COMPSTAR 2011 School and Workshop

"Gravitational Waves and Electromagnetic Radiation from Compact Stars"

Catania, May 3-12, 2011

`http://agenda.ct.infn.it/event/compstar2011`

Local organizers: M. Baldo, F. Burgio, H.-J. Schulze
Advisory committee: D. Blaschke, D.I. Jones, E. Kolomeitsev, J. Margueron, C. Pethick, P. Pizzochero, J. Pons, C. Providencia, L. Rezzolla, F.-K. Thielemann

Summary:

Following the previous School+Workshop meetings in Caen, Coimbra, and Ladek-Zdroj, the 2011 event was dedicated to the observational possibilities and their theoretical interpretation regarding emission of electromagnetic and gravitational waves from compact stars.

The numbers of participants was 50 students + 5 lecturers + 3 organizers during the school and 104 members for the workshop. They came from 21 countries and 42 were students, 26 postdocs.

Description of the scientific content of and discussion at the event:

School:

The following lectures were given at the school, divided into 2 $\times$ 2 morning lecture hours and 2...3 hours afternoon exercise and discussion sessions.

• *Observational Aspects regarding Electromagnetic Wave Emission (X-ray/Gamma Band) from Compact Stars*
Anna Watts (University of Amsterdam, Holland)

• *Observational Aspects regarding Electromagnetic Wave Emission (Radio/Optical Band) from Compact Stars*
Bob Rutledge (McGill University, Montreal, Canada)

• *Gravitational Wave Emission from Compact Stars*
Valeria Ferrari (Universita "Sapienza" Roma, Italy)

• *Numerical Relativity and Compact Stars*
Nikolaos Stergioulas (Thessaloniki University, Greece)

• *Protoneutron Stars and Supernovae*
Jim Lattimer (University of Stony Brook, USA)

Emphasis was put on actively involving the students during the afternoon exercise sessions. In particular the lectures of the observers (Watts, Rutledge) succeeded in this sense and were highly appreciated by the participants. Both presented the most recent observational results and provided motivation and constraints for the theoretical work in which most students are involved. The other lectures provided the necessary mathematical and computational background for theoretical calculations and simulations.

Several participants commented positively on the enthusiasm and dedication of the students during the training sessions, in spite of the time constraints and workload.

Workshop:

The workshop was dedicated as usual to a more general presentation and discussion of recent activities within the Compstar network. This year it was extended to 4 days due to the large number of participants, and even so the program was very tight, comprising 6 review talks (60 min) given by invited speakers and normal presentations (34 of 20 min and 11 of 30 min), for which students or young postdocs had priority. There was also a poster session with 19 contributions. The review talks were focused on the topic of the workshop:

• *Many-Body Aspects of Nuclear Astrophysics*
Omar Benhar (INFN Roma, Italy)

• *Gravitational Wave Emission from Neutron Stars*
Ian Jones (University of Southampton, UK)

• *Gravitational Wave Detectors*
Michele Punturo (INFN Perugia, Italy)

• *Recent Advances in the Microscopic Theory of the Equation of State*
Arnau Rios (University of Surrey, UK)

• *Numerical Relativity and Compact Stars*
Nick Stergioulas (Thessaloniki University, Greece)

• *Neutrino Emission from Neutron Stars*
Dima Yakovlev (Ioffe Institute, St. Petersburg, Russia)

Assessment of the results and impact of the event on the future direction of the field:

During presentations and discussion some important current developments emerged:

• Observations of neutron star masses become always more precise (of particular importance is the recent claim of a 2 solar mass star) and also some (less precise) radius determinations are now available. This situation is expected to improve dramatically in the not-so-far future and will allow to impose much stricter constraints on the theoretical EOS than is now possible.

• Related to this issue, the need to provide consistent and reliable theoretical nuclear EOS has been pointed out, in particular in view of the possible "exotic" components (quarks, mesons, hyperons) of high-density matter. The Compstar EOS initiative (http://klahn.ift.uni.wroc.pl/) has been set up to contribute to this goal, by providing a central site for collection and distribution of the results of the various theoretical groups, not only within the Compstar network.

• Observations of the cooling behavior of neutron stars (in particular the recently observed fast cooling of the Cassiopeia A neutron star) allow in principle to draw conclusions on the superfluid properties of the stellar matter. This is related to the problem of the nuclear EOS, and also in this field progress is soon expected by new observational data.

• Gravitational waves are a unique and complementary tool to study in particular the properties of the internal core of neutron stars. During the meeting, the need of accurate theoretical calculations has been pointed out, in order to be able to interpret the gravitational wave signals that are expected to be received by new and upgraded gravitational wave detectors in the future.

COMPSTAR 2011 : School and Workshop "Gravitational Waves and Electromagnetic Radiation from Compact Stars"

Tuesday 03 May 2011

Morning session (08:30-13:15)

time	title
08:30	**Registration**
09:00	**Welcome**
09:15	**Observational Aspects regarding Electromagnetic Wave Emission (X-ray/Gamma Band) from Compact Stars (Part I)** *Speaker: Prof. WATTS, Anna*
11:00	Coffee break
11:30	**Observational Aspects regarding Electromagnetic Wave Emission (X-ray/Gamma Band) from Compact Stars (Part II)** *Speaker: Prof. WATTS, Anna*

Afternoon session (15:00-18:00)

time	title
15:00	**Exercise and discussion**

Wednesday 04 May 2011

Morning session (09:00-13:00)

time	title
09:00	**Observational Aspects regarding Electromagnetic Wave Emission (Radio/Optical Band) from Compact Stars (Part I)** *Speaker: Prof. RUTLEDGE, Bob*
10:45	Coffee break
11:15	**Observational Aspects regarding Electromagnetic Wave Emission (Radio/Optical Band) from Compact Stars (Part II)** *Speaker: Prof. RUTLEDGE, Bob*

Afternoon session (15:00-18:00)

time	title
15:00	**Exercise and discussion**

Thursday 05 May 2011

Morning session (09:00-13:00)

time	title
09:00	**Gravitational Wave Emission from Compact Stars (Part I)** *Speaker: Prof. FERRARI, Valeria*
10:45	Coffee break
11:15	**Gravitational Wave Emission from Compact Stars (Part II)** *Speaker: Prof. FERRARI, Valeria*

Afternoon session (15:00-18:30)

time	title
15:00	**Visit to the LNS**
16:00	Coffee break
16:30	**Exercise and discussion**

Friday 06 May 2011

Morning session (09:00-13:00)

time	title
09:00	**Protoneutron Stars and Supernovae (Part I)** *Speaker: Prof. LATTIMER, Jim*
10:45	Coffee break
11:15	**Numerical Relativity and Compact Stars (Part I)** *Speaker: Prof. STERGIOULAS, Nick*

Afternoon session (15:00-18:00)

time	title
15:00	**Exercise and discussion**

Saturday 07 May 2011

Morning session (09:00-13:00)

time	title
09:00	**Numerical Relativity and Compact Stars (Part II)** *Speaker: Prof. STERGIOULAS, Nick*
10:45	Coffee break
11:15	**Protoneutron Stars and Supernovae (Part II)** *Speaker: Prof. LATTIMER, Jim*

Monday 09 May 2011

Morning session I (08:30-12:45)

time	title
08:30	**Registration**
09:00	**Welcome**
09:15	**Neutrino emission from neutron stars** *Speaker: YAKOVLEV, D.* Neutrino emission governs thermal evolution of neutron stars. Numerous neutrino emission processes in various layers of neutron stars are reviewed, including slow (modified Urca, baryon-baryon bremsstrahlung) and fast (direct Urca, and direct-Urca like) processes in neutron star cores. The main regulators of neutrino emission are described such as the composition of dense matter, superfluidity of various particle species, and strong magnetic fields. The density and temperature dependence of neutrino emissivity in neutron stars is outlined as well as the temperature dependence of integrated neutrino luminosity of the stars. The prospects to constrain the properties of dense matter in neutron stars and current models of neutrino emission from observations of neutron stars are summarized.
10:15	**Cooling neutron star in the Cassiopeia A supernova remnant: Evidence for superfluidity in the core** *Speaker: SHTERNIN, P.* According to recent results of Ho and Heinke 2009,2010 the Cassiopeia A supernova remnant contains a young (330 yr old) neutron star (NS) which has carbon atmosphere and shows noticeable decline of the effective surface temperature. We report a new (November 2010) Chandra observation which confirms the previously reported decline rate. The decline is naturally explained if neutrons have recently become superfluid (in triplet-state) in the NS core, producing a splash of neutrino emission due to Cooper pair formation (CPF) process that currently accelerates the cooling. This scenario puts stringent constraints on poorly known properties of NS cores: on density dependence of the temperature Tcn(rho) for the onset of neutron superfluidity [Tcn(rho) should have a wide peak with maximum ~(5-9)x10^8 K], on the reduction factor q of CPF process by collective effects in superfluid matter (q > 0.4), and on the intensity of neutrino emission before the onset of neutron superfluidity (30--100 times weaker than the standard modified Urca process). This is serious evidence for nucleon superfluidity in NS cores that comes from observations of cooling NSs.
10:45	Coffee break
11:15	**Cooling of Cas A within the nuclear medium cooling scenario** *Speaker: BLASCHKE, D.* We show that the cooling data for the youngest known neutron star in our galaxy, observed over the past 10 years in the center of the supernova remnant Cassiopeia A (Cas A) can be successfully explained within the Nuclear Medium Cooling scenario suggested by us many years ago. In this scenario the cooling rates are sensitive to the values of the neutron star masses. The rapid cooling of Cas A lies in the early era when also a very sensitive dependence on the heat conductivity of neutron star matter emerges. Our results published 7 years ago allow to successfully explain the new data at the price of fitting the thermal conductivity coefficient. Besides the hadronic scenario, we also discuss a scenario when the core of the star contains color superconducting quark matter.
11:45	**Approximated neutrino treatment in multidimensional hydrodynamics simulations** *Speaker: PEREGO, A.* The production and the transport of neutrino (of all flavors) in hot and dense matter is one of the key physical ingredients in modelling astrophysical events, like core collapse supernovae and double neutron star mergers. Multidimensional hydrodynamical simulations of these scenarions, with increasing detailed microphysical inputs, are currently under fast development; however, their coupling with a standard, multidimensional Boltzmann neutrino transport is behind the current computational capabilities, even for large supercomputers. Then, approximated schemes for neutrino transport have to be developed (and, actually, some of them have been developed in the past years). In this talk, I present a simplified, but physically motivated, neutrino scheme, which is based on a previous grey (i.e. not spectral) leakage scheme. Starting from a simple interpolation between the diffusive and the free streming regimes, now it includes a more detailed, spectral treatment, and it can be applied to all neutrino flavors. The scheme is developed and tested against a 1D core collapse code, with detailed Boltzmann neutrino transport. The extension to 3D cases is also discussed, both for core collapse and neutron star merger simulations.
12:05	**Spin excitons in superfluid Fermi liquids and neutrino shine of Cooper-pair recombinations** *Speaker: KOLOMEITSEV, E.* A role of a particle-particle p-wave spin interaction in a Fermi liquid with s-wave pairing is studied. The interaction can bind two single-fermion excitations in a state different from the Cooper pair, forming a new collective mode. Depending on the interaction strength the mode may lie below the pair-breaking threshold (2\Delta). The residual interaction removes also the square-root singularity in the phase space of pair breaking processes. The significance of these effects in nuclear matter is discussed at hand of the neutrino emissivity in the neutron Cooper-pair recombination.

12:25	**Cosmic recycling of millisecond pulsars** *Speaker: HO, W.* We compare the rotation rate of neutron stars in low-mass X-ray binaries (LMXBs) with the orbital period of the binaries. We find that, while short orbital period LMXBs span a range of neutron star rotation rates, all the long period LMXBs have fast rotators. We also find that the rotation rates are highest for the systems with the highest mean mass accretion rates, as can be expected if the accretion rate correlates with the orbital period. We show that these properties can be understood by a balance between spin-up due to accretion and spin-down due to gravitational radiation. Our scenario indicates that the gravitational radiation emitted by these systems may be detectable by future ground-based gravitational wave detectors.

Afternoon session I (14:30-18:40)

time	title
14:30	**Gravitational wave emission from neutron stars** *Speaker: JONES, I.* Gravitational wave emission from neutron stars is sensitive to almost every imaginable aspect of the behaviour of matter at high densities. In this talk I will review the most important microphysical issues that impact on gravitational wave emission. I will describe what we have already learnt from gravitational wave searches, and comment on how improved theoretical understanding of neutron star matter could help shape the gravitational wave search strategies of the future.
15:30	**Oscillations of superfluid neutron stars with crust** *Speaker: PASSAMONTI, A.* We study the effects of an elastic crust on the oscillation spectrum of superfluid neutron stars. We linearise the two-fluid dynamical equations and study the spectrum as an eigenvalue problem. The star is nonrotating and contains superfluid neutrons both in the core and in the inner crust. The entrainment is described by the most recent nuclear physics results. We find that the superfluid neutrons of the crust and their large effective mass have a significant impact on the spectrum of the shear and acoustic modes.
16:00	**Decoupling of superfluid and normal pulsation modes in neutron and hyperon stars** *Speaker: GUSAKOV, M.* We show that equations governing pulsations of superfluid neutron and hyperon stars can be splitted into two sets of weakly coupled equations, one describing the superfluid modes and another one -- the normal modes [1]. The coupling parameter s of these two sets of equations is small for realistic equations of state. Already an approximation s=0 is sufficient to calculate the pulsation spectrum within the accuracy of a few percents. Our results indicate that emission of gravitational waves from superfluid pulsation modes is suppressed in comparison to that from normal modes. The obtained results explain numerical calculations (see, e.g., [2, 3]) and suggest simple perturbative (in parameter s) scheme which drastically simplify the problem of calculation of the pulsation spectrum for superfluid neutron/hyperon stars. In particular, the proposed approach allows us to easily take into account realistic equations of state, dissipation, various composition of matter, temperature effects, baryon superfluidity, density-dependent profiles of baryon critical temperatures, and stellar rotation (see also Ref. [4] where this approach was applied to study non-radial oscillations of superfluid neutron stars). The study was supported by the Dynasty foundation, Ministry of Education and Science of Russian Federation (contract # 11.G34.31.0001 with SPbSPU and leading scientist G.G. Pavlov), RFBR 11-02-00253-a, and FASI (grant NSh-3769.2010.2). [1] M.E. Gusakov, E.M. Kantor, accepted by PRD Rapid Communication, arXiv:1007.2752. [2] L. Lindblom and G. Mendell, Astrophys. J. 421, 689 (1994). [3] U. Lee, Astron. Astrophys. 303, 515 (1995); L. Lindblom and G. Mendell, Phys. Rev. D61, 104003 (2000); S. Yoshida and U. Lee, Phys. Rev. D67, 124019 (2003); L.-M. Lin, N. Andersson, and G. L. Comer, Phys. Rev. D78, 083008 (2008). [4] A. I. Chugunov and M. E. Gusakov, in preparation (the preliminary results are available at: http://www.cenbg.in2p3.fr/heberge/MSPWorkshop/IMG/pdf/A-_Chugunov.pdf).
16:30	Coffee break

17:00 **R-Modes Oscillations and Rocket Effect in Rotating Superfluid Neutron Stars**

Speaker: COLUCCI, G.

We present some results about a novel damping mechanism of r-mode oscillations in neutron stars due to processes that change the number of protons, neutrons and electrons. Deviations from equilibrium of the number densities of the various species lead to the appearance in the Euler equations of the system of a dissipative mechanism, the so-called rocket effect. The evolution of the r-mode oscillations of a rotating neutron star are influenced by the rocket effect and we present estimates of the corresponding damping timescales. In the description of the system we employ a two-fluid model, with one fluid consisting of all the charged components locked together by the electromagnetic interaction, while the second fluid consists of superfluid neutrons. Both components can oscillate however the rocket effect can only efficiently damp the countermoving r-mode oscillations, with the two fluids oscillating out of phase. In our analysis we include the mutual friction dissipative process between the neutron superfluid and the charged component. We neglect the interaction between the two r-mode oscillations as well as effects related with the crust of the star. Moreover, we use a simplified model of neutron star assuming a uniform mass distribution.

17:20 **Contribution of hydrodynamic modes to the thermal properties of nuclear « pasta » in the neutron star crust**

Speaker: DI GALLO, L.

Shortly after its formation the neutron star temperature becomes sufficiently low for parts of the matter inside the star to be superfluid and/or superconducting. The first observational evidence for superfluidity were given by glitches and more recently discussions about the surface thermal emission are in that sense. Thermal properties of neutron stars are very sensitive to superfluidity and superconductivity effects. Here we will focus on the inhomogeneous "pasta phases" in the inner crust. The spectrum of collective excitations will be discussed within a superfluid hydrodynamics approach.This approach allows to describe wavelengths longer than the size of the Wigner-Seitz cell, thus the low energy part of the spectrum is included. As an application, we will discuss the contribution of these collective modes to the specific heat in comparison with other known contributions.

17:40 **Modeling magnetar QPOs as magneto-elastic oscillations**

Speaker: GABLER, M.

We extend a general-relativistic ideal magneto-hydrodynamical code to include the effects of elasticity. Using this numerical tool we analyze torsional, magneto-elastic oscillations of highly magnetized neutron stars (magnetars) in order to interpret observed quasi-periodic oscillations (QPOs) in soft-gamma repeaters. For axisymmetric magnetic field configurations the crustal shear oscillations are damped efficiently well below typical magnetar field strength. However, the interaction of the Alfv\'en continuum found in the core with the magnetized solid in the crust leads to different families of QPOs. These QPOs split into three families: Lower QPOs near the equator, Edge QPOs related to the last open field line and Upper QPOs at larger distance from the equator. Edge QPOs are called so because they are related to an edge in the corresponding Alfv\'en continuum. The Upper QPOs are of the same kind, while the Lower QPOs are turning-point QPOs, related to a turning point in the continuous spectrum. On the way to study how these magneto-elastic QPOs may modulate the x-ray emission, we further construct force-free equilibria of the magnetosphere cause by these QPOs.

18:00 **SGRs and AXPs: Massive Rotating White Dwarfs versus Magnetares**

Speaker: MALHEIRO, M.

The recent observations of SGR 0418+5729 offer an authentic Rosetta Stone for deciphering the energy source of Soft Gamma Ray Repeaters (SGRs) and Anomalous X-ray Pulsars (AXPs). The "magnetar" model, appeals to a yet untested new energy source in astrophysical systems: bulk magnetic energy. It leads for SGR 0418+5729 to results in contradiction with observations. It is shown how a consistent model for SGRs and AXPs can be expressed in terms of canonical physics and astrophysics within massive, fast rotating, and highly magnetized white dwarfs. The pioneering work of B. Paczynski (1990) on 1E 2259+586 is extended and further developed to describe the observed properties of all known SGRS and AXPs by assuming spin-down powered massive, fast rotating, and highly magnetized white dwarfs. Within this model, we obtain the theoretical prediction for the lower limit of the first time derivative of the rotational period of SGR 0418+5729, $\dot{P} \geq L_X P^3/(4\pi^2 I)=1.18\times 10^{-16}$ s/s being L_X and P the observed X-ray luminosity and rotational period of the source, and I the moment of inertia of the white dwarf. Besides the case of SGR 0418+5729, we also show that the energetics of all SGRs and AXPs, including their outburst activities can be well explained through the change of rotational energy of the white dwarf, associated to the observed sudden changes of the rotational period. For all sources, we find a surface dipole magnetic field $7.5\times 10^8 {\rm G}\lesssim B \lesssim 2.1\times 10^{11} {\rm G}$, well below the critical field $B_c=m^2_e c^3/(e\hbar)=4.42\times 10^{13}$ G.

18:20 **Can exist extra dimensional compact stars over two solar mass?**

Speaker: BARNAFOLDI, G.

Recently an interesting observation were presented: a compact object were found with mass about 2 M_{sol}. The measurement were done by usig the Shapiro delay (See more: Nature, 467 1082 2010). The main aim of this talk is to show can this observation rule out the existence of compact objects in a non-standard space-time with one compactified extra dimension. We are investigating a stationary, spherical extra dimensional compact object in $3+1_c+1$ dimensional space-time with a specific solution, based on our earlier study (Ref. AN.328 809 2007).

Tuesday 10 May 2011

Morning session II (09:00-13:10)

time	title
09:00	**The equation of state problem: recent advances in microscopic many-body theories** *Speaker: RIOS, A.* The calculation of the equation of state of neutron star matter is one of the major open questions in nuclear physics. It goes back to the origins of the field and it is at the basis of a substantial amount of past, present and future experimental work. In this talk, some of the latest theoretical advances will be reviewed critically and new promising techniques, which might offer new solutions to this old problem, will be discussed.
10:00	**The dynamics of compact binary inspirals and mergers** *Speaker: PANNARALE, F.* Investigating the final evolution of neutron star and black hole-neutron star binary systems promises to be particularly rewarding. These systems, in fact, are excellent sources of gravitational waves and leading candidates as short gamma-ray burst progenitors. I examine the gravitational wave signals emitted during their inspiral phase and discuss whether or not they may be distinguished from the ones emitted by black hole binaries and, hence, unveil information about the behaviour of matter at extreme densities. I moreover review the present understanding in the modelling of binary neutron star mergers in full General Relativity, underlining the considerable recent progress in both hydrodynamics and magnetohydrodynamics. Finally, I analyze the steps that still need to be taken in order to use this progress to model the central engine of short gamma-ray bursts.
10:30	**What a 2 Solar Mass Neutron Star Means** *Speaker: LATTIMER, J.* The recent determination a mass for PSR J1614-2230 of 1.97 Suns, with a one-sigma uncertainty of only 0.04 Suns, has important ramifications for neutron star properties. I will discuss model-independent limits to the energy density, pressure, spin period and baryon chemical potential using causality and general relativity, together with this mass. In addition, this measurement severely restricts, but does not rule out, the possibility of a significant amount of quark matter, either in a pure state or a mixed phase with hadrons. I will discuss more extreme limits that would ensue should the recent estimate of 2.4 Suns (0.4 Sun uncertainty) for the mass of the black widow pulsar, B1957+20, be confirmed. In addition, I will discuss recent refinements of the masses of several low-mass X-ray binaries which indicate that one or more could contain very light neutron stars, perhaps as low as 0.9 Suns. This would pose great difficulties for the present supernova paradigm of neutron star formation which demands their birth in a lepton-rich proto-neutron star phase.
11:00	Coffee break
11:30	**Are hybrid stars and twins excluded by the mass measurement of PSR 1614-2230 ?** *Speaker: LASTOWIECKI, R.* The recent mass measurement of PSR 1614-2230 has cast doubts on the possible existence of hybrid stars. We discuss results obtained within the three-flavor color superconducting NJL model for the equation of state (EoS) and resulting hybrid star configurations. We show that sufficiently high masses can be obtained for hybrid configurations provided quark matter is color superconducting with a nonvanishing vector coupling. Furthermore, twin configurations with high masses of about 2 M_sun can be obtained when additional contributions from the gluon sector are taken into account.
11:50	**CompOSE - The CompStar Online Supernovae Equations of state** *Speaker: KLAEHN, T.* I will report on recent progress in the development of a publicly available database for state of the art equations of state which have been developed within and outside of the CompStar RNP. I will present the basic functionality of the web interface which is already working and currently in a pre-release state. Further development steps and pending ideas will be discussed. This concerns technical questions as standardization and extent of provided data as well as the inclusion of meaningful additional information connected to the EoS. As an example, the agreement of EoS with available constraints from astrophysics and heavy ion collisions is of interest for potential users of the provided data tables. A last point of the presentation covers the question of modeling phase transitions, in particular from nuclear to quark matter, within the CompOSE framework.

12:10	**New results on 3D EoS for SN and NS simulations: the phase transition between inner crust and core of NS** *Speaker: PAIS, H.* We performed a three-dimensional, finite temperature Skyrme-Hartree-Fock + BCS (SHF) study of the inhomogeneous nuclear matter at density and temperatures leading to the transition to uniform matter. The transition is dependent on the effective nucleon-nucleon interaction used in the SHF model. We used four interactions, SkM*, SLy4, NRAPR and SQMC700 in the region of particle number densities 0.07 - 0.12 fm^-3, temperatures 0 - 6 MeV and proton fraction equal to 0.3. We find a smooth change in free energy, pressure and entropy of nuclear matter with increasing density and temperature up to a certain point in the density-temperature plane at which a discontinuity occurs, which is interpreted as a phase transition of either of the first or second order. The parameters of this transitions are discussed in the view of general properties of the Skyrme interactions used, such as the incompressibility of infinite nuclear matter and the symmetry energy.
12:30	**Estimation of the effect of hyperonic three-body forces on the maximum mass of neutron stars** *Speaker: VIDAñA, I.* A model based on a microscopic Brueckner--Hartree--Fock approach of hyperonic matter supplemented with additional simple phenomenological density-dependent contact terms is employed to estimate the effect of hyperonic three-body forces on the maximum mass of neutron stars. Our results show that although hyperonic three-body forces can reconcile the maximum mass of hyperonic stars with the current limit of $1.4-1.5 M_\odot$, they are unable to provide the repulsion needed to make the maximum mass compatible with the observation of massive neutron stars, such as the recent measurements of the unusually high masses of the millisecond pulsars PSR J1614-2230 ($1.97 \pm 0.04 M_\odot$) and PSR J1903+0327 ($1.667 \pm 0.021 M_\odot$).
12:50	**Restoration of the UA(1) symmetry in hot strongly interacting matter** *Speaker: BENIC, S.* A minimal generalization of the Witten-Veneziano relation to finite temperatures is proposed, mandated by STAR and PHENIX experimental results on eta' multiplicities. These results show that the zero-temperature Witten-Veneziano relation cannot be straightforwardly extended beyond temperatures T too close to the chiral restoration temperature T_Ch. Instead, a temperature dependence which should replace the T-dependence of the pure-gauge, Yang-Mills topological susceptibility in order to avoid the conflict of the Witten-Veneziano relation with experiment at T > 0, is proposed. This is illustrated through concrete T-dependences of pseudoscalar meson masses in a chirally well-behaved, Dyson-Schwinger approach.

Afternoon session II (14:30-18:30)

time	title
14:30	**The neutron star inner crust: upper limits on the observational consequences of nuclear pasta** *Speaker: NEWTON, W.* The composition of the inner neutron star crust has a number of observational consequences via its impact on the mechanical, thermal and hydrodynamic properties of the crustal matter. We examine the uncertainties in the crustal composition resulting from our current experimental uncertainties in the nuclear equation of state, focusing on the crust-core boundary layer's density and pressure, proton and free neutron fraction, and nuclear geometry. We derive upper limits on the observational signature of the non-spherical pasta layers.
15:00	**Nuclear symmetry energy at low density: impact on neutron-star crust** *Speaker: DUCOIN, C.* The density evolution of the symmetry energy is one of the major issues in exotic nuclear physics, where the isospin plays a crucial role. The equation of state of asymmetric nuclear matter is a basic input for the modelization of compact stars, and future nuclear experimental data are expected to better constrain the models. In particular, the symmetry energy at sub-saturation density affects the core-crust transition in neutron stars; this transition determines the mass and width of the crust, which are important to interpret the astrophysical observations. As regards nuclear experiments, several observables have been proposed to give a measure of L, the symmetry-energy slope at saturation density. In this presentation, I will explore the link between L and the core-crust transition, comparing the predictions of various nuclear models. This study emphasizes the importance of measuring low-density isospin properties in nuclei.

15:20 **Investigation of symmetry breaking and fluctuations on matter self-organisation in Neutron Star crusts, from crystalline to exotic structures**

Speaker: SéBILLE, F.

Theoretical models of NS assume that the outermost layer has the structure of a crystalline lattice of neutron-rich nuclei immersed in a degenerate electron gas. The inner part of the crust is composed by neutron-rich nuclei and electron gas and, in addition, by a gas of free neutrons. In this work we present a dynamical approach, the DYWAN model [1], to investigate the expected development of complex structures with many possible nuclear shapes in neutron star crust [2]. These structures are related to the existence of a large number of low-energy configurations. The objective is to address the question of structural configurations both beyond a mean-field approximation and the Wigner–Seitz approximation [3]. Since at low-energy excitations the leading contribution is provided by the mean-field, the latter has been studied in connexion with expected nuclear matter Equation of State [4], and its accuracy checked through the survival of meta-stable equilibrium over time periods longer than some thousands fm/c [5]. Current investigations relevant to neutron star crusts, include the sensitivity to the initial inputs of the self-consistent treatment , like nuclei species, heterogeneities, crystal lattice structures, as well as to collective, thermal excitations and fluctuations. Suitable treatments of particle correlations, dissipative effects and density fluctuations can be introduced in the model, these aspects are currently in progress and address the study of the behaviour of hot and excited matter as well as transport properties.

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[2] G. Watanabe et al. Phys. Rev. C 66 (2002) 012801(R).
[3] N.Chamel, S. Naimi, E. Khan, and J. Margueron, Phys. Rev. C 75 (2007) 055806
[4] B. Friedman, V.R. Pandharipande, Nucl. Phys. A (1981) 501.
[5] F. Sébille, F. Figerou and V. de la Mota, Nucl. Phys. A 822 (2009) 51.

15:40 **Crust-core transition in Neutron Stars**

Speaker: ALVAREZ CASTILLO, D.

The edge of the inner crust in Neutron Stars marks the start of a liquid core. This transition is investigated by means of a two fluid model, in the bulk approximation frame, which obeys thermodynamic Gibbs conditions, for various nuclear models. The energy per barion in the parabolic approximation includes the symmetry energy term which we empirically parametrize and separate into a high density and low density regions. The low density part plays a major role in the determination of the crust properties, i.e. mass, dimensions, moment of inertia, etc. Clusterization at low densities and the measured values at the saturation point are taken into account when building the symmetry energy form.

16:00 Coffee break

16:30 **Numerical solutions of force-free magnetosphere in NSs**

Speaker: VIGANò, D.

The study of the magnetosphere in magnetars is important to understand the properties of observed spectra. Since the Sixties, some force-free magnetospheric models have been proposed for pulsars. These are obtained in ideal MHD approximation, in which one neglects inertial, collisional and gravitational terms, due to the overwhelming electromagnetic forces. We present some results of a numerical relaxation approach, similar to the magnetofrictional method, widely used in modeling the solar corona (Roumeliotis et al. 1994). Our code provides axisimmetric force-free configurations, in which the geometry of the current distribution and the toroidal magnetic field is generally different from the self-similar solutions presented in Thompson et al. (2002), Pavan et al. (2009). We estimate the effects of resonant Compton scattering through the magnetosphere of magnetars and we discuss how their observed spectra are affected by different geometries of force-free configurations.

16:50 **Deconfinement to Quark Matter in Magnetars**

Speaker: DEXHEIMER, V.

We study the effect of high magnetic fields on the particle population of hybrid stars using an extended hadronic and quark SU(3) non-linear sigma model. In this model the degrees of freedom change naturally from hadrons to quarks as the density and/or temperature increases. The effects of high magnetic fields are visible in the macroscopic properties of the star, in particular in the predicted cooling curves.

17:10 **Magnetic fields generated by r-modes in accreting compact stars**

Speaker: BONANNO, L.

I show that the r-mode instability can generate strong toroidal fields in the core of accreting millisecond compact stars by inducing differential rotation. By following the spin frequency evolution on a long time scale and taking into account the magnetic damping rate in the evolution equations of r-modes, one finds different scenarios for neutron stars and quark stars. In particular, quark stars leave the millisecond pulsar region and evolve into radio pulsars.

17:30 **Neutron star matter in high magnetic field: possibility of conversion of neutron star to quark star**

Speaker: SINHA, M.

Pulsars are believed to be magnetized neutron stars (NS). Their surface magnetic field ranges from 10^8 to 10^12 G. On the other hand, the magnetars have surface field 10^14 - 10^15 G. It is believed that at the center, the field may be higher than that at the surface. Recent results and data suggest that high magnetic field in NS strongly affects the characteristic of the star. We study the effect of magnetic field on the NS matter and hence on the mass-radius relation of NS. We find that the effect of magnetic field on the NS matter is important when central magnetic field \ge 10^17 G. Moreover, if the central field is of the order of 10^19 G, then the matter becomes unstable which limits the maximum magnetic field at the center of magnetars. Then we discuss the effect of such high magnetic field on the phase transition of NS to quark star. We notice that the presence of magnetic field helps in initiation of the conversion process. The velocity of the conversion front however decreases due to the presence of magnetic field, as the presence of magnetic field reduces the effective pressure.

17:50 **Magnetized neutron star matter through relativistic Landau parameter description**

Speaker: PEREZ-GARCIA, M. Angeles

The Landau Fermi Liquid parameters are calculated for charge neutral asymmetric nuclear matter in beta equilibrium at zero temperature in the presence of a very strong magnetic field with relativistic mean-field models. Due to the isospin structure of beta equilibrium neutron star matter in presence of a strong magnetic field, with different populations of protons and neutrons and spin alignment to the field, we find non-vanishing Landau mixing parameters. Using the Fermi liquid formalism singlet and triplet excited quasiparticle states are analyzed, and we find that in-medium effects and magnetic fields are competing, however, the former are more important in the interaction energy range considered. It is found that for magnetic field strengths Log$_{10}$ B (G) ≤ 17 the relative low polarization of the system produces mild changes in the generalized Landau parameters with respect to the unmagnetized case, while for larger strengths there is a resolution of the degeneracy of the interaction energies of quasiparticles in the system.

Wednesday 11 May 2011

Morning session III (09:00-13:30)

time	title
09:00	**Numerical Relativity and Compact Stars** *Speaker: STERGIOULAS, N.*
10:00	**Overview of Gravitational Wave Detectors** *Speaker: PUNTURO, M.* The worldwide network of interferometric gravitational wave detectors is in a crucial turning point: the initial interferometers are completing their activities and an important upgrade step, toward the so called "advanced detectors", is under implementation. The working principles of these apparatuses will be described and the present status and results will be presented. The advanced detectors characteristics and the 3rd generation perspectives will be discussed.
11:00	Coffee break
11:30	**Stellar oscillations of hot young neutron stars** *Speaker: GUALTIERI, L.* We study the oscillation properties of a neutron star (NS) in the first minute of life after its birth in the aftermath of a core-collapse supernova explosion.To describe the NS core, we employ a finite-temperature equation of state (EOS) recently derived in the framework of nuclear many-body theory, using the Brueckner-Hartree-Fock approach; the envelope, instead, is described using the mean-field theory EOS of Shen. We determine how the frequencies and damping times of the quasi-normal modes of the hot, young NS depend on the physical quantities which characterize the stellar configurations during its quasi-stationary evolution, like the profiles of entropy and lepton fraction. We show that if the entropy jump between core and envelope is large, the frequencies of the first g-mode, of the fundamental mode and of the first p-mode tend to cluster in a small region near 1 kHz. Furthermore, the damping time of the first g-mode and of the f-mode are comparable. Therefore, during the initial phases of the NS evolution, the first g-mode can be as efficient as the f-mode as a source of gravitational waves.
12:00	**Gravitational Waves and Accretion Torques in Accreting Millisecond Pulsars** *Speaker: PATRUNO, A.* Accreting Millisecond Pulsars (AMPs) are ideal astronomical labs to test standard accretion theory. The torques acting on the accreting pulsar are induced by mass accretion and have a magnitude that depends mainly on the amount of mass transferred, the strength of the pulsar magnetic field and the pulsar spin frequency. However, in many AMPs the measured strength of spin frequency variations implies accretion torques whose magnitude is much smaller than expected from standard accretion theory. Therefore two hypothesis become viable to explain this: the presence of negative torques balancing accretion torques or the transfer of a small amount of angular momentum during the accretion process. We investigate the first possibility under the hypothesis that gravitational waves are at the origin of the negative torques. The second scenario instead is discussed under the hypothesis that some AMPs have reached spin equilibrium and gravitational waves do not play a dominant role.
12:20	**Status and Improvements for Schenberg Gravitational Wave** *Speaker: FRAJUCA, C.* A spherical gravitational wave (GW) detector has a heavy ball-shaped mass which vibrates when a GW passes through it. Such motion is monitored by transducers and the respective electronic signal is digitally analyzed One of such detectors, "Mario Schenberg", has resonant frequencies around 3.2 kHz with a bandwidth near 200 Hz. SCHENBERG weights 1.15 ton, it is being built in the Department of Materials at the University of Sao Paulo, its sphere has 65 cm in diameter and is made of a copper-aluminum alloy with 6% Al. The frequencies of running resonant-mass detectors typically lay below 1 kHz, making the transducer development for this higher frequency detector, somehow more complex. In this work, besides showing the status of the detector, a design of a improved mechanical impedance matcher for the microwave parametric transducer is presented. This design has many capabilities that the present one does not have, for instance the capability to change the size of the gap during operation and to operate in lower temperatures. To change the gap during the assembling of the detector, the presence of a micrometric screw is proposed, and to change the gap during operation, a electrostatic field is proposed. To improve the cooling down capability a presence of a copper film is proposed in some of the mechanical impedance matcher surfaces.
12:40	**Spinning up neutron stars to millisecond periods** *Speaker: ZDUNIK, J. L.* The evolution of a magnetized neutron star accreting matter from a disk is discussed. The dependence of the results on the magnetic field decay model is demonstrated. Results for different EOS are presented including softening of the matter due to the hyperon appereance. Rotating neutron stars and orbits around are calculated in the framework of general relativity. Approximate formulae for the parameters of an innermost orbit are derived. The role of relativistic effects is discussed and application of the model to some observed binary millisecond pulsars is presented. Measurements of the mass and magnetic field of a millisecond pulsar set the limit on the mean accretion rate in a close binary system where it had been spun up.

13:10 **Double neutron stars as sources of gravitational waves**

Speaker: GONDEK-ROSINSKA, D.

Coalescing neutron star binaries are expected to be among the most promising sources of gravitational radiation to be seen by VIRGO/LIGO detectors. I summarize our studies on properties of double neutron stars observable in gravitational waves and in the radio taking into account the selection effects specific to each method of detection. I will also review recent relativistic numerical results on late inspiral of neutron star binaries showing how we can impose constraints on the equation of state of dense nuclear matter with gravitational wave observations.

Free afternoon for excursion. Banquet at 20:00. (15:00-23:00)

Thursday 12 May 2011

Morning session IV (09:00-13:00)

time	title
09:00	**Many-body aspects in the physics of Compact Stars** *Speaker: BENHAR, O.*
10:00	**Superfluid compact stars** *Speaker: MANNARELLI, M.* We shall discuss some properties of matter at large densities. At very high baryonic densities the quark content of hadrons should be liberated and the actual degrees of freedom are deconfined quarks and gluons. At asymptotic density the favored phase can be determined employing QCD and it is known to be the color flavor locked (CFL) phase. This is a color superconductor and a "baryonic" superfluid, with very peculiar properties. We shall discuss the low energy properties of the CFL phase and derive the Lagrangian describing the collective modes of the system using the high density effective theory. The interaction terms of collective modes and vortices are determined and some generalization in the framework of the gravity analogs is proposed. Application to compact stars are briefly outlined.
10:30	**Moving of Vortices in Neutron Stars Core and Radioluminosity** *Speaker: AYVAZYAN, N.* Neutron star cores contain superfluid neutrons and superconductive protons. Because of star rotation they produce vortices. As the star spins down the vortices move toward the core crust boundary from the center of the star and hence the length of the vortices becomes shorter. We consider the energy release due to the shrink of the vortices as a possible source of radio emission from neutron stars and compare this with observations.
11:00	Coffee break
11:30	**Unified equation of state for supernova cores and neutron stars using the nuclear energy density functional theory** *Speaker: FANTINA, A. F.* Because of the wide range of conditions encountered in supernova cores and neutron star interiors spanning very different states of matter (densities from a few g cm^{-3} up to about 10^{15} g cm^{-3}, temperatures from 0 to hundreds of MeV, and nuclear isospin asymmetry), a fully microscopic description of the equation of state (EoS) is a very challenging task. An unified EoS based on the nuclear energy density functional theory will be presented. This approach is particularly well-suited for describing both the homogeneous and inhomogeneous phases of dense matter. In the latter case, the energy is calculated using the temperature-dependent Thomas-Fermi method extended up to the 4th order. Proton quantum shell effects are included via the Strutinsky integral theorem. The EoS is determined employing Skyrme functionals fitted to essentially all experimental nuclear mass data and constrained to reproduce various properties of infinite nuclear matter as obtained from many-body calculations using realistic two- and three-body interactions. Three different EoS at zero temperature will be shown, as well as some preliminary results at finite temperatures.
11:50	**New Equations of State in Simulations of Core-Collapse Supernovae** *Speaker: HEMPEL, M.* We investigate the implications of three new equation of state (EOS) tables in simulations of core-collapse supernova of massive stars. The spherically symmetric core collapse model applied is based on general relativistic radiation hydrodynamics and three flavor Boltzmann neutrino transport. First we give an introduction to the EOS model and highlight the most important differences compared to other commonly used EOSs. These are the inclusion of nuclear distributions in nuclear statistical equilibrium, among them light clusters like the deuteron, and new relativstic mean-field interactions which have not been studied in core-collapse supernova so far. We find that the additional light clusters appear in similar or even larger concentrations than the alpha particle in shock heated matter. At the end we discuss how supernova observables like the neutrino signal could be used to constrain the properties of the EOS. Most importantly, we find that the different EOSs leave a clear imprint on the time until black hole formation for a 40 M_sun progenitor and the mean energy of emitted mu- and tau-neutrinos.

12:10 **Breaking stress of neutron star crust**

Speaker: CHUGUNOV, A.

The breaking stress (the maximum of the stress-strain curve) of neutron star crust is important for neutron star physics including pulsar glitches, emission of gravitational waves from static mountains, and flares from star quakes. We perform many molecular dynamic simulations of the breaking stress at different coupling parameters (inverse temperatures), strain rates and composition of matter. We describe our results with the Zhurkov model of strength. We apply this model to estimate the breaking stress for timescales ~1 s -- 1 year, which are most important for applications, but much longer than can be directly simulated. At these timescales the breaking stress depends strongly on the temperature. For coupling parameter $\Gamma<200$ matter breaks at very small stress, if it is applied for a few years. This viscoelastic creep can limit the lifetime of mountains on neutron stars. We also suggest an alternative model of timescale-independent breaking stress, which can be used to estimate an upper limit on the breaking stress. This work was partially supported by the Russian Foundation for Basic Research (grant 11-02-00253-a), by the State Program ``Leading Scientific Schools of Russian Federation'' (grant NSh 3769.2010.2), by the President grant for young Russian scientists (MK-5857.2010.2), by United States DOE grant (DE-FG02-87ER40365) and by Shared University Research grants from IBM, Inc. to Indiana University.

12:40 **The contribution of longitudinal plasmons to the thermodynamics of dense electron plasma**

Speaker: KLIMENKO, V.

We study plasma effects on thermodynamics of equilibrium electromagnetic radiation in dense electron plasma of arbitrary degeneracy. At the temperatures close to the plasma temperature the significant contribution arises from the longitudinal plasma waves. In the non-relativistic plasma this contribution is dominant over the contribution from transverse photons due by the factor $(c/v_f)^3$ which comes from the plasmon occupation number. Applications of these results to radiation transfer in neutron stars envelopes are discussed.

Afternoon session IV (14:20-18:50)

time title

14:20 **Magneto-rotational neutron star evolution: the role of core vortex pinning**

Speaker: GLAMPEDAKIS, K.

We consider the pinning of superfluid (neutron) vortices to magnetic fluxtubes associated with a type II (proton) superconductor in neutron star cores. We demonstrate that core pinning affects the spin-down of the system significantly, and discuss implications for regular radio pulsars and magnetars. We find that magnetars are likely to be in the pinning regime, while most radio pulsars are not. We discuss some astrophysical implications of this result.

14:50 **Multifluid models of pulsar glitches**

Speaker: HASKELL, B.

Glitches, i.e. sudden increases in the spin rate, have been observed in more than a hundred pulsars, some of which have now been studied for 30 years. Our theoretical understanding of these phenomena is, however, still unsatisfactory. I will show how the multifluid approach to superfluid neutron star modelling (which has been successfullyy applied to stellar oscillations) can be used, together with the pinning forces calculated by Grill and Pizzochero, to describe the giant glitches of the Vela pulsar. I will also discuss which micro-physical inputs are required for the model and suggest directions for future research.

15:20 **Gravitational collapse to third family compact stars**

Speaker: BRILLANTE, A.

The transition from neutron stars to denser stars with a softer equation of state is being discussed since the late 70's. Even before, Gerlach introduced the concept of a "third family of stable equilibria", besides white dwarfs and neutron stars. We present a study of hybrid stars, where the deconfined phase is described by the MIT bag model with finite strange quark mass and superconducting gap. For the equation of state of the normal phase the relativistic mean-field model is employed. The dynamical process of quark core formation is studied with a simplified hydrodynamical approach assuming a constant density core. The emission of gravitational waves during the transition of rotationally distorted stars are studied using the quadrupole approximation. Corresponding twin stars are selected by demanding equal baryon number and angular momentum. The impact of the parameter choice for the quark matter equation of state on the energy release and dynamics of the collapse is investigated. Bekenstein's charge-generalization of Misner's and Sharp's approach for the relativistic radial motion of an ideal liquid is presented in a new form, using Eulerian coordinates.

15:40 **Magnetic field estimates for accreting neutron stars in massive binary systems and comparison with magnetic field decay models**

Speaker: CHASHKINA, A.

Some modern models of neutron star evolution predict that initially large magnetic fields rapidly decay down to some saturation value $\sim {\rm few} 10^{13}$~G. Lower magnetic fields do not decay significantly (Pons, et al., 2009). It is difficult to check predictions of the model for initially highly magnetized objects on the time scale of few million years. We propose to use Be/X-ray binaries for this purpose. We use several different methods to estimate magnetic field of neutron stars in this accreting systems using the data obtained by the RXTE satellite (Galache et al., 2005). Only using the most modern approach proposed by Shakura et al. (2011) we are able to obtain a field distribution compatible with predictions of the theoretical model of field decay: even neutron stars with the longest spin periods then have magnetic fields $<{\rm few} 10^{13}}$~G.

16:00	Coffee break
16:30	**Supercritical accretion onto compact objects** *Speaker: ABOLMASOV, P.* Being one of the most effective processes of energy release, accretion onto compact objects may easily produce super-Eddington luminosities. Super-Eddington, or supercritical accretion is probably a common phenomenon among massive stars accreting on thermal and sometimes even on evolutionary timescales. Complex outflows and thick discs shift the spectral energy distribution toward UV/EUV or even optical spectral range and also disturb the surrounding interstellar or circumstellar medium. Both effects give origin to bright emission line nebulae. I compare these theoretical predictions to the observational data on several Ultraluminous X-ray sources and a couple of related objects including SS433 and WR+BH binaries.
16:50	**Thermal evolution and braking indices of young pulsars** *Speaker: KANTOR, E.* We study whether thermal evolution of young pulsars can have an effect on their braking indices. We employed a model which assumes that a star possesses strong enough magnetic field with toroidal component so that toroidal magnetic flux tubes can pin neutron vortices. In the latter case glitches occur in the outer core, where the toroidal field is localized (R. Dib, V. M. Kaspi, F.P. Gavriil. ApJ, 673, 1044 (2008)). In our simplified model we assumed that the star spins down due to the magnetic dipole radiation. In that case the braking index should be equal to 3. However, as the star cools down a fraction of superfluid neutrons which is effectively decoupled from the rest of the star, increases. This affects the stellar dynamic properties, and, in particular, noticeably reduces its braking index. The indices calculated allowing for such an effect agree well with the observations of five young pulsars whose braking indices are the only reliably measured and all lie in the range from 2 to 3 (M.A. Livingstone, et al. Astrophys. Space Sci, 308, 317 (2007)). The study was supported by the Dynasty foundation, Ministry of Education and Science of Russian Federation (contract # 11.G34.31.0001 with SPbSPU and leading scientist G.G. Pavlov), RFBR 11-02-00253-a, and FASI (grant NSh-3769.2010.2).
17:10	**Population synthesis of isolated compact objects** *Speaker: BOLDIN, P.* Population synthesis is a method for direct modeling of various populations of weakly interacting objects with non-trivial evolution. Population synthesis can be applied to a wide range of sources: from isolated stars to interacting binary stars. It can be used to study various subjects: from HR-diagram of stellar clusters to the number of double radiopulsars in our Galaxy. We describe population synthesis using the example of isolated cooling neutron stars. With plausible distributions of initial parameters it is possible to calculate a synthetic Log N -- Log S distribution, and to compare it with the observed one. The initial parameters of such a model include: birth rate, spatial and velocity distributions, mass spectrum, and of course a set of cooling curves. Among all ingredients of this population synthesis cooling curves are the most important. Our population synthesis code can be used as an additional test for cooling curves of isolated neutron stars. In this respect it is useful to test the underlying nuclear physics. In order make our code easily accessible for the community, we wrapped it into a web-tool (http://www.astro.uni-jena.de/Net-PSICoNS/) which everyone can use to check their cooling curves by comparison of the modeled and observed Log N -- Log S distributions. The web-tool is described in Boldin et al. Astron. Nach. 332, 122 (2011).
17:30	**Multi-dimensional Hydrodynamical Simulations of the Burning of a Neutron Star to a Hybrid Star** *Speaker: HERZOG, M.* We perform multi-dimensional hydrodynamical simulations of the conversion of a hadronic neutron star to a strange quark star. Following the example of thermonuclear burning in white dwarfs, we model the conversion process as a combustion. First results show that the combustion becomes turbulent and the resulting star is a hybrid star containing a atrange quark matter core and a hadronic outer layer.
17:50	**Some aspects of the thermal properties of accreting neutron stars** *Speaker: FORTIN, M.* Quasi-persistent neutron star X-ray binaries exhibit two distinct phases. During the outbursts, that are characterized by a high luminosity (of the order of 10^36-10^39 erg s^-1), the neutron star accretes matter for periods ranging from years to decades. Then, in the quiescent phase, when accretion significantly decreases, the luminosity is significantly lower (less than ~10^34 erg s^-1). In the deep crustal heating scenario (Brown et al., 2008), during the outbursts, the accreted matter sinks deeper into the crust as new material is accreted and it undergoes a series of nuclear reactions. In quiescence, the heat released by the reactions propagates through the neutron star and is radiated away. The subsequent cooling enables to constraint the properties of neutron stars. Previous works (Shternin et al., 2007; Brown & Cumming, 2009) show that the cooling of two of these quasi-persistent neutron star X-ray binaries, KS 1731-260 and MXB 1659-29, is consistent with a standard neutrino emission, a high thermal conductivity and neutron superfluidity in the crust. Recent observations of two other sources, EXO 0748-676 and XTE J1701-462 (Fridriksson et al., 2010 ; Diaz Trigo et al., 2011) suggest residual accretion during quiescence. We present models of the cooling of these Soft X-ray Transients.
18:10	**Concluding Remarks**

POSTERS

M. Bejger : The progenitor neutron star of PSR J1614-2230

P. Blottiau : Impact of electro-weak processes in type II supernovae collapse

D. Chatterjee : Role of nonlinear bulk viscosity in r-mode instability

A. Danilenko : Optical spectroscopy of the Guitar Nebula

G. Di Bernardo : Implications of recent measurements on Cosmic Ray electrons, positrons and light nuclei

M. Fortin : 2 Solar mass pulsar and the EoS of hyperon matter

Xu-Guang Huang: Bulk viscosities and r-mode of a magnetized quark star

F. Grill : Vortex-Lattice interaction in pulsar glitches

A. Kirichenko : A likely optical counterpart of the PSR J1357-6429

G. Kovacs : GR and numerical methods

C. Losa : Superfluid properties of the inner crust of neutron stars with finite range pairing interaction

A. Lovato : Density dependent nucleon-nucleon interaction

A. Marunovic : Radial stability of the dark-energy stars

E. Massot : EOS of hyperon matter within a relativistic chiral HF description

G. Pagliara : Formation of quark-hadron mixed phases in protoneutron stars

L. Samuelsson : Ambipolar diffusion in superfluid neutron stars

A. Snopek : The influence of the EoS on the maximum mass of differentially rotating neutron stars

M. Timofeyeva : Properties of nucleon-hyperon matter

D. Zyuzin : 3C 58 and G292.0+1.8 pulsar wind nebulae in the optical and infrared