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Book of Abstracts

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Plenary Talk / 0

Gravitational waves from isolated neutron stars

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Isolated neutron stars can emit gravitational waves via a variety of mechanisms. These emission channels are highly sensitive to the nature of matter in the star, and can potentially reveal information on the high density equation of state not accessible via other means. In this talk I will review these mechanisms, and discuss how they relate to the microphysics of the stellar matter. I will also talk about the gravitational wave upper limits obtained thus far, discuss what they already tell us about neutron star physics, and look ahead to the future.

Plenary Talk / 1

gravitational wave emission from isolated neutron stars and the dynamics of the associated unstable oscillation modes

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This talk will provide an update on gravitational wave emission from isolated neutron stars and on the dynamics of the associated unstable oscillation modes.

Plenary Talk / 2

Some new aspects of the QCD phase transition in proto-neutron stars and core-collapse supernovae

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Recently it was shown that a phase transition to deconfined quark matter can lead to the formation of a novel kind of third family of compact stars, that is present only in the hot, early stages of their evolution. Such a feature can be related to unusual thermal properties of the equation of state in the phase coexistence region, which manifest themselves as a negative slope of the phase transition line in the pressure-temperature phase diagram. A third family is interesting for core-collapse supernovae, as a collapse from the second to the third branch could trigger an explosion, as indicated in previous works. In addition, the unusual thermal properties could lead to a special, inverted form of convection in proto-neutron stars.

Plenary Talk / 3

Measurements of Masses and Radii Of Neutron Stars

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In this talk I will present the current state of mass and radius measurements of neutron stars in low mass X-ray binaries obtained during thermonuclear X-ray bursts or in quiescence. Taking into account a number of systematic uncertainties that may be present in

the measurements as well as the results of recent theoretical calculations we obtain strong and quantitative constraints on the properties of the equation of state between above
the nuclear saturation density. Our measurements strongly favor radii in the 9.9-11.2 km range for a ˜1.5 M_{sun} neutron star.

Afternoon session / 4

The Critical Strain Angle along the Neutron Star Crust

We estimate the critical strain angle throughout the neutron star crust. We propose that the critical strain angle is proportional to the ratio of the total Coulomb potential energy to the kinetic energy of the relativistic electrons, $\theta_{cr} \sim E_C/E_K$, in one Wigner-Sietz cell. Since the character of the Coulomb interaction varies throughout the inner crust according to the shapes of the nuclear pasta geometries (i.e. spherical, rod, slab), the critical strain angle is also variable from layer to layer. We found that θ_{cr} is around 0.1 in the outer crust which is in agreement with the numerical results of Horowitz&Kadau(2009), whilst it reduces to $10^{-2} - 10^{-3}$ in the inner crust where the rod-like and slab-like configurations exist, thus the crust becomes more fragile. We also include the weak screening effect in terms of the Thomas-Fermi model that doesn't change the results appreciably. Our results are also compatible with the recently observed minimum glitch of the Crab pulsar in the scope of the starquake model from which we also obtain some clues about the nature of the fracturing process and the vortices unpinning in the inner crust.

Afternoon session / 5

The effect of the magnetic field on the inner crust of neutron stars

The effect of strong magnetic fields, of the order of 10^{16}-10^{17}G, on the extension of the crust of magnetized neutron stars is discussed. The dynamical instability region of neutron-proton-electron matter at subsaturation densities and the mode with the largest growth rate are determined within a relativistic mean field model. It is shown that a strong magnetic field has a large effect on the instability region, defining the crust-core transition as a wide density range.

Afternoon session / 6

Spin polarized neutron star matter and core-crust transition in the neutron stars

It is well known that the magnetars and the pulsars are neutron stars have strong surface magnetic field about 1015 [2] and 1013 [3] Gauss, respectively. The structural properties of these objects, such as its maximum mass and the location of core-crusts interface, is a subject that theoretical astrophysicists have desired to study. In order to determine the core-crust transition parameters, the equation of state (EOS) and the nuclear symmetry energy play a crucial role [1]. The EOS of the neutron star matter depend on spin polarized states which can be produce by super strong magnetic fields. Therefor the investigation of the neutron star properties at different spin state becomes important. In this work, we study the effect of the spin polarization on the core-crust transition parameters. In this work, we have used the spin polarized dependent nuclear symmetry energy that is computed in the lowest order constrained variational (LOCV) formalism as a microscopic approach [4]. The LOCV method is a powerful tool for determination of the properties of the nucleonic matter at zero

and finite temperatures [5, 6]. Reference [1] Ch. C. Moustakidis, Phys. Rev. C 86 (2012) 015801. [2] F. Pacini, Nature (London) 216 (1967) 567. [3] C. Thompson and R. Duncan, Astrophsics J 473, (1996) 322. [4] M. Bigdeli, Int. J. Mod. phys. E 22 (2013) 1350054. [5] G. H. Bordbar and M. Modarres, Phys. Rev. C 57 (1998) 714. [6] M. Bigdeli, Phys. Rev. C 82 (2010) 054312.

Afternoon session / 8

Modification of magicity toward the dripline and its impact on electron-capture rates for stellar core collapse

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The importance of microphysical inputs from laboratory nuclear experiments and theoretical nuclear structure calculations in the understanding of core collapse dynamics and the subsequent supernova explosion, is largely recognized in the recent literature. In this work, we analyze the impact of the masses of very neutron rich nuclei on the matter composition during collapse, and the corresponding electron capture rate. To this end, we introduce an empirical modification of the popular Duflo-Zuker mass model to account for possible shell quenching far from stability. We study the effect of this quenching on the average electron capture rate. We show that the preeminence of the closed shells with $N = 50$ and $N = 82$ in the collapse dynamics is considerably decreased if the shell gaps are reduced in the region of ^{78}Ni and beyond. As a consequence, local modifications of the overall electron capture rate of up to 30\% can be expected, depending on the strength of magicity quenching. This finding has potentially important consequences on the entropy generation, the neutrino emissivity, and the mass of the core at bounce. Our work underlines the importance of new experimental measurements in this region of the nuclear chart, the most crucial information being the nuclear mass and the Gamow-Teller strength. Reliable microscopic calculations of the associated elementary rate, in a wide range of temperatures and electron densities, optimized on these new empirical information, will be additionally needed to get quantitative predictions of the collapse dynamics.

Afternoon session / 9

Electromagnetic structure of Neutron Stars

Physical and observational properties of neutron stars (NSs) are deeply influenced by the morphology of their magnetic field. Therefore an accurate description of both the interior and exterior stellar magnetic field is necessary to improve our understanding of NS phenomenology. I will present a comprehensive numerical study of GR equilibria of magnetised NSs, taking into account different magnetic field geometries (including twisted magnetospheres) and the combined role of rotation, showing how the two determine the overall deformation of the star. I will also address the gauge freedom in choosing different prescriptions for the surface charge and current, their physical implications, and how they modify the exterior electromagnetic properties.

Plenary Talk / 11

R process nucleosynthesis in supernovae and neutron star mergers

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Plenary Talk / 12

Transport phenomena in neutron stars

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Plenary Talk / 14

Probing neutron star properties with pulsar glitches

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The superfluid state of neutrons strongly affects the rotational properties of neutron stars, since their angular momentum is quantized in vortex lines whose interaction with the nuclear lattice in the crust can explain the rotational glitches observed in numerous pulsars. The study of those interactions at the microscopic level and their implementation in macroscopic and realistic models for the rotating star are crucial to put constraints on the EoS and on the superfluid state of matter as well as on the pulsar�s mass. In this lecture, we review the main aspects of the theory of pulsar glitches, as well as recent advances in their realistic modelling.

Afternoon session / 15

A simple model for pulsar glitches

In my presentation I'll describe an analytical two-components model for pulsar rotational dynamics: the aim is to reduce the computationally difficult 3D hydrodynamics to a 1D (radial) problem. The model takes into account consistently for the non-uniform structure of the star and superfluid entrainment. I'll show how this simple model can be used to put a constraint to the mass of the pulsars that display very large glitches (like Vela).

Afternoon session / 16

Microscopic Vortex Velocity for Neutron Stars

Rotational dynamics of a neutron star is governed by the distribution and motion of vortex lines within the neutron superfluid. Interaction of the vortex lines with the ambient matter plays a significant role in the glitches, thermal evolution and magnetic field evolution of pulsars. Thus, correctly treating the vortex motion in the inner crust and the outer core of neutron stars is a key ingredient in modeling a number of observational phenomena of pulsars. In this work we outline the first principles to calculate the microscopic vortex velocity both in the inner crust and outer core. Then we discuss some implications for neutron star's dynamics.

Afternoon session / 17

Force-free magnetospheres of neutron stars

Evolution of magnetic fields in neutron stars depends strongly on the specific boundary conditions imposed at the stellar surface and the properties of the surrounding magnetosphere. In this talk, I will present various current-free (vacuum) and force-free models of neutron star magnetospheres, describe the resulting boundary conditions, and discuss their implications for the evolution of the neutron star magnetic field through simulations with a magneto-thermal evolution code.

Afternoon session / 18

Non-ideal effects in relativistic plasmas with the ECHO code for GRMHD

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Axisymmetric GRMHD equilibria in 3+1: general formalism, numerical methods, and application to magnetized NS modeling We review the force-free and GRMHD equations for stationary and axisymmetric equilibria in general relativity within the 3+1 formalism. Numerical methods and detailed GRMHD modeling for the description of the structure and magnetosphere of magnetized neutron stars are shown and discussed, for both the static and rotating cases, employing the (extended) conformal flatness approximation. In particular we present the XNS and X-ECHO codes developed by the Firenze group.

Afternoon session / 19

Learning about neutron stars from pulsar precession observations

I present results studying the periodic variations in PSR B1828-11 and demonstrate that the evidence is in favour of a precession interpretation over the recent claims that this pulsar is undergoing magnetospheric switching. Furthermore, I will establish that the periodicity is changing and discuss the consequence that this has for both models.

Afternoon session / 20

3D Hall Evolution of Magnetic Fields in Neutron Stars

We have recently developed a 3D numerical model to evolve the Hall-Ohmic magnetic field in neutron stars (NSs). Our model is an important extension to the state-of-the-art 2D magneto-thermal model of Pons+ (2007, 2009), Vigano+ (2012, 2013). We have now validated and benchmarked our new 3D model, and we are beginning to investigate how Hall-driven evolution in 3D compares to the known evolutionary picture in 2D. I provide an overview of our numerical scheme, its suitability for different magnetic configurations, and discuss 3D magnetic decay and evolution in several important physical limits. I also outline the trajectory for future numerical experiments, and how cross-coupling with other codes will invite exciting, next generation research into NS physics and evolution.

Evening session / 21

Propeller effect in X-ray pulsars

Propeller effect in X-ray pulsars Propeller effect, i.e. centrifugal inhibition of accretion, is an immediate evidence of the presence of a strong dipole magnetic field in accreting neutron stars. Observation of this effect requires high sensitivity of X-ray telescopes and become possible only recently. From the theoretical point of view many aspects of this effect (spectrum formation, matter leakage through the centrifugal barrier, etc) are still not developed due to the lack of a high quality observational data. In this talk I will review observational manifestations of the propeller effect in accreting neutron stars with broad range of the magnetic fields from 10ˆ8 to 10ˆ14 G.

Evening session / **22**

On the maximum accretion luminosity of magnetized neutron stars: connecting X-ray pulsars and ultraluminous X-ray sources

We study properties of luminous X-ray pulsars using a simplified model of the accretion column based on diffusion approach. The maximal possible luminosity is calculated as a function of the neutron star (NS) magnetic field strength and spin period. It is shown that the luminosity can reach values of the order of 10ˆ{40} erg/s for the magnetar-like magnetic field (B > 10ˆ{14}G) and long spin periods (P >1.5 s). The relative narrowness of an area of feasible NS parameters which are able to provide higher luminosities leads to the conclusion that L ˜ 10ˆ{40} erg/s is a good estimate for the limiting accretion luminosity of an NS. Because this luminosity coincides with the cut-off observed in the high-mass X-ray binaries luminosity function which otherwise does not show any features at lower luminosities, we can conclude that a substantial part of ultraluminous X-ray sources are accreting NSs in binary systems.

Plenary Talk / **23**

Gravitational-wave signal from binary neutron stars: a systematic analysis of the spectral properties

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Plenary Talk / **24**

”Topics in the Theory of Dense Matter: Progress and Challenges”

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I shall discuss a number of subjects including the equation of state of uniform nucleonic matter, collective oscillations in the inner crust of neutron stars, the neutron superfluid density in the inner crust, elastic properties of the crust, induced interactions between nucleons and the transition to quark matter.

Plenary Talk / 25

Neutron stars in alternative theories of gravity - models,astrophysical implications and universal relations

The talk is devoted on neutron stars in alternative theories of gravity: their structure, deviations from pure general relativity and astrophysical implications. Both static and rapidly rotating solutions are considered. A wide range of universal relations for neutron star and their generalization to alternative theories of gravity are also discussed. Among them are gravitational wave asteroseismology relations, the I-Love-Q relations, and relations involving the stellar compactness.

Plenary Talk / 27

Inferring properties of the central engine of short GRBs

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Isolated neutron stars are potentially excellent emitters of gravitational waves throughout many stages of their lives. I will review recent advances in our understanding of gravitational wave emission mechanisms from both young and old neutron stars. I will also discuss ongoing efforts to detect these gravitational waves with Advanced LIGO.

Plenary Talk / 28

Neutron stars as the progenitors & central engines of GRBs

It has now been shown that many short GRBs also have plateau phases which are comparable to those observed in long GRBs. However, this challenges the typical short GRB progenitor model (the merger of two neutron stars or a neutron star and a black hole) as all significant accretion onto the black hole is expected to occur during the prompt emission phase. The recent discovery of massive neutron stars lends support to an alternative central engine model, a magnetar formed via the merger of 2 neutron stars. In this scenario, a plateau phase followed by a shallow decay phase is predicted due dipole radiation from the magnetar. In some cases the magnetar may be unstable and collapses to form a black hole within a few hundred seconds, giving a characteristic steep decay phase as the energy injection rapidly turns off. Additionally, magnetars can be formed via the collapse of a massive star and, therefore, could also be the central engines of many long GRBs explaining the plateaus observed in both populations.

Plenary Talk / 29

Interacting fermion star in Kaluza–Klein World, FRG Approach to Nuclear Matter in Extreme Conditions

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Recently we have explored the properties of an interacting fermionic compact star in a 1+4 dimensional Kaluza–Klein-like spacetime, where an extra microscopical spacelike dimension was intro-

duced (See Sz. Karsai's talk). Here, we present wether we would able to measure the effect of these extra dimensions by gravitational wave detectors.

Afternoon session / 31

Neutrino-nucleon interactions in supernovae matter

Neutrino-nucleon interactions at high density and temperature play a major role in the outcome of various processes during core-collapse supernovae (CCSNe) explosions. Their impact ranges from shock revival via neutrino heating to determining nucleosynthesis of heavy elements in the neutrino driven wind or via neutrino nucleosynthesis. Precise modelling of these scenarios requires accurate description of the underlying neutrino interaction rates, while at the same time adhering to computational constraints. In this context, we present a suitable method for precise calculations of neutrino mean free paths, for absorption and scattering type reactions. To be precise, we compute the exact Hartree response of nucleons (treating nucleons as quasi free fermions) for neutrinos, explicitely allowing for inelasticity, relativistic nucleons and massive leptons. We also discuss inclusion of the momentum transfer dependence of weak coupling constants. This approach is then compared to other computation methods for neutrino-nucleon interactions. In particular, we use it as a reference to asses the quality of various approximations for neutrino-nucleon interactions that are currently applied in CCSN simulations, such as the elastic approximation or analytic corrections for nucleon recoil and weak magnetism. This allows for a better understanding of the suitability of these approximations and for an estimation of the resulting uncertainties in the neutrino spectra of CCSNe.

Afternoon session / 32

Spherically Symmetric Core-Collapse Supernova Simulations

Core-Collapse Supernovae (CCSNe) occur at the end of the evolution of massive stars. The detailed explosion mechanism of these violent events and their outcomes are still not fully understood. On the one hand multi-dimensional simulations of CCSNe are needed to investigate the underlying explosion mechanism. On the other hand they are currently too expensive to allow broad systematic studies, that are highly required to better understand these events. The PUSH method provides a parametrization framework for spherically symmetric simulations to efficiently study many important aspects of CCSNe: the effects of the shock passage through the star, explosive supernova nucleosynthesis and the progenitor-remnant connection. We calibrate PUSH to reproduce the observed properties of SN 1987A for an appropriate progenitor model and use the method to conduct a broad progenitor study. We discuss the explosion dynamics and energetics for stars of solar metallicity. Furthermore, the explodability of a wide range of progenitors is investigated, together with a possible distinction between low and high compactness progenitors in the explosion and remnant properties.

Afternoon session / 33

R-process nucleosynthesis and binary neutron star mergers

The question of the origin of heavy elements has undergone a change in the last few years. Recent numerical simulations have demonstrated that binary neutron star mergers are the most likely progenitors of heavy elements in our galaxy instead of core-collapse supernova. This is due to a more neutron-rich environment that allows a more robust rapid neutron capture (r-process) nucleosynthesis. This change has also allowed for a multi-channel classifcation of ejecta to emerge: dynamical, neutrino driven wind, and viscous wind ejecta. Of these, the dynamical ejecta is the most amenable to numercial relativity simulations due to the shorter time scales. Furthermore, improved treatments of neutrino emission has improved the microphysics of the dynamical ejecta, which in turn provides a more robust environment for r-process nucleosynthesis. Up until this point, analysis of the dynamical ejecta has mostly been confined to single simulations and no thorough parameter study has been completed. In this talk, we will discuss the dependence of the dynamical ejecta nucleosynthesis on the initial composition of the binary neutron star, such as equation of state, masses, and mass ratios using numerical relativiy and neutrino transport simulations.

Afternoon session / 34

Hadron-quark phase transition in hybrid stars and first insights for generating a new supernova EoS

The subject of this presentation is the quark-hadron phase transition in neutron stars (NS) and core collapse supernovae (CCSN). We employ a hybrid equation of state consisting of the the state-of-the-art EOS HS(DD2) for the hadronic part and the constant speed of sound EOS for the quark phase. We show how this EOS is related to a standard bag model. We systematically vary the phase transition parameters, investigate the maximum masses and classify the resulting hybrid stars into four cases (as done in [1]). The problem of reconfinement is also discussed, which has not been considered in previous parameter scans. Finally, we explore if there is a parameter region where the hybrid EOS supports 2 M⊙ and that might be favorable for CCSN explosions at the same time. [1] M. G. Alford et al., Phys. Rev. D 88, 8, (2013)

Afternoon session / 35

Cool quark matter

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I will report results from recent efforts in perturbative QCD to build a framework for dealing with the bulk thermodynamic properties of dense quark matter at small but nonzero temperatures. The new results extend the applicability of the current state-of-the-art Equation of State of zero-temperature quark matter, smoothly connecting it to that of hot quark-gluon plasma. Applications of the new EoS to phenomenological neutron star calculations will be discussed as well, as will the prospects of extending the calculations to further orders in the weak coupling expansion.

Evening session / 37

Maximum mass, moment of inertia and compactness of relativistic stars

A number of recent works have highlighted that it is possible to express the properties of general-relativistic stellar equilibrium configurations in terms of functions that do not depend on the specific equation of state employed to describe matter at nuclear densities. These functions are normally referred to as "universal relations" and have been found to apply, within limits, both to static or stationary isolated stars, as well as to fully dynamical and merging binary systems. Further extending

the idea that universal relations can be valid also away from stability, we show that a universal relation is exhibited also by equilibrium solutions that are not stable. In particular, the mass of rotating configurations on the turning-point line shows a universal behaviour when expressed in terms of the normalised Keplerian angular momentum. In turn, this allows us to compute the maximum mass allowed by uniform rotation simply in terms of the maximum mass of the nonrotating configuration. We further introduce an improvement to a previous fit by Lattimer & Schutz (2005) of the universal relation between the dimensionless moment of inertia and the stellar compactness, which could provide an accurate tool to constrain the equation of state of nuclear matter when measurements of the moment of inertia become available.

Evening session / 38

Artificial entropy viscosity in numerical relativistic hydrodynamics

Artificial entropy viscosity in numerical relativistic hydrodynamics Large scale numerical simulations are one of the most useful tools to shed light on the physics of neutron stars, but due to their high computational cost and great accuracy requirements the research for better numerical methods is constantly ongoing. We present a new fast and accurate numerical scheme called artificial entropy viscosity which offers several advantages over the currently used high-resolution shock-capturing techniques. We discuss the theoretical background of the method, its implementation and application to the simulation of binary neutron star systems and results thereof.

Plenary Talk / 39

Observational constraints on the physical properties of neutron stars

Plenary Talk / 40

Observational aspects of isolated neutron stars

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Multi-wavelength observations over the last decades proved the existence of observationally very diverse manifestations of isolated NSs (INSs) and led to the separation of INSs into distinct classes. Most of the ˜2,300 known INSs are radio pulsars with periods P < 8 s and magnetic field B ˜ 10 12 G, but there are objects with much greater potential for understanding the INSs diversity. This includes: Magnetars, X-ray Dim INSs (XDINSs), high-B rotation-powered pulsars, Rotating radio transients (RraTs) , and Central Compact Objects (CCOs). In this talk I will focus on the observational properties of XDINSs and magnetars. I will present a summary of the phenomenology with focus on the X-ray properties.

Plenary Talk / 41

Astrophysical constraints on the equation of state?

I will review several ongoing projects which aim at examining how astrophysical observations of neutron stars (mass, radius, spin frequency, thermal emission and evolution,…) may constrain the properties and composition of neutron star matter.

Afternoon session / 42

Numerical modelling of compact static stars in Minimal Dilatonic Gravity

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The minimal dilatonic gravity (MDG) is a theory, which is locally equivalent to the f(R) theories of gravity and gives an alternative description of the effects of dark matter and dark energy. In this talk we report the progress on modelling relativistic static spherically symmetric stars in MDG under different equations of state (EOS) of neutron matter and we discuss the dependence of the star structure on the mass of the scalar dilaton.

Afternoon session / 44

Phase lags of quasi-periodic oscillations across source states in the low-mass X-ray binary 4U 1636-53

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A step towards to understanding how radiative processes give rise to the rich set of variability features, namely the quasi-periodic oscillations, actually seen in the X-ray light curves of low-mass X-ray binaries is given by the study of the energy and frequency dependence of the phase lags of the QPOs in the light curves. Here we studied the phase lags of all QPOs in the range of 1 Hz to 1300 Hz detected in the low-mass X-ray binary 4U 1636-53 using a methodology that allowed us to study, for the first time, the dependence of the phase lags upon energy and frequency as the source changes its states as it moves through the colour-colour diagram. Our results suggest that within the context of models of up-scattering Comptonization, the phase lags dependencies upon frequency and energy can be used to extract size scales and physical conditions of the medium that produces the lags.

Evening session / 47

The extraordinary 2011 outburst of the magnetar Swift J1822.3-1606 Magnetar Model for GRBs

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Magnetars are highly magnetized neutron star and energetic X-ray/ soft gamma ray bursts are often observed from these sources. The most energetic of these bursts,- the giant flares have been observed only from a few sources and exhibit distinct observational characteristics. The 2011 outburst of the relatively low magnetic field magnetar was quite extraordinary because of the unusual timing features present. Periodic modulations at the spin period of the underlying neutron star were clearly visible, remarkably similar to what is observed during the decaying tail of magnetar giant flares. We investigated the temporal characteristics of X-ray emission during the early phases of this outburst.

It was observed that the hardness ratio (HR) is strongly anti-correlated X-ray pulse profile intensity much alike that is observed in the case of giant flares. The evolution of the pulse profile morphology also showed a similar behaviour like that for the giant flares but on much longer time scales. The energy emitted during the entire outburst is comparable to energy released in minutes during the decaying tail of the giant flares. Based on their similarities, we suggest that the triggering mechanisms of the giant flares and the outburst are likely the same. We propose that the trapped fireball that develops in the magnetosphere at the onset of the outburst radiates away efficiently in minutes in magnetars exhibiting giant flares, while in other magnetars, such as Swift J1822.3–1606, the efficiency of radiation of the fireball is not as high and, therefore, lasts much longer displaying outbursts. We discuss such a scenario in the light of the existing theoretical magnetar models.

Afternoon session / **48**

Accretion in white dwarf binaries - short time variability and broadband noise characteristics: connecting CVs to neutron star and black hole binaries

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I review accretion in Cataclysmic Variable systems with emphasis on flicker
noise and its variations that have been a diagnostic tool in understanding the structure in accretion disks.
I study the nature of time variability of brightness of non-magnetic
cataclysmic variables. Dwarf novae demonstrate band limited noise in the UV and X-ray energy bands, which can be adequately explained
in the framework of the model of propagating fluctuations as in XRBs. The detected frequency breaks in the range (1-6) mHz indicates
an optically thick disk truncation in the inner disk of some dwarf novae systems in quiescence.
Analysis of other available data (SS Cyg, SU UMa, WZ Sge, Z Cha) indicate that during the outburst the inner
disk radius moves towards the white dwarf and recedes as the outburst declines while changes in the X-ray energy
spectrum is also observed. Cross-correlations between the simultaneous
Optical, UV and X-ray light curves show time lags in the X-rays (90-180 sec) consistent with truncated inner optically thick disk.
I compare magnetic and nonmagnetic CVs in terms of their broadband noise characteristics
which in general show compliance with the model of propagating fluctuations.
In addition, I discuss comparisons with X-ray binaries.

Summary:

Plenary Talk / **49**

Quark Deconfinement in the Context of the Millisecond Magnetar Model for GRBs

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The properties of late time activity in Long and Short GRBs, point strongly toward a long lived energy injection mechanism. The millisecond magnetar model provides naturally with such input in the form of a relativistic magnetically driven wind. The standard pictures however predicts a steady smooth injection, that looks at odds with the presence of late time bursts observed in the light-curve of several events. Among the possible explanations it has been suggested that a phase transition in the newly born magnetar, and in particular quark deconfinement, could be at the origin of those events. We present here a study of the timescales and energetic properties expected for such events, in the context of the millisecond model for GRBs.

Plenary Talk / 50

Do hyperons exist in the interior of neutron stars?

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In this work I review the role of hyperons on the properties of neutron and proto-neutron stars. In particular, I revise the so-called "hyperon puzzle", go over some of the solutions proposed to tackle it, and discuss the implications that the recent measurements of unusually high neutron star masses have on our present knowledge of hypernuclear physics. I reexamine also the role of hyperons on the cooling properties of newly born neutron stars and on the so-called r-mode instability.

Afternoon session / 52

Constraints on the neutron star properties from the relativistic energy density functional

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Recent developments of the relativistic nuclear energy density functional (RNEDF) provide a self-consistent framework for the description of a variety of nuclear properties of astrophysical relevance, including the nuclear matter equation of state, and various neutron star properties. The RNEDF is supplemented with the covariance analysis in order to assess statistical uncertainties of calculated quantities and correlations between relevant quantities. Recently a method has been introduced that establishes relations between the properties of collective excitations in finite nuclei and the phase transition density and pressure at the inner edge separating the liquid core and the solid crust of a neutron star. A theoretical framework that includes the thermodynamic method, the RNEDF, and the quasiparticle random-phase approximation has been employed in a self-consistent calculation of the neutron star core-to-crust transition density and pressure. This approach crucially depends on the experimental results for collective excitations in nuclei that constrain the symmetry energy in nuclear matter, in particular excitation energies of giant resonances, energy-weighted pygmy dipole strength, and dipole polarizability. The RNEDF framework also provides an insight into the neutron star mass-radius relationship.

Afternoon session / 53

Relativistic stars in Starobinsky gravity with matched asymptotic expansion

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We study the structure of relativistic stars in R+alpha*R^2 theory using the method of matched asymptotic expansion to handle the higher order derivatives in field equations arising from the

higher order curvature term. We find solutions, parametrized by α, for uniform density stars matching to the Schwarzschild solution outside the star. We obtain the mass-radius relations and study the dependence of maximum mass on alpha. We find that M_{max} is proportional to alphaˆ(-3/2) for values of alpha larger than 10 kmˆ2. For each alpha the maximum mass configuration has the biggest compactness parameter (eta = GM/Rcˆ2) and we argue that the general relativistic stellar configuration corresponding to alpha=0 is the most compact among these.

Afternoon session / 54

Excluded volume effect and neutron stars'equation of state

Author: Ludwik Turko[None]

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After a short review on the role of excluded volume corrections for the equation of state (EoS) of hadronic matter as probed in heavy-ion collision experiments [1], we present recent applications of excluded volume modifications in the EoS of neutron stars including a Bayesian analysis of mass-radius constraints and hybrid star phenomenology [2] and neutron star cooling [3]. We argue that the repulsive interactions in hadronic matter that arise from the account of excluded volume corrections have their fundamental background in the quark substructure of hadrons that entails a repulsive quark exchange interaction because of the Pauli principle. At the same time this Pauli blocking is to be seen as a precursor effect of the inevitable hadron dissociation (Mott effect) and quark deconfinement at high phase space densities. The excluded volume effect in the neutron star EoS is a necessary condition for obtaining high-mass twin star solutions which, once observed in nature, would provide indirect evidence for the existence of a critical endpoint in the QCD phase diagram [4], the holy grail of third generation heavy-ion collision experiments.

Contributed Talk / 57

Neutron stars in scalar-tensor theories with a massive scalar field

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In the scalar-tensor theories with a massive scalar field the coupling constants, and the coupling functions in general, which are observationally allowed, can differ significantly from those in the massless case. This fact naturally implies that the scalar-tensor neutron stars with a massive scalar field can have rather different structure and properties in comparison with their counterparts in the massless case and in general relativity. In the talk we will present slowly rotating neutron stars in scalar-tensor theories with a massive gravitational scalar. Two examples of scalar-tensor theories are examined - the first example is the massive Brans-Dicke theory and the second one is a massive scalar-tensor theory indistinguishable from general relativity in the weak field limit. In the later case we study the effect of the scalar field mass on the spontaneous scalarization of neutron stars. Our numerical results show that the inclusion of a mass term for the scalar field indeed changes the picture drastically compared to the massless case. It turns out that mass, radius and moment of inertia for neutron stars in massive scalar-tensor theories can differ drastically from the pure GR solutions if sufficiently large masses of the scalar field are considered.

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Nonlinear Superfluid Dynamics - Evidence in Pulsars

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Theoretical basis and observational evidence for nonlinear dynamics will be discussed.

Contributed Talk / 60

Multiwavelength observations of gamma-ray loud binaries

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Gamma-ray loud binaries are are a recently identified class of X-ray binaries in which interaction of an outflow from the compact object with the wind and radiation emitted by a companion star leads to the production of very-high energy gamma-ray emission. Only five systems have been firmly detected so far as persistent or regularly variable TeV gamma-ray emitters. The nature of the TeV emission from these systems is not clear yet, but there are reasons to believe that similar to PSR B1259-63 all these system harbour pulsars, hidden in the wind of the companion star. Detailed studies of the broadband spectral and timing properties of these sources are crucial for understanding the nature of these peculiar objects. In my talk I will review the outcome of extensive multiwavelength observations of the 2014 PSR B1259-63 periastron passage, which shed a light on the nature of the puzzling GeV flare from the system, and also discuss what can we learn from the numerous X-ray observations of LSI +61 303 performed the last decade by SWIFT, Suzaku, XMM and Chandra satellites.

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Interaction modes of magnetic compact stars with gaseous environment near a supermassive black hole

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We examine the role of a dipole-type magnetic field of a compact (neutron) star for its interaction with the ambient interstellar medium, and the resulting drag as the star orbits near a supermassive black hole. The enhancement of the orbital decay is found to be very small in the Galactic centre (the mini-spiral region of Sgr A*), where the environment density is very low, but it becomes quite important in Active Galactic Nuclei, where a relatively dense accretion disc is present. Different regimes of the mutual interaction occur depending on the magnetic field strength, the ISM density, and the parameters (relative velocity, magnetic moment, rotation period, and compactness) of the star.