Abstract Submitted
for the OSF12 Meeting of
The American Physical Society

Extending Newton's Apsidal Theorem[1] CAMERON TUCKERMAN, ULRICH ZURCHER[2], Physics Department, Cleveland State University — For the Kepler potential $\Phi_0 = \mu/r$, the orbit is closed and the apsidal angle is a full circle $\Delta\Theta = 2\pi$. For the potential $\Phi(r) = \mu/r^{2-n}$, the orbit is open [Bertrand's theorem] and the trajectory has the general shape of a rosette. Newton found an expression for the Apsidal precession for small eccentricities $\Delta\Theta = 2\pi/\sqrt{n}$. We extend this result for arbitrary orbital parameters; we introduce a description in terms of an effective angular momentum and a Keplerian potential $\Phi_{\text{eff}} = -\rho/r$. We find an exact expression for the Apsidal precession. For $|n| < 0.3$, we find $\Delta\Theta = 2\pi/n^{\alpha}$ and find expressions for the exponent α that are correct with 1%. We discuss possible applications to the orbits of stars in elliptical galaxies.

[1]Supported by a grant from the Provost's Initiative for Undergraduate Research [CSU]
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Date submitted: 04 Sep 2012 Electronic form version 1.4