Abstract Submitted
for the OSF09 Meeting of
The American Physical Society

Libration Patterns in Synchronized Orbits of Natural Satellites[1]
DAVID CARPENTER, Hayes High School, BARBARA ANDERECK, Ohio Wesleyan University — The synchronization of the orbital periods of the natural satellites of planets resembles the synchronization of mechanical oscillators. When the satellites are of comparable mass, each gravitationally influences the orbits of the other satellites. Eccentricities of the orbits cause nonlinear oscillations. The satellites can therefore modulate each other's periods slightly through altering each other's eccentricities. In this study, Mathematica 7 was used to model a planet with only two satellites, based on the orbital properties of Jupiter and two of its satellites, Io and Europa. This was chosen because Io, Europa and Ganymede actually are synchronized with orbital periods in ratios of 1:2:4. The orbits are also phase-locked, with conjunctions between Io and Europa always occurring at Io's perijove, and at Europa's apojove. If the angle between the semimajor axes of the two orbits is deliberately displaced in the model, libration of the axes occurs. The characteristics of these libration patterns were investigated by mapping the changing location of the perijoves over thousands of orbits. By varying the distances of the satellites from the planet, the increase in the strength of perturbations as period resonances were approached was also studied.

[1]Supported by REU/RET NSF Grant #0648751.

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Date submitted: 17 Sep 2009 Electronic form version 1.4