Abstract Submitted
for the APR09 Meeting of
The American Physical Society

Self Coupled Gravity: Another Approach to General Relativity
JAMES CRAWFORD, Penn State University — In 1960, Arnowitt, Deser, and Misner published a paper arguing (in the context of General Relativity) that if one includes the gravitational self-energy in the total energy of a point charge, the total energy is rendered finite. This paper is also discussed in Ashtekar's book where he gives a more "simple-minded calculation." Motivated by this work, I consider a "toy" field theoretic model of gravity where the static gravitational energy density is assumed to be in electrostatic form and where this (negative) energy density contributes as a gravitational source. In the case of a charged point particle, the additional gravitational energy density renders the total energy finite. In addition, the self coupling results in a non-Newtonian form for the gravitational field of a massive body, giving rise to perihelion precession. The amount of precession depends on the precise form of the relativistic force law, but for theoretically reasonable choices it gives the same order of magnitude as the General Relativistic value. Finally, I comment on the form that a fully relativistic version (in particular, including time dependence) of this model should take, and rediscover, among other possibilities, the Einstein-Hilbert action. Work Supported in part by a grant from the Eberly Science Fund – Penn State Fayette.

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Date submitted: 09 Jan 2009 Electronic form version 1.4