Analysis of Asteroid Physical and Osculating Orbital Parameters to Constrain Existing Data Quality and Evolutionary Processes of the Solar System

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**Introduction**

Asteroids are minor bodies of the Solar System which orbit the Sun and are too small to be considered planets which are therefore designated the “minor planets.” Sizes range from small particles to the 945 kilometer diameter of Ceres. They are broadly divided into three categories based on composition: C-type, S-type, and M-type for carbonaceous, silicaceous, and metallic, respectively. Believed to be the remnants of collided planetesimals, asteroids are the building-blocks of all planets in the Solar System; their impacts with the rocky planets are highly energetic events which have guided the course of each’s evolution. Life on Earth, for example, is constantly threatened by major asteroid impacts, which have been the causes of major mass extinctions. Although the threat of such large-scale impacts is greatly reduced now compared with the Solar System in its infancy, asteroids also represent a major resource to humanity, both scientific and economic. Not only do they provide a window into the processes that dominated the evolution of the Solar System (and likely other solar systems), but metallic asteroids have immense resource value due to the highly concentrated valuable metals contained within them, as well as the large number and size of such bodies.

There are six Keplerian orbital elements which can describe the orbit of a celestial body. These are: Semimajor axis () - half of the longest diameter of the orbital ellipse, eccentricity () - a unitless measure of the elongation of the orbit, inclination () - the angle between the orbital plane and some plane of reference, longitude of the ascending node () - the angle from a reference direction to the intersection of the orbital plane with the reference plane where the body is “ascending”, or moving upward through the reference plane, argument of periapsis () - or the angle between and the periapsis (shortest distance from the object around which the given body is orbiting), and true anomaly - the position of the body at a certain time or epoch. The parameters of importance for the present study are semimajor axis, eccentricity, and inclination, as well as the derived orbital characteristics of apoapsis (farthest distance from the object around which the body is orbiting) and periapsis.

There are also several physical parameters which are beneficial to consider and utilize. These include: Absolute magnitude - how bright the asteroid would appear if it was one astronomical unit (au) from both the Earth and the Sun at a phase angle of zero, albedo - the reflectivity of the asteroid, diameter, rotational period, and whether or not the asteroid has a natural satellite.

**Abstract**

The present study seeks to demonstrate that an analysis of the osculating orbital elements (orbital elements which describe only the current orbits of a celestial body and not the average orbit over longer timescales, in the presence of perturbations) and certain physical parameters of asteroids can reveal features of both the present and past Solar System. In addition, the quality of existing asteroid data will be evaluated and accounted for where necessary.

**Methodology**