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An updated Effective-One-Body model for non-precessing binary black holes

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The Effective-one-body (EOB) formalism, which describes semi-analytically the dynamics of coalescing binary black holes and the associated gravitational radiation, has undergone several refinements since its original formulation, gradually extending the region in parameter space over which the model provides highly accurate predictions for the gravitational waveforms. As a result, EOB waveforms have played a central role in the detection and subsequent analysis of the first gravitational-wave observation announced earlier this year. In this talk, I will present an updated version of the EOB model calibrated to a set of recently produced numerical-relativity waveforms and a description of multipolar waveform modes beyond the dominant quadrupole mode for non-precessing binary black holes.

Interaction between bosonic dark matter and stars

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Searches for dark matter imprints are one of the most active areas of current research. We focus here on light fields with mass mB, such as axions and axionlike candidates. Using perturbative techniques and full-blown nonlinear numerical relativity methods, we show the following. (i) Dark matter can pile up in the center of stars, leading to configurations and geometries oscillating with a frequency that is a multiple of $f = 2.510^14(mB*c^2/eV)$ Hz. These configurations are stable throughout most of the parameter space, and arise out of credible mechanisms for dark-matter capture. We also show that (ii) collapse of the host star to a black hole is avoided by efficient gravitational cooling mechanisms.

Master equation solutions in the linear regime of characteristic formulation of general relativity

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From the field equations in the linear regime of the characteristic formulation of general relativity, Bishop, for a Schwarzschildś background, and Madler, for a Minkowskiś background, were able to show that it is possible to derive a fourth order ordinary differential equation, called master equation, for the J metric variable of the Bondi-Sachs metric. Once
beta, another Bondi-Sachs potential, is obtained from the field equations, and J is obtained from the master equation, the other metric variables are solved integrating directly the rest of the field equations. In the past, the master equation was

solved for the first multipolar terms, for both the Minkowskiś and Schwarzschildś backgrounds. Also, Madler recently reported a generalization of the exact solutions to the linearised field equations when a Minkowskiś background is considered, expressing the master equation family of solutions for the vacuum in terms of Besselś functions of the first and the second kind. Here, we report new solutions to the master equation for any multipolar moment l, with and without matter sources in terms only of the first kind Besselś functions for the Minkowski, and in terms of the Confluent Heunś functions (Generalised Hypergeometric) for radiative (nonradiative) case in the Schwarzschildś background. We particularize our families of solutions for the known cases for l =2 reported previously in the literature and find complete agreement, showing the robustness of our results.

Progress on the numerical calculation of the self-force in the time domain.

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Extreme Mass Ratio Inspirals (EMRIś), the inspiral of a small compact object into a massive black hole, promises to be one of the main sources for future space based gravitational wave detectors. In order to model such systems, it is necessary to take into account the interaction of the small object with its own back scattered field (the self-force problem).

The effective source approach to the self-force problem has proven to be a valuable tool in numerical calculations of the self-force in the time domaain. The first self-consistent evolutions of a scalar charge in orbit around a Schwarzschild black hole were performed a few years ago using a finite difference code on a full multi-patch 3D grid. The main limitation of those simulations was the limited accuracy caused by the non-smoothness of the effective source across the particle.

In this talk I will present the ideas and main ingredients of a new code based on the Discontinuous Galerkin method that overcomes the accuracy issue and present some new results.
