

MSc Defense

Peter Zimmerman

Date: Monday August 22nd, 2011

Time: 2:00p.m.

Location: Science Complex 1511

Title: Self-force on a point particle falling in a Reissner-Nordstrom black hole

Abstract: I investigate the electromagnetic self-force on a point charge falling radially into a Reissner-Nordstrom black hole. The self-force results from an interaction between a small piece of the radiated field emitted by the particle in its past history that has backscattered off the spacetime curvature and returns to the particle at its current location. To compute the radiation field, I first perform a multipole decomposition of the relevant components of the electromagnetic field strength tensor. I then numerically calculate the field multipoles mode-by-mode using the second-order characteristic scheme of Lousto and Price. The radiation field constructed from the summed modes still contains a local contribution that is formally divergent at the location of the particle. To split the field into divergent and non-divergent pieces, I adopt the Detweiler-Whiting singular-regular decomposition. A regularization mechanism is required to remove the singular piece of the full field in order to obtain the field responsible for the self-force. To regularize the field, I implement the mode-sum method introduced by Barack and Ori. This procedure involves computing the multipole coefficients of the singular field, which leads to the regularization parameters A, B, C, and D. The regularization parameters involve acceleration terms resulting from the static electromagnetic field sourced by the charged black hole. This is the first self-force computation to incorporate acceleration terms into the regularization parameters. I compute the self-force on a particle starting from rest for a range of charge values of the black hole. This data is used to examine how the self-force behaves as a function of charge. I find that the self-force is repulsive and increases with the black hole's charge.

Advisor: Eric Poisson

Chair: Leonid Brown

Examining Committee: Eric Poisson, Luis Lehner, Leonid Brown, Robert Wickham