Andrea Viceré
Università degli Studi di Urbino, Italy
INFN, Firenze, Italy

Physics with the large scale gravitational wave detectors

Abstract

The Virgo detector is about to start a science run, which will be in coincidence with LSC detectors taking science data. After presenting a brief status of Virgo, I will review the established results on gravitational wave searches. I will then discuss the prospects for improvement in the short/medium term offered also by the agreement on data sharing between the LIGO Scientific Collaboration and the Virgo Collaboration recently signed, and in the longer term due to the program of detector upgrades.

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Bruno Giacomazzo
Albert Einstein Institute, Golm, Germany

Gravitational waves emission from the collapse of differentially rotating neutron stars

Abstract

We present new results from the collapse of strongly differentially rotating neutron-stars. We consider models with different values of J/M^2, where J is the angular momentum and M the mass of the system. We have found that only the collapse of "Sub-Kerr" models ($J/M^2 < 1$) produces a black-hole and that the dynamics looks similar to what already observed for uniformly rotating stars. We have also studied the final fate of a "Supra-Kerr" model ($J/M^2 > 1$) observing a very different dynamic with the development of non-axisymmetric instabilities. For each case we also present the gravitational wave signal emitted from these sources which has revealed to be much higher than what obtained with the collapse of uniformly rotating NS.

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Ernazar Abdikamalov
SISSA, Trieste, Italy

Calculations of phase-transition induced by collapse of neutron stars and related gravitational wave emission

Abstract

We are carrying out numerical computations of the collapse of rapidly rotating neutron stars caused by a phase transition from nuclear matter to quark matter in the stellar core. Modelling the gravitational-wave emission with an improved quadrupole approximation, it has been found that

the spectrum of gravitational waves produced by the collapse is dominated by the fundamental quasi-radial and quadrupole oscillation modes of the star.

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Omar Benhar
INFN, Roma, Italy

Constraining the EOS of quark matter with gravitational wave observations

Abstract

We discuss the possibility that detection of gravitational waves emitted by a compact star may provide information on the nature of the source and constraints on the dynamical model employed to obtain the EOS.

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Leonardo Gualtieri
Università degli Studi di Roma “La Sapienza”, Italy

Unstable oscillations in Proto-Neutron Stars

Abstract

During the first seconds of life of a proto-neutron star, convective instability sets in. This corresponds, at a linear level, to the appearance of unstable g-modes. This instability could be crucial in determining the subsequent evolution of the star, and its gravitational wave emission. We have studied, with a perturbative approach, the unstable oscillations of proto-neutron stars, finding out how their characteristic growth time evolves, and we have investigated the possibility of coupling between these modes and stable oscillatory g-modes.

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Francesco Haardt
Università dell'Insubria, Como, Italy

The imprint of massive black hole formation models on the LISA data stream

Abstract

The formation, merging, and accretion history of massive black holes along the hierarchical build–up of cosmic structures leaves a unique imprint on the background of gravitational waves at mHz frequencies. I study, by means of dedicated simulations of black hole build–up, the possibility of constraining different models of black hole cosmic evolution using future gravitational wave space–borne missions, such as LISA.

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Alessandro Melchiorri
Università degli Studi di Roma “La Sapienza”, Italy

WMAP-normalized Inflationary Model Predictions and the Search for Primordial Gravitational Waves with Direct Detection Experiments

Abstract

In addition to density perturbations, inflationary models of the early universe generally predict a stochastic background of gravitational waves or tensor fluctuations. By making use of the inflationary flow approach for single field models and fitting the models with Monte-Carlo techniques to cosmic microwave background (CMB) data from the *Wilkinson Microwave Anisotropy Probe* (WMAP), we discuss the expected properties of the gravitational wave background from inflation at scales corresponding to direct detection experiments with laser interferometers in space. We complement the Monte-Carlo numerical calculations by including predictions expected under several classes of analytical inflationary models. We find that an improved version of *Big Bang Observer* (BBO-grand) can be used to detect a gravitational wave background at 0.1 Hz with a corresponding CMB tensor-to-scalar ratio above 10^{-4}. Even if the CMB tensor-to-scalar ratio were to be above 10^{-2}, we suggest that BBO-grand will be useful to study inflationary models as the standard version of BBO, with a sensitivity to a stochastic gravitational wave background $\Omega_{\rm GW}h^2 > 10^{-17}$, will only allow a marginal detection of the amplitude while leaving the tensor spectral index at 0.1 Hz unconstrained. We also discuss the extent to which CMB measurements can be used to predict the gravitational wave background amplitude in a direct detection experiment and how any measurement of the amplitude and the spectral tilt of the gravitational wave background at direct detection frequencies together with the CMB tensor-to-scalar ratio can be used to establish slow-roll inflation.

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Gaetano Vilasi
Università degli Studi di Salerno, Italy

Non-linear gravitational waves and their polarization

Abstract

Solutions of vacuum Einstein's field equations, for the class of pseudo-Riemannian 4-metrics admitting a non Abelian 2-dimensional Lie algebra G of Killing fields, are explicitly described. A subclass of these metrics represent nonlinear gravitational waves obeying to two nonlinear superposition laws. The energy and the polarization of this family of waves are explicitly evaluated and their sources are also described.

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Andrea Passamonti
Aristotle University of Thessaloniki, Greece

Gravitational Waves from Nonlinear Oscillations of Neutron Stars

Abstract

Oscillations of neutron stars can arise during strongly nonlinear phases of stellar evolution, such as during the post-bounce phase in core collapse of massive stars or during the merger of compact binary systems. Nonlinear interactions between various oscillation modes can saturate or enhance the amplitude of pulsations and generate an interesting gravitational wave signal. Nonlinear features are present in the gravitational wave spectrum of pulsating neutron stars, and for galactic sources they could be detectable by the second generation of gravitational wave detectors.

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Marco Bruni
University of Portsmouth, UK
Università degli Studi di Roma “Tor Vergata”, Italy

The generated cosmological gravitational wave background

Abstract

I discuss the formalism to compute the cosmological gravitational wave background generated at second order by the self-coupling of first order scalar perturbations. As an example, I present results on the generation of gravitational waves by linear perturbation in the radiation dominated era.

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