough to be relevant under these circumstances.

Funding provided by:
•Differential tuition
•Summer Research Experience for Undergraduates Program through OSRP