Programme proposal: ***06-RNP-106***
Programme title: ***The New Physics of Compact Stars***
Programme acronym: ***CompStar***

Acronym of the Standing Committee: ***PESC***

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ABSTRACT:
Over the last decade, compact stars have been shown to be excellent tools to test fundamental properties of gravity and matter under extreme conditions. The new generation of space X-ray and gamma-ray observatories are enabling new observations and breakthrough discoveries (kHz quasi- periodic oscillations, bursting millisecond pulsars, half-day long X-ray superbursts). The thermal emission from isolated neutron stars has provided important information on their radii and cooling history. At the same time, improvements in radio telescopes and interferometric techniques have increased the number of known binary pulsars, allowing for extremely precise neutron star mass measurements and tests of general relativity (GR). Finally, a large multinational effort has taken place in the last decade to build detectors, offering the exciting prospect of the detection of gravitational waves.

We are thus experiencing the blooming of ***astronuclear physics***, an exciting research area in which the physics of compact stars plays a fundamental role. While a part of this physics relies on theories that are well tested in terrestrial laboratories, a good part of it is basically unknown in the regimes found in compact stars. Unveiling this picture is a task made challenging by the multidisciplinary character of the problem, which requires expertise from historically independent disciplines, such as nuclear and particle physics, astrophysics, gravitational and computational physics. The present project aims at linking the best European scientists in these fields, to reach a better understanding of the physics of compact stars. To make this possible it will be necessary to create a European environment in which experts from different fields can collaborate, present their results and discuss the implications across disciplines. By doing this, they will train a new generation of young researchers who will have skills in multiple areas and thus the ability to unravel the complex physics behind compact stars.

Keywords: Neutron Stars, Dense QCD Matter, Gravitational Waves, Neutrino Astrophysics, Computational Physics.

Previous Application to ESF: PC04-933

STATUS OF RELEVANT RESEARCH:

There is a wide spectrum of complementary expertise in Europe in the physics and astrophysics of compact stars. We need to combine this expertise through activities that allow scientists to meet, exchange information and start new collaborations. In particular, the three main thematic areas of research we plan to explore are

- *nuclear-physics properties of compact stars, their impact on the astrophysical evolution and observability of compact stars and viceversa*
- *properties of QCD in compact stars and phase transitions that could take place in their interiors*
- *gravitational-wave emission from single and binary compact stars*

In what follows we briefly discuss the status of the research in these three areas and how different physics rules the evolution of compact stars at different stages.

The birth

Compact stars are known to be born in the aftermath of successful core collapse Supernovae explosions. At present, the details of the explosion mechanism of core collapse supernovae are still uncertain. There is general agreement that the physics of neutrino transport is a key ingredient to a successful explosion. Following core collapse, a hot proto-neutron star (PNS) is formed and neutrinos take away some 99% of the binding energy that is released to form a NS. Within *CompStar*, we will study the crucial problem of the effect of strong correlations between nucleons on the neutrino opacities. The second key to a successful supernova explosion seems to be the interplay of rotation, convection and magnetic fields, which is a multidimensional problem (observations show large anisotropies in the ejected material). Within *CompStar*, we can attempt ambitious projects on multidimensional PNS structure, dynamics and evolution that require input from various fields, such as the origin of superstrong magnetic fields by simulating the magneto-rotational collapse and turbulent dynamo action in newly-born rotating PNSs, using a realistic EOS and self-consistent neutrino opacities of PNSs, including the kinetics of the formation of strange hadrons (hyperons, kaons, quarks) during the evolution of PNSs.

The crust, the envelope and the atmosphere

A few hours after birth a neutron star has cooled down below 10^9 K, a solid crust will be formed in the external layers. The crust of neutron stars contains only a few percent of the NS mass, but plays a crucial role in NS evolution (cooling, accretion, bursts) and dynamics (glitches, non-axial deformations). Its structure above 10^11 g/cm^3 is still uncertain. Are nuclei ordered in a nearly perfect crystal lattice with only one nuclide present or is the structure heterogeneous? *CompStar* will try to answer these questions using the best many-body theories and modern nuclear physics input. The answer is of crucial importance for the electrical conductivity of the crust (important for the magnetic field evolution) and its heat conductivity (crucial for the relation between the surface and the core temperature).

The electromagnetic spectrum is determined by the temperature at the base of the envelope and by how photons diffuse through the atmosphere. We will model the thermal emission of NSs in the presence of strong magnetic fields, with the purpose of providing realistic spectra to be confronted with X-ray observations of isolated NSs.

Some of the bottom crust layers can be sources of powerful neutrino radiation; we plan to continue the studies of this new NS cooling channel. The flow of superfluid neutrons is affected by the nuclear lattice. Conversely, the nuclear lattice affects the neutron pairing. Both effects are important for pulsar glitch dynamics. Additionally, we plan also to calculate the elastic response of the crust to various types of deformation, including the calculation of the critical (breaking) strain. We will apply these results to modeling of non-radial pulsations and glitches. Using new Hartree-Fock codes, we will perform the calculation of the structure of the inner neutron star crust, using for the first time a correct treatment of the unbound neutron wave functions. We will also continue modeling the deep crustal heating in accreting neutron stars, which is crucial for the observed surface temperature in the quiescent periods of X-ray transients.

The outer core

The NS core contains more than 95% of the stellar mass and its central density may exceed 10^{15} g/cm^3. Its structure is determined by the poorly known EOS at densities exceeding $5*10^{14}$ g/cm^3. This part of the EOS can be strongly influenced by the presence of hyperons, and research within *CompStar* will be aimed to clarify the role of the three-body forces involving hyperons on the maximum mass of neutron stars with hyperonic cores. New measurements of NS radii will be used to constrain this EOS.

Another new area to be considered within *CompStar* are solid NS cores in which elastic strain can support non-axial deformations, crucial for the emission of gravitational waves. Combining microscopic and macroscopic expertise of *CompStar* teams we will also study the damping of NS pulsation modes by the dissipative processes (going beyond the bulk-viscosity limit and including the nonlinearity of the dissipation process), glitches, or the diffusion of magnetic fields in pulsars.

The inner core: properties of QCD in compact stars

One of the most exciting fields of current research in nuclear physics is the investigation of the phase boundary between hadronic matter and the hypothetical fifth state of matter predicted by QCD (the underlying gauge theory of strong interactions): the quark-gluon plasma. In laboratory experiments with relativistic heavy-ion collisions (e.g. with the SPS at CERN Geneva and the recently completed RHIC at BNL Brookhaven) one is able to probe only the high-temperature domain of the QCD phase diagram under conditions of strong non-equilibrium.

The high-densities and high-temperature region is known to be reached only in the early Universe and during the first minute of life of neutron stars. The high-density and low-temperature region of the phase boundary, where the most interesting correlation- and condensation phenomena are anticipated, is expected to occur only in the interiors of neutron stars. However, these objects should really be considered compact stars since most likely their central region consists rather of exotic phases of matter (e.g. hyperons), boson condensates (pions, kaons, H-matter) or deconfined quark matter (u, d, s quarks). Strange quark matter has even been discussed to be more stable than Fe, the most stable nucleus, which would lead to compact stars composed largely of pure quark matter. Any progress in the interpretation or prediction of characteristic phenomena of the compact star evolution is tightly related to our knowledge of the properties of high-density matter which have to be predicted using techniques of nuclear many-body theory and finite-density (and temperature) field theory. This interdisciplinary character of the present project bears the potential that any progress in one subfield may lead to innovative and even spectacular discoveries in the complementary.

The most striking new aspect in this field of research which serves as the background and justification for undertaking the project is the recent finding that high-density QCD at the above mentioned phase transition to the quark-gluon plasma might support a color superconducting quark matter phase characterized by rather large

(~100 MeV) pairing gaps due to the formation of a diquark condensate. This conjecture has been confirmed in a large number of independent works using different effective approaches to high-density QCD and can thus be considered as robust. The only place to experimentally test these results is in compact stars and their characteristic observables. Therefore, some of the teams in *CompStar* have performed exploratory research in order to find out whether the magnetic fields and the cooling curves of pulsars are compatible with rough estimates for scenarios of color superconducting quark matter with large pairing gaps.

These first estimates have found great resonance in the nuclear and particle physics community and should thus be followed by a more elaborate research. Within the present proposal the most experienced European groups for this task which also have long-standing mutual contacts join in the task to comprehensively explore the consequences of diquark condensation phenomena for compact star evolution with the purpose of identifying observable characteristics for the discrimination of the possible color superconducting quark matter phase from other, more conventional scenarios for high-density QCD phases.

Gravitational-Waves: a new window into compact stars

Eagerly anticipated for over 30 years, a number of major European (GEO600 and VIRGO) and other (LIGO, TAMA) gravitational-wave observatories are now for the first time actually taking data! This is placing enormous pressure on the community to both study realistic sources of gravitational waves, and predict the signals they will produce in the detectors. The programme *CompStar* will address this urgent and exciting issue by adding the most recent, state-of-the-art microphysics to the present tools in the theory of gravitational-wave sources, applying them to calculations of the most promising sources of gravitational waves. This will be accomplished by adding some of Europe's (and the world's) strongest groups with expertise in these new areas. *CompStar* will also develop new tools for the foundations of the next generation of gravitational-wave detectors being proposed, including the space based detector LISA, one of the ``Cornerstone Missions'' of ESA planned for launch in about a decade. Together, these gravitational wave observatories, armed with results from *CompStar*, will create a completely new window on the universe, providing information that is either difficult or impossible to obtain by traditional (electromagnetic waves, neutrinos) observations.

It is important to underline that a major interest in observing gravitational waves from compact stars comes from the possibility of learning more about the behaviour of matter at very high densities. In particular, it is of great interest from the point of view of nuclear physics to understand how non-symmetric nuclear matter behaves and to constrain models for nucleon-nucleon interactions in dense matter which are at present rather poorly constrained by laboratory data. Just by making comparison with the most basic observed properties of neutron stars, for instance, it has been shown that quite a large number of models thought to be favoured on the basis of laboratory data can be ruled out. By making a more detailed comparison and, in particular, by analysing oscillation modes of compact stars and the gravitational waves which they produce, it is hoped to constrain these interaction models much more closely. The study of gravitational waves produced by compact star oscillations can also give evidence for the conditions under which exotic particles and possible phase transitions may appear. Obtaining evidence for the threshold density at which hyperons appear, or a QCD phase transition occurs would contribute greatly to improving understanding of nuclear interaction. Together with our collaborators, we aim to investigate the impact on the oscillation modes of varying prescriptions for this input physics so as to be ready for making a confrontation with gravitational-wave data when it arrives.

Gravitational waves are also hoped to provide the decisive clue to the nature of the central engine of gamma-ray bursts (GRBs). While the class of long GRBs is conclusively linked to the death of a rare breed of massive stars, the first hints on the nature of the engine of short bursts have only been obtained since summer 2005. The first afterglow observations show that short bursts definitely have a different progenitor: they occur at lower redshifts, in galaxies with and without star formation, they have a substantially lower output in gamma-rays and do not go along with a supernova explosion. The merger of two neutron stars is one of the most popular, but certainly not the only plausible model. The definite proof of the binary nature of the short GRB central engine is expected to come from the detection of a "chirp" gravitational signal detected coincidently with a short GRB. Thus, reliable predictions of gravitational wave signals could settle one of the most long-standing problems of modern astrophysics.

Finally, accurate gravitational wave waveforms are required to probe the fundamental nature of gravity, as well as the unique physical and astronomical information the gravitational waves carry, ranging from nuclear and particle physics, for which compact stars present a potentially invaluable laboratory. However, theoretically determined waveforms are crucial not only to understanding the physical content of the detected gravitational wave; they are also required for detection. Physical information in the data may be extracted through template matching techniques, which *presuppose* that reliable sample waveforms are known. Without theoretical templates to search against, it may be difficult or impossible to dig out the very weak gravitational wave signal, buried deep in detector noise. Accurate theoretical templates both enhance the chances of detection and provide the only means of achieving a physical understanding of the exotic sources we seek to study.

EXPECTED BENEFIT FROM EUROPEAN COLLABORATION IN THIS AREA

The primary goal of this project is to create a European research area in astronuclear physics in which scientific results are spread and interaction between different disciplines is facilitated. The main benefit is directed to the new generation of young researchers interested in the field, who will have the opportunity of being trained in a much wider sense than what they can find locally in their own institutions, where usually is difficult to find researchers from all the involved fields. For this purpose, the focus of the project has been put on the organization of schools and workshops during five years, which will cover most of the training needs of two different generations of PhD students.

From the point of view of scientific results, the interaction between fields provoked by the initiative will allow to address and resolve a number of issues which are not satisfactory until now:

- The nuclear physics community will provide "usable" realistic EOSs of dense matter, neutrino emissivities and viscosities (in tabular form or with public codes) that people working in compact stellar oscillations, hydrodynamics, or NS thermal evolution have been demanding for years.
- The experts in astrophysical sources of gravitational waves will generate more realistic templates to be used in matched filtering techniques to improve the signal-to-noise ratio in the detections.
- The astrophysical community will make an effort to localize and explain to the nuclear or QCD physicists what are the actual astrophysical observables in compact stars and the uncertainties.

- Experts from all areas can work together to correlate information from different observables (gravitational waves, neutrino detectors, X-ray observations) and compare with the theoretical models. This multilateral effort is far more efficient than the sum of individual efforts in each area.

Last but not least, we want to emphasize the timeliness of the project: gravitational wave interferometers are beginning to take real data and the next 5-10 years will be crucial for the field. The new generation of high energy satellites is now fully functional (Chandra, XMM, Integral), and new even more ambitious projects are planned in the near future (Glast, Constellation-X, XEUS). The new generation of neutrino detectors is ready: in the event of a supernova similar to SN1987A, SuperKamiokande and SNO would collect thousands of neutrinos (instead of 19).

PROGRAMME COLLABORATION:

In response to the increased need for a closer collaboration among the nuclear-physics and the astrophysics communities interested in the investigation of the properties of compact stars, a number of scientists have already started organizing meetings dedicated to the discussion of these interdisciplinary subjects.
Dedicated workshops of this community have been held at INP Orsay, France (April 2005), ECT* Trento, Italy (September 2005) and Alicante, Spain (September 2006).

During these meetings, which have been entirely self-funded, the great potential related to a collaborative and interdisciplinary investigation of compact stars have emerged very clearly. Similarly, it has become clear that there is a need to train a new generation of young researchers that would be able to bridge between the two communities and provide a new and more complete understanding of the properties of compact stars.

The programme collaboration is well-prepared for organizing interdisciplinary training programmes as, e.g., the HISS Dubna (http://theor.jinr.ru/~dm2006), or the six-week training programme in fall 2007 at ECT* Trento (http://www.ect.it, in preparation).

EUROPEAN CONTEXT

At the moment, this collaboration involves more than **70** permanent scientists distributed over **34** Institutes in **12** European countries. When young researchers (students and postdoctoral research associates) are also considered, the number of scientists actively involved is well above a hundred. A brief list of the persons and Institutes involved is summarized below.

PROPOSED ACTIVITIES:

Duration and Participants (revised 29.11.07):

We plan to organize six events during the 5 years, each consisting of an advanced school extended over 7 days, which will be followed by a workshop of 4 days. We expect to host about 40 young researchers and 6 lecturers for each School (46 participants), while each Workshop shall have about 20 more experts (66 participants in total). In what follows we list the planned calendar of activities, specifiying for each event the expected date, title and place.

Date	Title of the School/Workshop	Place
02/08	*The Complex Physics of Compact Stars*	Karpacz (Poland)
02/09	*Physics of the Neutron Star Crust*	Coimbra (Portugal)
03/10	*Neutrino Processes and Compact Star Cooling*	Les Houches (France)
09/10	*Equation of State for Compact Star Interiors*	Erice (Italy)
10/11	*Computational Relativistic Astrophysics*	Potsdam (Germany)
10/12	*Gravitational-wave emission from Compact Stars*	Paris (France)

Budget Estimate (revised 29.11.07):

I) Due to the fact that living expenses and accomodation costs in Poland are still considerably lower than in the other western European countries, we revise the cost estimate of the first school in Karpacz (Ladek Zdroj) according to:

A) 40 students for full duration (11 days) = 40x500 Euro = 20 kEuro,

B) 6 lecturers for school (7 days) = 6x300 Euro = 1.8 kEuro,

C) 26 experts for workshop (4 days) = 26x250 Euro = 6.5 kEuro,

resulting in subtotal living and accomodation costs of **28,3 kEuro**.
The support request for lecturers is relatively low since there is a garanteed support for some lecturers from the University of Wroclaw which has been accounted for.

II) For the 5 other School+Workshop events we stay with the previous basis, only revising duration and lecturer number. With a maximum of 100 Euro per day and per participant necessary to cover accomodation and living expenses, we estimate A=44 kEuro, B=4.2 kEuro and C=10.4 kEuro, so that the organization of each event will require 48.6 kEuro. Subtotal: 5x48.6 kEuro = **243 kEuro**

III) In addition, we expect that 20 kEuro will be necessary for running expenses related to the organization of each of the 6 School+Workshop events. The latter will be dedicated mostly to the reimbursement of the travel expenses for the lecturers of the Schools, the young researchers, and those researchers coming from less developed areas of Europe. We expect matching funds for the reimbursement of the travel expenses of other researches. Subtotal: 6x20 kEuro= **120 kEuro**

In summary, the requested support for the programme from I)+II)+III) and a 7.5% administration fee amounts to **<u>420,648 kEuro</u>** for a period of 5 years.

The request is for **48,3 kEuro** in the year 2008, for **68,6 kEuro** in the years 2009, 2011 and 2012, respectively, and for **137,2 kEuro** in 2010 (two events). To these annual budgets the administration fee has to be added.

The revised budget amounts to a reduction by 30,6 kEuro, i.e. 6.8 %. Since by 27.11. a commitment from ESF members to above 75% of the original requested budget (451,25 kEuro) was reached, this support level should correspond to above 80% of the above revised budget.

APPENDICES:

Curriculum Vitae of David Blaschke

Present position: Full Professor

Personal Data:

Born September 22nd, 1959, in Güstrow, Germany, German nationality and citizenship

Education and Diplomas:

1983 Diploma Rostock University

1987 PhD (Dr. rer. nat.) Rostock University

1995 Habilitation (Dr rer. nat. habil.) Rostock University

Employment Record:

1988-1991 Assistant, Department of Physics, Rostock University

1991-1992 Scientific Associate, Theory Division, CERN Geneva, Switzerland

1992-1995 Senior Assistant, MPI for Nuclear Physics Heidelberg, Germany

1996-1998 Privatdozent, Department of Physics, Rostock University, Germany

1998-2003 Professor (C3) for Particle- and Astrophysics, Rostock University

2001 – to date Vice Director, BLTP at JINR Dubna, Russia

since 2006 Full Professor, University of Wroclaw, Poland

Long Term Visits & Positions Abroad:

1984 Visiting Scientist, JINR Dubna, Russia

1989 Visiting Fellow, Yerevan State University, Armenia

1997 Visitor, Argonne National Laboratory, USA

2000, 2004 Visiting Scholar during workshop programs at INT Seattle, USA

2000 Senior Fellowship, ECT* Trento, Italy,

2004 Visiting Professor, Universität Bielefeld, Germany

2005 Guest scientist, GSI Darmstadt, Germany

2006 Visiting Professor, Universität Rostock, Germany

Memberships:

German Physical Society, European Physical Society

Projects:

1999 Workshop on 'Understanding Deconfinement in QCD', 2000 Workshop on 'Physics of Neutron Star Interiors' both at ECT* Trento, Italy, 2001-2003 DAAD Summer Schools (3 events) on 'Many-Particle Theory' in Dubna, Russia, 2003 NATO Advanced Research Workshop in Yerevan, Armenia, 2003-2006 Virtual Institute of the Helmholtz Association 'Dense Hadronic Matter and QCD Phase Transitions' at GSI Darmstadt (speaker), 2004-2006 Helmholtz International Summer Schools (6 events) on 'Structure of Matter' in Dubna, Russia, Workshop on 'The new Physics of Compact Stars' at ECT* Trento, Italy, 2005

Research:

Quantum field theory at finite temperature, Dense hadronic matter and QCD phase transitions, Quark matter in Heavy Ion Collisions and in Compact Stars

Publications:

more than 150 publications, four books (Editor). Total number of citations (according to SPIRES -HEP) above 1500. Five papers with more than 50 citations.

Relevant Publications:

Constraints on the high-density nuclear equation of state from the phenomenology of compact stars and heavy-ion collisions, T. Klähn, D. Blaschke, et al., Physical Review C 74, 035802 (2006)

Superdense QCD Matter and Compact Stars, D. Blaschke and D. Sedrakian (Eds.), NATO Science Series vol. 197, Springer (2006)

Population synthesis as a probe of neutron star thermal evolution, S. Popov, H. Grigorian, R. Turolla and D. Blaschke, Astronomy & Astrophysics 448, 327 (2006)

The phase diagram of three-flavor quark matter under compact star constraints, D. Blaschke, S. Fredriksson, H. Grigorian, A. Öztas and F. Sandin, Physical Review D 72, 065020 (2005)

Diquark condensates and compact star cooling, D. Blaschke, T. Klähn and D.N. Voskresensky, Astrophysical Journal 533, 406 (2000)

Curriculum Vitæ of Pierre Pizzochero

Present position: Associate Professor

Personal data:

Born May 15th, 1959, in Milano, Italy, Italian and French nationality, Italian citizenship.

Education:

1985 Laurea in Physics (summa cum laude), Università degli Studi di Milano

1986 M.A. in Physics, S.U.N.Y. at Stony Brook (USA)

1989 Ph.D. in Physics, S.U.N.Y. at Stony Brook (USA)

Employment record:

1989-1990 Postdoctoral Fellow, S.U.N.Y. at Stony Brook (USA)

1990-1993 Researcher at Istituto Nazionale di Fisica Nucleare (INFN), sez. di Milano

1993-2002 Assistant Research Professor at Università degli Studi di Milano

2002 to date Associate Professor at Università degli Studi di Milano

2006 to date Coordinator of Theoretical Physicists at INFN, sez. di Milano

Long term visits & positions abroad:

1989-1990 Postdoctoral Fellow, S.U.N.Y. at Stony Brook (USA)

1991 Visiting Scientist at California Institute of Technology, Pasadena (USA)

1992 Visiting Fellow at Institute for Nuclear Theory, Seattle (USA)

Research:

Theoretical nuclear astrophysics of Neutron Stars; superfluid properties of dense matter; theory of Supernovæ; neutrino astrophysics.

Publications:

29 publications, with normalized score=13.1 (publication/number of authors). Total number of citations (according to NASA ADS database) about 340. One paper with more than 50 citations, 6 with more than 20 citations.

Relevant publications:

Realistic energies for vortex pinning in intermediate-density neutron star matter, P. Donati and P.M. Pizzochero, Physics Letters B640, 74 (2006)

Fully Consistent Semi-Classical Treatment of Vortex-Nucleus Interaction in Rotating Neutron Stars, P. Donati and P.M. Pizzochero, Nuclear Physics A742, 363 (2004)

Is There Nuclear Pinning of Vortices in Superfluid Pulsars?, P. Donati and P.M. Pizzochero, Physical Review Letters 90, 211101 (2003)

Nuclear Impurities in the Superfluid Crust of Neutron Stars: Quantum Calculation and Observable Effects on the Cooling, P.M. Pizzochero et al., Astrophysical Journal 569, 381 (2002)

Mass-Energy Relation for SN 1987A from Observations, H.A. Bethe and P.M. Pizzochero, Astrophysical Journal Letters 350, L33 (1990)

Curriculum Vitae of Luciano Rezzolla

Present position: Professor

Personal Data:

Born September 25th, 1967, in Milan, Italy, Italian nationality and citizenship

Education:

1992 Laurea in Physics, summa cum laude

1996 PhD in Astrophysics

Employement Record:

2006 - 2006 Professor and Head of the Numerical Relativity Division at the Albert Einstein Institute, Max Planck for Gravitational Physics, Potsdam, Germany

2004 - 2005 Director of the Computing Centre at SISSA

2004 - 2006 Associate Professor in Relativistic Astrophysics at SISSA

2000 - 2003 Assistant Research Professor in Relativistic Astrophysics at SISSA

1999 - 2000 Advanced Fellow, Astrophysics Sector at SISSA/ISAS

1998 -1999 Postdoctoral Research Associate at the Physics Department of the University of Illinois at Urbana-Champaign with Prof. Fred K. Lamb

1996 -1999 Member of ``The Binary Black Hole Grand Challenge Alliance''

1996 -1998 Postdoctoral Research Associate at NCSA, University of Illinois at Urbana-Champaign with Prof. Stuart L. Shapiro

Long Term Visits & Positions Abroad:

2004 - to date Adjunct Associate Professor at the Department of Physics and Astronomy Louisiana State University, Baton Rouge, USA

2001, 2002, 2004 Visiting Professor during the summer period at the Albert Einstein Institute, Golm, Germany

2003 Visiting Professor during the summer period at Kvali Institute for Theoretical Physics, Santa Barbara, USA

Memberships:

European Physical Society, Italian Society of General Relativity and Gravitation (Secretary)

Research:

Relativistic astrophysics, relativistic hydrodynamics and magnethohydrodynamics, physics and astrophysics of neutron stars, simulations of sources of gravitational waves, numerical relativity.

Publications:

more than 50 publications. Total number of citations (according to SPIRES-HEP) about 450. Three papers with with more than 50 citations. Editor of one book of conference proceedings and author of a book on relativistic hydrodynamics to be published by the Oxford University Press.

Relevant Publications:

Challenging the paradigm of singularity excision in gravitational collapse, L. Baiotti and L. Rezzolla, Physical Review Letters 97, 141101 (2006)

Mean-Field Dynamo Action in Protoneutron Stars, A. Bonanno, L. Rezzolla and V. Urpin, Astronomy & Astrophysics Letters 410, L33 (2003)

Frequencies of f modes in differentially rotating relativistic stars and secular stability limits, S'i. Yoshida, L. Rezzolla, Y. Eriguchi and S. Karino, Astrophysical Journal Letters 568, L41 (2002)

General Relativistic Electromagnetic Fields of a Slowly Rotating Magnetized Neutron Star. I. Formulation of the equations, L. Rezzolla, B. J. Ahmedov, and J. C. Miller, Mon. Not. Roy. Ast. Soc. 322, 723 (2001)

r-mode Oscillations in Rotating Magnetic Neutron Stars, L. Rezzolla, F. K. Lamb, and S. L. Shapiro, Astrophysical Journal Letters 531, L141-144 (2000)

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