The motion of extended bodies in general relativity

Stage topic Description

The trajectory of an orbiting spacecraft can be changed with internal motion. In general relativity it has been shown within the ACT that the trajectory around a central mass of an oscillating two-body system can differ significantly from the trajectory of a single-body system (for a circular trajectory) [1]. In the model used the implementation of the oscillating constraint between the two bodies is coordinate dependant, which leads to different dynamical behaviours for different implementation of the constraint. The goal of this stage is to use Dixon's theory [2], which is coordinate independent, to implement an oscillating constraint. The candidate will study the influence of the varying mass multipoles of a test mass on its trajectory and compare the results to the case of a point mass. A study has already been done for a constant mass quadrupole in a Schwarzschild spacetime [3,4]. The resulting model of the stage should be applicable to any varying mass multipole rotating around a central mass, such as a vibrating crystal or nanoparticle rotating around a central mass.

Candidate's tasks

- apply Dixon's theory for varying mass multipoles in a Schwarzschild spacetime and study their influence on the trajectory of the extended body, compare the results to those of a point mass;
- give an estimate of the effect on a vibrating crystal or nanoparticle rotating around a central mass.

The ideal candidate

Good background in general relativity
Numerical analysis competences

References

[1] L. Bergamin, P. Delva and A. Hees, Vibrating systems in Schwarzschild spacetime: towards new experiments in gravitation?, *Classical and Quantum Gravity*, 26, 18
[2] Dixon, W. G., Dynamics of extended bodies in general relativity: III. Equations of motion, 1974, Royal Society of London Philosophical Transactions Series A, 277, 59
[3] Bini, D., Cherubini, C., Filippi, S., and Geralico, A, Extended bodies with quadrupole moment interacting with gravitational monopoles: reciprocity relations, 2009, General Relativity and Gravitation, 54
[4] Bini, D., Fortini, P., Geralico, A, and Ortolan, A, Quadrupole effects on the motion of extended bodies in Schwarzschild spacetime, 2008, Classical and Quantum Gravity, 25