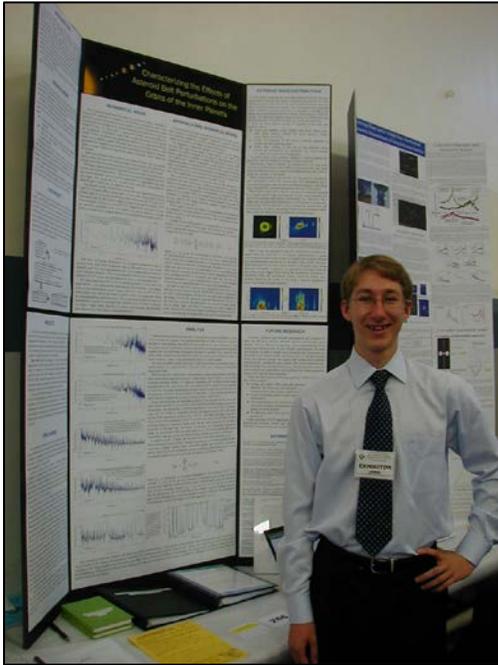# 2012 State NMJAS Paper Competition Winner

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Characterizing the Effects of Asteroid Belt Perturbations on the Orbits of the Inner Planets

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Abstract: The planets of the solar system are subject to multiple gravitational perturbations from other solar system bodies including other planets, large asteroids (as discrete point masses), and small asteroids (cumulatively). The largest uncertainty in our knowledge of the orbits of the inner planets (Mercury, Venus, Earth, and Mars) is due to gravitational perturbations from the complicated and uneven mass distribution within the asteroid belt (e.g., masses of asteroids range over many orders of magnitude). The goals of this project are to computationally model the effects of perturbations from the 300 largest asteroids on the orbits of the inner planets; specifically, this project looks to characterize the perturbative effects as a noise problem, which is a novel approach. In order to do this, I have created a numerical integration framework that models Newtonian solar system interactions. Initial integrations show that numerical red noise is orders of magnitude below asteroid gravitational perturbations. I analyze these perturbations by comparing integrations with and without specific subsets of perturbing asteroids. To analyze orbital element residuals I use power spectra. These yield the frequencies and amplitudes of the gravitational perturbation signals and are the first step to characterizing perturbations from a noise perspective. I find that the power spectra can exhibit red noise at low frequencies and reach a noise floor (white noise) at higher frequencies. White noise precludes the knowledge of planetary motion at the sub-meter to meter level, an original result. Tools to discriminate between chaotic and stochastic motion will be employed in future work.