Emanuele Berti - curriculum vitae - 03/25/2008

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References

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Current Position

Starting 8/27/2007	**NASA ORAU Senior Post-doctoral Fellow**, Jet Propulsion Laboratory, California Institute of Technology, Pasadena, California (USA).

Previous Positions

9/1/2006–8/31/2007	**Research Scientist**, McDonnell Center for the Space Sciences, Department of Physics, Washington University, Saint Louis, Missouri (USA). Position supported by NASA Grant NNG06GI60 (*General Relativity, Inspiralling Compact Binaries and LISA*) awarded to Washington University in Saint Louis.
10/1/2003–8/31/2006	**Post-doctoral position** with Prof. Clifford M. Will. I spent the first year of my appointment in the Groupe de Cosmologie et Gravitation (GRϵCO), Institut d'Astrophysique de Paris before moving to Saint Louis (9/1/2004).
11/11/2001–9/30/2003	**Post-doctoral position** at the Aristotle University of Thessaloniki (local coordinator: Prof. Kostas D. Kokkotas) within the European Network on *Gravitational Wave Astronomy*. Among other activities, I attended the Advanced EU Network School *Sources of Gravitational Waves* in Trieste, Italy (9/15/2003–9/26/2003).

Education

1/28/2002	**PhD in Astrophysics**, University of Rome *La Sapienza*. Supervisor: Prof. Valeria Ferrari. During my PhD I attended an Advanced School on *The Standard Model and QCD, Gravitational Waves and Cosmology* in Parma, Italy (9/4/2000–9/15/2000).
10/30/1998	**Laurea degree in Theoretical Physics** (Laurea in Fisica), University of Rome *La Sapienza*, Full marks *cum laude* (110/110 e lode). Supervisors: Prof. Valeria Ferrari, Dr. Omar Benhar.
1993	**High school diploma** (maturità classica), Liceo Classico M. Buratti (Viterbo), Full marks (60/60). Best high school student award (*Premio Rotary Viterbo Scuola*).

Other Activities and Awards

1999	Awarded an INFN grant to recent graduates (Laurea degree). First classified in Theoretical Physics.
December 1998–June 1999	Contract with the Italian Encyclopedia *Treccani* as a scientific reviewer for papers on neural networks to be published in a monograph on Biology (*Frontiere della Vita*) whose Advisory Board included four Nobel prize winners.

Computing Knowledge

Programming languages:	Fortran, C, HTML
Scientific software:	Maple, Mathematica, MATLAB, Gnuplot, XMGrace, Origin, IDL (among others)
Operating systems:	UNIX, Linux, Windows, Mac OS X

Research interests

I am mainly interested in experimental verifications of classical general relativity, the modelling of compact objects, and astrophysical sources of gravitational waves. Over the years I acquired a unique blend of skills by working on perturbation theory of stars and black holes, post-Newtonian theory, numerical relativity, high-energy and nuclear physics, gravitational-wave data-analysis and astrophysics.

Numbers in square brackets refer to my publication list.

Perturbation theory of stars and black holes

I have considerable experience on perturbation theory of stars and black holes. I derived analytically (and integrated numerically) the perturbed Einstein equations for stars and black holes using different formalisms (metric-based, Newman-Penrose) and gauges: see in particular Refs. [T2, A1-A7]. Perturbation theory can be applied to many astrophysical scenarios involving gravitational-wave emission. For example, it is a key tool to study the properties of extreme-mass ratio inspirals, which are one of the target sources of the planned space-based interferometer LISA [A33]. Black-hole perturbation theory is also useful in non-astrophysical scenarios with interesting, and largely unexplored, theoretical and phenomenological applications in other fields. Some examples include (1) higher dimensional black holes, such as those that may be produced at the Large Hadron Collider according to some TeV-gravity scenarios, (2) brane-world black holes, (3) black holes in non-asymptotically flat (de Sitter/anti-de Sitter) spacetimes and (4) analogue black holes. From a theoretical point of view, I have used perturbation theory to study the stability of brane-world black holes [A10] and to compute the gravitational-wave emission of mini-black holes in TeV-gravity scenarios [A12, A19]. I have also applied perturbation theory to analogue black holes [A16, B5]. These studies can deepen our understanding of the relation between classical general relativity and quantum physics, and possibly lead to observational verifications of rotational superradiance.

Quasinormal modes (QNMs) of stars and black holes

I am an expert in the calculation of QNMs of stars (either non-rotating or slowly rotating) and black holes. I learned and numerically implemented various techniques: the so-called "resonance method," Leaver's continued fraction method, WKB techniques and integrations in the complex-frequency plane. Some of these methods can be extended to study QNMs of rapidly rotating stars and the associated gravitational-wave instabilities. According to recent conjectures, QNMs may also be related to the quantum properties of black holes. I have investigated this problem in a series of papers, showing that the proposed conjectures do not seem to apply to charged (Reissner-Nordström) or rotating (Kerr) black holes (Refs. [A9], [A11], [A14]; for a short review see [B4]). More recently I explored the QNM spectrum of charged *and* rotating (Kerr-Newman) black holes under various approximations for the coupling of electromagnetic and gravitational perturbations [A18], and the possibility that QNMs might be related to thermodynamic phase transitions of black holes [A32]. QNMs are also of interest in the context of the AdS/CFT conjecture. The reason is that the damping times of black-hole oscillations in anti-de Sitter spacetimes (which can be obtained by simple techniques) give thermalization timescales in the corresponding conformal field theories, which are very difficult to compute [A8].

Structure and instabilities of rotating relativistic stars

When I was in Greece I worked with Kostas Kokkotas and Nick Stergioulas, who are both world experts in the structure and instabilities of rotating relativistic stars. I used Nick's publicly available `RNS` code to numerically compute fast-rotating relativistic stellar models. Together we explored the possibility of approximating the vacuum spacetime surrounding a fast rotating neutron star by certain analytical solutions of the Einstein equations [A13]. Later, with Frances White, Mina Maniopoulou and Marco Bruni, we built on that work to explore the range of validity of the Hartle-Thorne slow-rotation approximation and to give an invariant characterization, based on the Newman-Penrose formalism, of neutron-star spacetimes [A15]. The main purpose of this research is the development of semi-analytical approximations to (1) compute gravitational-wave emission from rapidly rotating compact stars, (2) study the related Chandrasekhar-Friedman-Schutz instabilities, (3) deal with other astrophysical phenomena (e.g. accretion) occurring in their vicinities.

Nuclear physics and the equation of state of neutron stars

One of my supervisors as an undergraduate was nuclear physicist Omar Benhar. With Benhar and other students and post-docs we studied the effect of "realistic," nuclear physics-based models for the equation of state of matter at extreme densities on the gravitational radiation from oscillating neutron stars. I have a working knowledge of many-body Hamiltonian and mean-field theory models (see Refs. [T1, A1] and also [T2], [A4–A7], [A13], [A15]). My codes on the structure and oscillations of compact stars can easily be adapted to incorporate exotic equations of state, including e.g. the effects of color superconductivity or of quark matter in the stellar interior. Gravitational-wave detection by LIGO or (according to recent proposals) even upper limits on the amplitude of the waves could give interesting information on the state of matter at extreme densities.

Gravitational waves from binary inspiral and tests of alternative theories of gravity

One of my major areas of interest is the study of gravitational-wave templates for matched-filtering detection of inspiralling compact binaries. In Paris, with Alessandra Buonanno and Clifford Will we studied parameter estimation for the main observational targets of the planned space-based interferometer LISA: spinning binaries of massive black holes and stellar-mass objects inspiralling into intermediate-mass black holes. We also considered how present design choices will affect the bounds that LISA could place on alternative theories of gravity (such as theories of the scalar-tensor type, and theories in which the graviton has non-zero mass). I wrote a numerical code to perform fast Monte-Carlo simulations of a population of binaries randomly oriented and distributed across the sky, taking into account the orbital motion of LISA. My code turned out to be much faster than similar codes by other researchers, and it is a useful tool to simulate LISA's response to different theoretical waveforms and to improve the design of the instrument. These are two of the main goals of my present research in Curt Cutler's group at the Jet Propulsion Laboratory. My work with Buonanno and Will is described in detail in Ref. [A17]; a shorter account was included in the Classical and Quantum Gravity annual highlights collection for 2005/2006 [B6].

Massive black-hole binaries to be observed by LISA, depending on their formation mechanism, could have significant eccentricity [B8]. Motivated by this possibility, with Clifford Will and Nicolás Yunes we are studying measurement errors in the detection of gravitational waves from eccentric binaries [P2]. More in general, I am working to implement more realistic models of the inspiral waveforms in my parameter estimation code (e.g. allowing for spin-precession effects and post-Newtonian amplitude corrections).

Analytical studies of numerical simulations of compact binary inspiral

With Vitor Cardoso and the Jena numerical relativity group I recently carried out an in-depth analysis of the inspiral, merger and ringdown of unequal mass black-hole binaries [A26, A27]. We analyzed a catalogue of numerical simulations for seven different values of the mass ratio (from $q = M_2/M_1 = 1$ to $q = 4$), comparing numerical waveforms with the post-Newtonian approximation. We found that the post-Newtonian equations predict remarkably well the relation between the wave amplitude and the orbital frequency for each multipolar component of the radiation in the inspiral phase, and that the convergence of the post-Newtonian series to the numerical results is non-monotonic. We studied the total energy emitted in the merger phase and the spin of the final black hole, finding that they scale like η^2 and η respectively, where $\eta = q/(1+q)^2$ is the so-called symmetric mass ratio. By looking at the multipolar distribution of the radiation we found that odd-m multipoles are suppressed in the equal mass limit, and that higher multipoles carry a larger fraction of the total energy as q increases. We also showed that ringdown fits can be used to obtain precise estimates of the mass and spin of the final black hole, which are in remarkable agreement with energy and angular momentum balance calculations. We are now extending these studies to eccentric and spinning binaries [A30, A33, B10, P3].

Our main purpose is to gain a deeper analytical understanding of the radiation emitted by black-hole binaries. This understanding will be useful to create a "data analysis pipeline" connecting analytical calculations of the early inspiral and late ringdown phases with numerical simulations, and especially with gravitational-wave searches in actual detector data. An important goal of this research is to minimize computational requirements in building optimal template banks for gravitational-wave detection. After detection, an improved understanding of the waves' properties will be crucial for gravitational-wave astronomy, e.g. to reduce the errors in parameter estimation of merging black holes observed by LIGO and LISA. In this context, with Curt Cutler and Michele Vallisneri we plan to use advanced waveform models to estimate the relative magnitude of systematic and statistical errors in gravitational-wave observations. The idea is to explore the possibility that, given the high signal-to-noise ratio of LISA, our limited knowledge of the theoretical waveforms may result in systematic errors being comparable to statistical errors [P1].

With Sai Iyer and Clifford Will we have studied post-Newtonian diagnostic tools for simulations of compact binaries in numerical relativity [A24, A29]. We explored how the predictions of numerical relativity can be reproduced by post-Newtonian expansions when the latter are supplemented by phenomenological terms to properly take into account important physical effects (tidal deformations, rotation of the binary members, orbital eccentricity and so on). This semi-phenomenological approach can help the numerical relativity community to understand the physical content (and possible invalid approximations) of their simulations. A challenge for the post-Newtonian approximation comes from intermediate-mass ratio inspirals of intermediate-mass black holes into supermassive black holes (to be observed by LISA), or of stellar-mass compact objects into intermediate-mass black holes (to be observed by Earth-based interferometers). For these systems the mass ratio is (1) too low for the post-Newtonian approximation to converge quickly, (2) too large to use black-hole perturbation theory, (3) small enough to be a significant challenge for present numerical simulations of black-hole binaries. I am interested in the development of hybrid data-analysis tools taking the best from all three approaches.

Numerical simulations of black-hole binaries are a blossoming field, and my work is at the forefront of this research. Last February I helped organize a successful workshop on these topics (*NR meets 3PN*) in Saint Louis. Our research with Uli Sperhake and the Jena group has been selected among the highlights of the Amaldi 7 conference [B10]. I am now starting a collaboration with the Caltech numerical relativity group, that produced the most accurate simulations of inspiralling black-hole binaries to date. Furthermore, I have recently been asked to give an invited talk on my work at the April 2008 APS meeting in Saint Louis, and to write a review article on this subject with Manuela Campanelli [P9].

Detection of black-hole ringdown

The so-called "ringdown" waves emitted by newly born, oscillating supermassive black holes will be detected by LISA with large signal-to-noise ratio throughout the whole observable Universe. With Vitor Cardoso and Clifford Will, we studied in detail LISA's capabilities to measure the quasinormal ringing of massive black holes [A21]. We developed a more rigorous treatment of parameter estimation from ringdown waves, including more than one QNM frequency in the expansion of the gravitational waveform. This problem is theoretically and experimentally relevant: if a gravitational-wave detector can be used to measure at least two QNM frequencies, it will provide a direct experimental proof of the no-hair theorem of general relativity. We have recently extended our analysis to Earth-based detectors such as LIGO, Advanced LIGO and Virgo [A28]. These studies require a preliminary assessment of the level of excitation of different QNMs [B7], a topic that I have explored analyzing waveforms produced by numerical relativity codes [A25, A26, A27] and using analytical methods [A22, A23].

Cosmology and the merger history of massive black holes with LISA

LISA will detect the inspiral of massive black-hole binaries with large signal-to-noise ratio out to cosmological distances. Massive black holes are observed in the bulges of nearly all local galaxies, and galaxies are thought to form by repeated mergers of the associated dark-matter halos. Since massive black-hole binaries are "clean" systems, they can be thought of as standard candles (or "standard sirens"), and their observation in gravitational waves can be used to study structure formation in the early universe. I am very interested in combining numerical relativity waveforms and the parameter estimation tools that I developed for inspiral and ringdown to understand quantitatively how LISA could be used to explore the merger history of massive black holes [B6, B8]. If measurements of the luminosity distance and source location are accurate enough, these observations could be used to place constraints on cosmological scenarios and/or on alternative theories of gravity. Together with Marta Volonteri we are now exploring the implications of merger simulations in numerical relativity on the cosmological evolution of black-hole spins [A31, P6]. We are also leading an effort to explore the scientific potential of LISA within the recently formed LISA Science Performance Evaluation taskforce [P6]. More details are available on the taskforce wiki:

`http://www.tapir.caltech.edu/dokuwiki/lisape:home`

As a side project in cosmology, and to learn the basics of galactic dynamics, I recently collaborated with Ram Cowsik and his students in Saint Louis on the theoretical interpretation of recent observations of the Fornax dwarf galaxy. The idea is to explain observations by considering the effects of dynamical friction within a two-component King-Poisson model describing both ordinary matter and dark matter [P7].

I am interested in broadening my knowledge of general relativity, astrophysics and high-energy physics in any possible way. I like to work on astrophysical applications of general relativity, but also on more theoretically-oriented topics. As a rule of thumb, I prefer to work on problems in relativity that are subject to experimental tests, mainly (though not only) through gravitational-wave detectors.

Publications

Refereed Journals

A1. O. Benhar, E. Berti, V. Ferrari, *The imprint of the equation of state on the axial w-modes of oscillating neutron stars*, Mon. Not. R. Astron. Soc. **310**, 797 (1999). gr-qc/9901037
A2. V. Ferrari, M. D'Andrea, E. Berti, *Gravitational waves emitted by extrasolar planetary systems*, Int. J. of Mod. Phys. D **9**, n. 5, 495 (2000). astro-ph/0001463
A3. E. Berti, V. Ferrari, *Excitation of g-modes of solar type stars by an orbiting companion*, Phys. Rev. D **63**, 064031 (2001). astro-ph/0011364
A4. L. Gualtieri, E. Berti, J.A. Pons, G. Miniutti, V. Ferrari, *Gravitational signals emitted by a point mass orbiting a neutron star: a perturbative approach*, Phys. Rev. D **64**, 104007 (2001). gr-qc/0107046
A5. J.A. Pons, E. Berti, L. Gualtieri, G. Miniutti, V. Ferrari, *Gravitational signals emitted by a point mass orbiting a neutron star: effects of stellar structure*, Phys. Rev. D. **65**, 104021 (2002). gr-qc/0111104
A6. E. Berti, J.A. Pons, L. Gualtieri, G. Miniutti, V. Ferrari, *Are post-Newtonian templates faithful and effectual in detecting gravitational signals from neutron star binaries?*, Phys. Rev. D **66**, 064013 (2002). gr-qc/0208011
A7. G. Miniutti, J.A. Pons, E. Berti, L. Gualtieri, V. Ferrari, *Non-radial oscillation modes as a probe of density discontinuities in neutron stars*, Mon. Not. R. Astron. Soc. **338**, 389 (2003). astro-ph/0206142
A8. E. Berti, K.D. Kokkotas, *Quasinormal modes of Reissner-Nordström anti-de Sitter black holes: scalar, electromagnetic and gravitational perturbations*, Phys. Rev. D **67**, 064020 (2003). gr-qc/0301052
A9. E. Berti, K.D. Kokkotas, *Asymptotic quasinormal modes of Reissner-Nordström and Kerr black holes*, Phys. Rev. D **68**, 044027 (2003). hep-th/0303029
A10. E. Berti, K.D. Kokkotas, E. Papantonopoulos, *Stability of five-dimensional rotating black holes projected on the brane*, Phys. Rev. D **68**, 064020 (2003). gr-qc/0306106
A11. E. Berti, V. Cardoso, K.D. Kokkotas, H. Onozawa, *Highly damped quasinormal modes of Kerr black holes*, Phys. Rev. D **68**, 124018 (2003). hep-th/0307013
A12. E. Berti, M. Cavagliá, L. Gualtieri, *Gravitational energy loss in high energy particle collisions: ultrarelativistic plunge into a multidimensional black hole*, Phys. Rev. D **69**, 124011 (2004). hep-th/0309203
A13. E. Berti, N. Stergioulas, *Approximate matching of analytic and numerical solutions for rapidly rotating neutron stars*, Mon. Not. R. Astron. Soc. **350**, 1416 (2004). gr-qc/0310061
A14. E. Berti, V. Cardoso, S. Yoshida, *Highly damped quasinormal modes of Kerr black holes: A complete numerical investigation*, Phys. Rev. D **69**, 124018 (2004). gr-qc/0401052
A15. E. Berti, F. White, A. Maniopoulou, M. Bruni, *Rotating neutron stars: an invariant comparison of approximate and numerical spacetime models*, Mon. Not. R. Astron. Soc. **358**, 923 (2005). gr-qc/0405146
A16. E. Berti, V. Cardoso, J. P. S. Lemos, *Quasinormal modes and classical wave propagation in analogue black holes*, Phys. Rev. D **70**, 124006 (2004). gr-qc/0408099
A17. E. Berti, A. Buonanno, C. M. Will, *Estimating spinning binary parameters and testing alternative theories of gravity with LISA*, Phys. Rev. D **71**, 084025 (2005). gr-qc/0411129
A18. E. Berti, K. D. Kokkotas, *Quasinormal modes of Kerr-Newman black holes: coupling of electromagnetic and gravitational perturbations*, Phys. Rev. D **71**, 124008 (2005). gr-qc/0502065
A19. V. Cardoso, E. Berti, M. Cavagliá, *What we (don't) know about black hole formation from high-energy collisions*, Class. Quant. Grav. **22**, L61 (2005). gr-qc/0505125
A20. E. Berti, V. Cardoso, M. Casals, *Eigenfunctions and eigenvalues of spin-weighted spheroidal harmonics in four and higher dimensions*, Phys. Rev. D. **73**, 024013 (2006); Erratum: Phys. Rev. D **73**, 109902(E) (2006). gr-qc/0511111
A21. E. Berti, V. Cardoso, C. M. Will, *On gravitational-wave spectroscopy of massive black holes with the space interferometer LISA*, Phys. Rev. D. **73**, 064030 (2006). gr-qc/0512160
A22. E. Berti, V. Cardoso, *Supermassive black holes or boson stars? Hair counting with gravitational-wave detectors*, Int. J. of Mod. Phys. D **15**, n. 12, 2209 (2006). gr-qc/0605101
This essay received an Honorable Mention in the Gravity Research Foundation Essay Competition, 2006.
A23. E. Berti, V. Cardoso, *Quasinormal ringing of Kerr black holes: The excitation factors*, Phys. Rev. D **74**, 104020 (2006). gr-qc/0605118
A24. E. Berti, S. Iyer, C. M. Will, *Eccentricity content of binary black hole initial data*, Phys. Rev. D **74**, 061503(R) (2006). gr-qc/0607047
A25. N. Dorband, E. Berti, P. Diener, E. Schnetter, M. Tiglio, *A numerical study of the quasinormal mode excitation of Kerr black holes*, Phys. Rev. D **74**, 084028 (2006). gr-qc/0608091

A26. E. Berti, V. Cardoso, J. A. González, U. Sperhake, *Mining information from binary black hole mergers: a comparison of estimation methods for complex exponentials in noise*, Phys. Rev. D **75**, 124017 (2007). gr-qc/0701086

A27. E. Berti, V. Cardoso, J. A. González, U. Sperhake, M. Hannam, S. Husa, B. Brügmann, *Inspiral, merger and ringdown of unequal mass black hole binaries: a multipolar analysis*, Phys. Rev. D **76**, 064034 (2007). gr-qc/0703053

A28. E. Berti, J. Cardoso, V. Cardoso, M. Cavaglià, *Matched-filtering and parameter estimation of ringdown waveforms*, Phys. Rev. D **76**, 104044 (2007). arXiv:0707.1202[gr-qc]

A29. E. Berti, S. Iyer, C. M. Will, *A post-Newtonian diagnosis of quasiequilibrium configurations of neutron star-neutron star and neutron star-black hole binaries*, Phys. Rev. D **77**, 024019 (2008). arXiv:0709.2589[gr-qc]

A30. U. Sperhake, E. Berti, V. Cardoso, J. A. González, B. Brügmann, M. Ansorg, *Eccentric binary black-hole mergers: The transition from inspiral to plunge in general relativity*, Phys. Rev. D submitted. arXiv:0710.3823[gr-qc]

A31. E. Berti, M. Volonteri, *Cosmological black hole spin evolution by mergers and accretion*, Astrophys. J. Lett. submitted. arXiv:0802.0025[astro-ph]

A32. E. Berti, V. Cardoso, *Quasinormal modes and thermodynamic phase transitions*, Phys. Rev. D in press. arXiv:0802.1889[hep-th]

A33. N. Yunes, E. Berti, *Accuracy of the post-Newtonian approximation: Optimal asymptotic expansion for quasi-circular, extreme-mass ratio inspirals*, Phys. Rev. D submitted. arXiv:0803.1853[gr-qc]

Conference Proceedings

B1. O. Benhar, E. Berti, V. Ferrari, *The imprint of the equation of state on the axial w-modes of oscillating neutron stars*, in *Gravitational Waves: A Challenge to Theoretical Astrophysics*, ICTP Lecture Notes Series III, May 2001. Online at http://www.ictp.trieste.it/~pub_off/lectures/vol3.html

B2. E. Berti, V. Ferrari, *Gravitational waves emitted by extrasolar planetary systems*, in *Gravitational Waves: A Challenge to Theoretical Astrophysics*, ICTP Lecture Notes Series III, May 2001. Online at http://www.ictp.trieste.it/~pub_off/lectures/vol3.html

B3. E. Berti, *Stellar perturbation theory and the detection of gravitational waves from neutron star binaries*, Proceedings of the 10th Greek Relativity Meeting (NEB-X), Kalithea (Chalkidiki), May-June 2002.

B4. E. Berti, *Black hole quasinormal modes: hints of quantum gravity?*, short review for the Proceedings of the Workshop on Dynamics and Thermodynamics of Black Holes and Naked Singularities (Milan), May 2004. gr-qc/0411025

B5. E. Berti, *Black holes in a bathtub*, Proceedings of the 11th Greek Relativity Meeting (NEB-XI), University of the Aegean, Lesbos, June 2004. Online at http://www.iop.org/EJ/abstract/1742-6596/8/1/013

B6. E. Berti, A. Buonanno, C. M. Will, *Testing general relativity and probing the merger history of massive black holes with LISA*, Class. Quant. Grav. **22**, S943 (2005). Special Issue for the Proceedings of the 9th Gravitational Wave Data Analysis Workshop (GWDAW-9) held in Annecy (France), December 2004. gr-qc/0504017

This paper was included in the Classical and Quantum Gravity annual highlights collection for 2005/2006: http://herald.iop.org/cqg.highlights/m75/ayc/174703/link/401.

B7. E. Berti, V. Cardoso, C. M. Will, *Considerations on the excitation of black hole quasinormal modes*, in *Recent Advances in Astronomy and Astrophysics: 7th International Conference of the Hellenic Astronomical Society*, ed. N. Solomos (AIP Conference Proceedings, Vol. 848, American Institute of Physics, Washington), p. 687 (2006). gr-qc/0601077

B8. E. Berti, *LISA observations of massive black hole mergers: event rates and issues in waveform modelling*, Class. Quantum Grav. **23**, S785 (2006). Special Issue for the Proceedings of the 10th Gravitational Wave Data Analysis Workshop (GWDAW-10), Brownsville (Texas), December 2005. gr-qc/0602470

B9. E. Berti, V. Cardoso, Clifford M. Will, *Black hole spectroscopy with LISA*, AIP Conf. Proc. **873**, 82 (2006). Proceedings of the 6th International LISA Symposium, Goddard Space Flight Center, Greenbelt (Maryland), June 2006.

B10. E. Berti, V. Cardoso, J. A. González, U. Sperhake, B. Brügmann, *Multipolar analysis of spinning binaries*, Class. Quantum Grav. in press. Invited Contribution from the Amaldi7 Parallel Sessions, Sydney, Australia, July 2007.

In preparation as of October 2007:

P1. E. Berti, C. Cutler, M. Vallisneri *et al.*, *Systematic and statistical errors in gravitational wave detection from compact binaries.*
P2. E. Berti, C. M. Will, N. Yunes, *LISA eccentric binaries: detection and parameter estimation.*
P3. N. Yunes, E. Berti, V. Cardoso, J. A. González, U. Sperhake, *Accuracy of the Post-Newtonian approximation for inspiralling black hole binaries.*
P4. U. Sperhake, E. Berti, V. Cardoso, J. A. González, F. Pretorius, *The high-energy collision of two black holes.*
P5. E. Berti, V. Cardoso, C. Cutler, *Measuring the remnant's spin direction using gravitational waves from a binary merger.*
P6. E. Berti, M. Volonteri *et al.*, *LISA constraints on black hole formation scenarios.*
P7. R. Cowsik, E. Berti, A. Sircar, K. Wagoner, *Embedding model and the dynamical friction effects in the Fornax dwarf galaxy.*
P8. L. Gualtieri, E. Berti, V. Cardoso, U. Sperhake, *Transformation of multipolar expansions of gravitational waveforms under rotations and boosts.*
P9. E. Berti, M. Campanelli, *Perturbative Interface to the Binary Black Hole Problem* (a review article for *Living Reviews in Relativity*).

Theses

T1. *Studio delle frequenze di emissione gravitazionale da stelle di neutroni in relazione all'equazione di stato.* Laurea thesis, in Italian, November 1998. Online at
`http://www.astro.auth.gr/~berti/laurea.ps.gz` (Gzipped Postscript)
T2. *Gravitational waves from perturbed stars.* PhD thesis, in English, October 2001. Online at
`http://www.astro.auth.gr/~berti/phd.ps` (Postscript)
`http://www.astro.auth.gr/~berti/phd.pdf` (PDF)

Other activities

Conference organizer

- *NR meets 3PN (A Workshop on the Interface between Post-Newtonian Theory and Numerical Relativity)*
  Washington University in Saint Louis, February 8-11 2007.
  `http://nrm3pn.wustl.edu`
- *16th Midwest Relativity Meeting*
  Washington University in Saint Louis, November 17-18 2006.
  `http://mwrm.wustl.edu/`
- *NEB-X (10th Hellenic Relativity Conference)*
  Peninsula of Cassandra (Chalkidiki, Greece), May 30-June 2 2002.
  `http://www.astro.auth.gr/gravity/NEB_X.html`

Referee

Physical Review Letters, *Physical Review D*, *Classical and Quantum Gravity*, *General Relativity and Gravitation*, *New Journal of Physics*, *International Journal of Modern Physics D*, *Canadian Journal of Physics*, *Modern Physics Letters A*, *Journal of Physics G: Nuclear and Particle Physics*, *Central European Journal of Physics*, *Physica Scripta*

Other

Responsible (with Marta Volonteri) of producing cosmological black hole formation models to be used as testbeds in the taskforce on LISA Science Performance Evaluation (by Parameter Estimation). More information is available on the taskforce wiki:

`http://www.tapir.caltech.edu/dokuwiki/lisape:home`

Presently co-authoring (with Manuela Campanelli) the review article *Perturbative Interface to the Binary Black Hole Problem* for the online journal *Living Reviews in Relativity*: see

`http://relativity.livingreviews.org/`

Talks

Forecoming

- *Post-Newtonian diagnostics for initial data*,
  invited talk at the April APS Meeting, Saint Louis, 4/12-15/08.
- *Cosmological black hole spin evolution by mergers and accretion: Implications for gravitational wave astronomy*,
  High Energy Astrophysics Division (HEAD) Meeting of the American Astronomical Society, Los Angeles, 3/31/08.

2008

- *Linking numerical relativity to gravitational-wave astronomy*,
  Seminar at the Center for Computational Relativity and Gravitation, Rochester Institute of Technology, Rochester (New York), 3/7/08.
- *Synergy of analytical and numerical relativity: prospects for astrophysics and gravitational-wave detection*,
  Seminar at Washington University in Saint Louis (Missouri), 2/28/08.
- *Gravitational wave astronomy*,
  Colloquium at Washington University in Saint Louis (Missouri), 2/27/08.
- Coordinator (with Larry Kidder) of the discussion session on *Interfacing post-Newtonian theory, numerical relativity and perturbation theory* at the KITP Miniprogram *Interplay between Numerical Relativity and Data Analysis*, Kavli Institute for Theoretical Physics, Santa Barbara (California), 1/7/08-1/18/08.
  See `http://www.kitp.ucsb.edu/activities/auto2/?id=944`

2007

- *Gravitational waves from binary black hole mergers: implications for astrophysics and fundamental physics*,
  Dipartimento di Fisica, Universitá di Roma "La Sapienza", Rome, Italy, 12/19/07.
- *Black hole binary mergers and black hole spectroscopy*,
  CaJAGWR seminar, California Institute of Technology, Pasadena (California), 4/12/07.
- *Post-Newtonian diagnosis of compact binary inspirals*,
  Relativistic Astrophysics group meeting, Jet Propulsion Laboratory, Pasadena (California), 9/7/07.
- *Analytical insights into numerical simulations of compact binaries*,
  GRϵCO seminar at the Institut d'Astrophysique de Paris (France), 7/26/07 and 7/27/07.
- *Gravitational waves from binary black hole mergers*,
  Institute for Astronomy and Astrophysics, Tübingen (Germany), 7/9/07.
- *The inspiral-merger-ringdown transition in unequal-mass black hole binaries*,
  NR meets 3PN (A Workshop on the Interface between Post-Newtonian Theory and Numerical Relativity), Washington University in Saint Louis (Missouri), 2/8/07–2/11/07.
- *Gravitational waves and alternative gravity theories*,
  Rethinking Gravity: From the Planck Scale to the size of the Universe, Tucson (Arizona), 1/22/07–1/24/07.

2006

- *Gravitational wave astronomy*,
  Gravitational and High-Energy Theory Group, Oxford (Mississippi), 10/10/06.
- *Gravitational wave astronomy*,
  Emerging Themes in Physics (Workshop for Young Scientists), Austin (Texas), 10/5/06–10/6/2006.
- *Waveform models and parameter estimation for intermediate mass ratio inspirals*,
  LISA Astro-GR@AEI (EMRIs and IMRIs), Golm (Germany), 9/18/06–9/22/06.
- *Supermassive black hole (astro)physics and tests of general relativity with LISA*,
  Physikalisch-Astronomische Fakultät der Friedrich-Schiller-Universität, Jena (Germany), 9/14/06.
- *Measuring supermassive black hole parameters with LISA*,
  Physics and Astrophysics of Supermassive Black Holes, Santa Fe (New Mexico), 7/10/06–7/14/06.
- *Black hole spectroscopy with LISA*,
  6th International LISA symposium, Goddard Space Flight Center, Greenbelt (Maryland), 6/19/06–6/23/2006.
- *Post-Newtonian diagnostic of compact binaries in quasiequilibrium*,
  Workshop on Astrophysical Applications of Numerical Relativity, Guanajuato (Mexico), 5/6/06–5/11/06.
- *Massive black hole mergers: waveform modelling and parameter estimation*,
  Workshop on Astrophysical Applications of Numerical Relativity, Guanajuato (Mexico), 5/6/06–5/11/06.

- *Tests of general relativity with LISA*,
  Politecnico di Torino (Italy), 1/12/06.
- *Tests of general relativity with LISA*,
  Dipartimento di Fisica dell'Universitá di Tor Vergata, Roma (Italy), 1/9/06.

2005

- *Supermassive black hole binaries*,
  10th Gravitational Wave Data Analysis Workshop, Brownsville (Texas), 12/15/05–12/18/05.
- *Taking black hole fingerprints with LISA*,
  Department of Physics and Astronomy, Louisiana State University, Baton Rouge (USA), 11/10/05.
- *The quasinormal spectrum of black holes*,
  Center for Computation and Technology, Louisiana State University, Baton Rouge (USA), 11/8/05.
- *Testing general relativity with LISA*,
  7th Astronomy Conference of the Hellenic Astronomical Society,
  Lixourion, Kefallinia Island (Greece), 9/8/05–9/11/05.
- *Binary parameter estimation and detection of ringdown waves with LISA*,
  Albert Einstein Century Conference, Paris (France), 7/18/05–7/22/05.
- *What will LISA tell us about black hole physics?*,
  Black Holes V, Banff (Canada), 5/13/05–5/18/05.
- *Estimating spinning binary parameters and testing alternative theories of gravity with LISA*,
  Center for Gravitational Physics and Geometry, Penn State University, State College (USA), 4/14/05.

2004

- *Black hole quasinormal modes and the area quantum*,
  Quantum General Relativity session, GR17, Dublin (Ireland), 7/18/04–7/23/04.
- *Rotating neutron stars: an invariant comparison of approximate and numerical spacetime models*,
  Relativistic Astrophysics session, GR17, Dublin (Ireland), 7/18/04–7/23/04.
- *Black hole quasinormal modes: recent developments and new applications*,
  NEB-XI (11th Hellenic Relativity Conference), Department of Marine Sciences,
  University of the Aegean, Lesbos (Greece), 6/2/04–6/5/04.
- *Black hole quasinormal modes: hints of quantum gravity?*,
  Workshop on Dynamics and Thermodynamics of Black Holes and Naked Singularities,
  Dipartimento di Matematica, Politecnico di Milano (Italy), 5/13/04–5/15/04.
- *Rotating relativistic stars and rotating black holes*,
  Invited talk at the LUTH (Laboratoire de l'Univers et de ses Théories),
  Observatoire de Paris-Meudon (France), 3/17/04.

2003

- *Black hole perturbation theory, the area quantum and large extra dimensions*,
  GRϵCO seminar at the Institut d'Astrophysique de Paris (France), 10/30/03.
- *Black hole quasinormal modes and the area quantum*,
  5th Meeting and Advanced School of the EU Network on *Sources of Gravitational Waves*,
  Trieste (Italy), 9/15/03–9/26/03.
- *What do classical black hole oscillations tell us about their quantum properties?*,
  Institute of Cosmology and Gravitation, Portsmouth (UK), 9/8/03.
- *Black hole oscillations and stability*,
  Institute of Cosmology and Gravitation, Portsmouth (UK), 2/18/03.

2002

- *Towards the computation of quasinormal modes for rapidly rotating compact stars*,
  4th Meeting of the EU Network on *Sources of Gravitational Waves*,
  Palma de Mallorca (Spain), 9/26/02–9/28/02.
- *Gravitational waves from neutron star binaries*,
  NEB-X (10th Hellenic Relativity Conference),
  Peninsula of Cassandra (Chalkidiki, Greece), 5/30/02-6/2/02.
- *Gravitational waves from pulsating stars and stars in binary systems*,

Aristotle University of Thessaloniki, 3/12/02.
- *Scattering processes in coalescing binary systems*,
  3rd Meeting of the EU Network on *Sources of Gravitational Waves*,
  Southampton (England), 1/31/02-2/3/02.

2001

- *Perturbative formalisms for binary neutron stars*,
  2nd Meeting of the EU Network on *Sources of Gravitational Waves*,
  Peninsula of Cassandra (Chalkidiki, Greece), 6/6/01-6/10/01.

2000

- *Gravitational waves emitted by binary systems*,
  Talk given on 11/29/00 during a two-week visit at Stony Brook University, New York, USA.
- *Gravitational waves emitted by extrasolar planetary systems*,
  Conference on *Gravitational waves: a challenge to Theoretical Astrophysics*,
  ICTP (International Center for Theoretical Physics), Trieste, Italy (Jun 2000).
- *Gravitational waves emitted by extrasolar planetary systems*,
  Conferenza Nazionale di Fisica Teorica, IIASS (International Institute for Advanced Scientific Studies),
  Vietri sul Mare (Salerno), Italy (Apr 2000).