Kostas Kokkotas
Aristotle University of Thessaloniki, Greece

Magnetized Stars, their relation to SGRs and to Gravitational Waves

Abstract

Recent observations of quasi-periodic oscillations following the giant flares in soft gamma-ray repeaters (SGRs) suggest a close coupling between the seismic motion of the crust and the oscillation modes of strongly magnetized star (magnetar). The theory of SGRs will be briefly described and the connection between the observed X-ray spectra and the crust oscillations will be discussed . Finally, it will be addressed the efficiency in gravitational waves of such processes and we will conclude with a list of open issues.

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Kostas Glampedakis
SISSA, Trieste, Italy

Neutron star asteroseismology via magnetar flares

Abstract

The recent discovery of quasi-periodic oscillations during giant flares in some Soft-Gamma-Ray-Repeaters may constitute the first detection of neutron star oscillation modes. If true, these observations could serve as a probe of neutron star structure. In this talk I will provide an up-to-date review of theoretical work on this topic.

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Stefania Marassi
Università degli Studi di Roma "La Sapienza", Italy

A new approach to the study of quasi-normal modes of rotating stars

Abstract

While gravitational waves asteroseismology for non-rotating stars is well developed, the understanding of oscillations of fastly rotating stars is still an open issue. We propose a new approach to study quasi-normal modes of fastly rotating stars in two dimensions: we solve the equations that describe stellar perturbations on a non-spherical background in two-dimension and in the frequency domain, using an appropriate spectral decomposition. We shall briefly illustrate the general method and we shall show the results we have obtained for slowly rotating stars, as a first test of our approach.

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Roberto De Pietri
Università di Parma, Italy
INFN, Parma, Italy

Bar-mode instability in full GR

Abstract

The non-axisymmetric dynamical instability of rapidly rotating compact object are a very effective way of generating strongly quadrupolar deformed stellar configuration from axi-symmetric one and may play a significant role in the enhancement of the gravitational wave signal emitted during stellar core collapse. I present results of simulations in full General Relativity of the dynamical instability against bar-mode deformations of rapidly and differentially rotating neutron stars. Because of the high accuracy and long-term stability of our code we are able to study the BAR-mode dynamical instability of rapidly rotating compact objects without the introduction of perturbations in the initial axisymmetric configuration and to accurately determine the threshold for the development of the instability as well as the emitted gravitational wave signal. We also find that the instability is non persistent.

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Alessandro Nagar
Politecnico di Torino, Italy

Binary black hole merger in the extreme mass ratio limit: comparison between analytical and numerical results

Abstract

We discuss the transition from quasi-circular inspiral to plunge of a system of two nonrotating black holes of masses m_1 and m_2 in the extreme mass ratio limit $m_1 m_2 \ll (m_1 + m_2)^2$. In the spirit of the Effective One Body (EOB) approach to the general relativistic dynamics of binary systems, the dynamics of the two black hole system is represented in terms of an effective particle of mass $\mu \equiv m_1 m_2/(m_1 + m_2)$ moving in a (quasi-)Schwarzschild background of mass $M \equiv m_1 + m_2$ and subjected to an $\mathcal{O}(\mu)$ radiation reaction force defined by Padé resumming high-order Post-Newtonian results. We then complete this approach by numerically computing, à la Regge-Wheeler-Zerilli, the gravitational radiation emitted by such a particle. Several tests of the numerical procedure are presented. We focus on gravitational waveforms and the related energy and angular momentum losses. We conclude by also showing some (preliminary) comparisons between EOB-type predictions and Numerical Relativity results.

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Mariafelicia De Laurentis
Politecnico di Torino, Italy

GW bursts from gravitational capture in Kerr black holes

Abstract

Celestial bodies captured by a Kerr black hole can, with equal probability, be corotating or counter-rotating with respect to the black hole. When the initial orbital angular momentum is opposite to that of the hole the infall trajectory presents, while apporoaching or entering the ergosphere, an inversion point, where the orbital angular momentum of the body changes sign. This is true assuming the angular momentum of the hole to be much bigger than the one of the captured object. This "knee" corresponds to a little burst of emitted gravitational waves. The features of this burst are exposed and discussed.

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Francesco Pannarale Greco
Università degli Studi di Roma "La Sapienza", Italy

Tidal Effects in Binary Coalescence

Abstract

We compute the gravitational signal emitted when a neutron star moves around a Schwarzschild black hole on an inspiralling circular orbit. Tidal interactions in the binary are taken into account by means of the affine model approach, in which the NS is viewed as a deformable ellipsoid. We compare the orbital and the tidal contributions to the signal, assuming that the star moves in a safe region where, although very close to the black hole, it has not yet been disrupted. Sharp peaks corresponding to the excitation of the star's non radial oscillation modes are present in the tidal signal. We find that during the last revolutions the star is a non-spherical oscillating object in contrast to the initial conditions that are usually adopted in full GR calculations: this model may be a tool to estimate more reliable initial conditions for numerical relativity simulations of merging processes.

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Sebastiano Bernuzzi
Università di Parma, Italy

Gaussian pulse excitation of compact objects' spacetime modes

Abstract

We discuss, in a perturbative regime, the scattering of Gaussian pulses of odd-parity gravitational radiation off a non-rotating relativistic star and a Schwarzschild black hole. We focus on the excitation of the w-modes of the star as a function of the width σ of the pulse and we contrast it with the outcome of a Schwarzschild black hole of the same mass. For sufficiently large values of σ the backscattered signal is dominated by the tail of the Regge-Wheeler potential, the quasi-normal modes are not excited and the nature of the central object cannot be established. On the other hand, for sufficiently narrow values of σ, the waveforms are dominated by characteristic spacetime modes.

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Enrico Barausse
SISSA, Trieste, Italy

Extreme mass ratio inspirals in non-pure Kerr spacetimes

Abstract

We study the emission of gravitational waves by stellar mass black holes moving in highly-accurate, numerically-generated spacetimes containing a supermassive black hole and a self-gravitating torus with comparable mass and spin. In order to maximize their impact on the produced waveforms, we have considered tori that are compact, massive and close to the central black hole, investigating under what conditions the LISA experiment could detect their presence.

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