CALIFORNIA STATE SCIENCE FAIR
2017 PROJECT SUMMARY

Name(s)

Raymond D. Ramlow

Project Number

S1825

Project Title

A Critical Analysis of Four Orbital Determination Methods under Varying Viewing Geometries

Abstract

Objectives/Goals

The objective of this project is to determine the efficacy of four methods of preliminary orbit determination (those of Olbers, Gauss, Herget and Laplace) under differing observational inputs.

Methods/Materials

A laptop, Python 2.7 with Numpy and PyFITS, MPC orbital data and several remote telescopes were used. All orbital determination methods and analysis were implemented in Python. Sample orbits for selected minor planets were used to generate lists of positions, and triads of these positions were then used to regenerate the orbital elements using the four methods while varying the characteristics of the triads used. Error from the original orbit was determined.

Results

The method of Herget was more accurate than other methods under all circumstances, with percent error from the original orbit falling under 1% for 80% of trials in which the orbit converged. For the Gaussian method, this value was 71%; for the Laplacian, this was 63%; for the Olbers, this was 55%. The Herget and Gauss methods performed especially well when the time intervals between observations in a triad were increasingly uneven.

Conclusions/Discussion

Methods of preliminary orbit determination are useful in providing orbits from limited data (3 observations) and are therefore important in determining the orbits of faint near-Earth asteroids that are only briefly observed. This project concluded that the method which produces the least error is the Herget method, and that this is what should be used in such circumstances.

Summary Statement

The Herget method is deemed to be the most accurate of four methods of preliminary orbit determination analysed.

Help Received

All necessary programs were written myself, and the methodology is my own.