IWARA2020 Video Conference - 9th International Workshop on Astronomy and Relativistic Astrophysics

Sunday, 6 September 2020 - Saturday, 12 September 2020

Book of Abstracts

The event is the 9th in a series of meetings gathering scientists working on astroparticle physics, cosmology, gravitation, nuclear physics, and related fields. As in previous years, the IWARA2020 meeting sessions will consist of invited and contributed talks, poster sessions, and will cover recent developments in the following topics:

• New phenomena and new states of matter in the Universe
• General relativity, gravitation, cosmology
• New directions for general relativity: past, present and future of general relativity
• FRW cosmologies
• Cosmic microwave background radiation
• First Stars, hypernovae, and faint supernovae in the early Universe
• Quantum gravity and quantum cosmology
• Gravity and the unification of fundamental interactions
• Supersymmetry and Inflation
• String theory
• White dwarfs, neutron stars and pulsars
• Black hole physics and astrophysics
• Gamma-ray emission in the Universe
• High energy cosmic rays
• Gravitational waves
• Dark energy and dark matter
• Strange matter and strange stars
• Antimatter in the Universe
• High-energy cosmic neutrinos
• Blazars
• Quantum chromodynamics, nuclear and particle physics and new states of matter in the Universe.
• Heavy ion collisions and the formation of the quark-gluon plasma in heavy ion collisions and in the first instants of the Universe
• Strong magnetic fields in the Universe, strong magnetic fields in compact stars and in galaxies, ultra-strong magnetic fields in neutron star mergers, quark stars and magnetars, strong magnetic fields and the cosmic microwave background
• Laboratories, observatories, telescopes and other experimental and observational facilities that will define the future directions of astrophysics, astronomy, cosmology, nuclear and astroparticle physics as well as the future of physics at the energy frontiers, and topics related to these.

Contents

ARCHAEOASTRONOMY, BHs, GRBs, SNOVAE / 50

IWARA 2023: Proposal from Guatemala

Author: Jose Rodrigo Sacahui Reyes[1]

[1] *Universidad de San Carlos de Guatemala*

Guatemala is a small country located in Central America, which has a great legacy of one of the biggest cultures of the American Continent, the Mayas, a civilization with a great scientific legacy and that developed a great understanding of astronomy. They measured the time based on astronomical events predicting solar eclipses and their calendar is one of the most precise ever developed. In the present the numbers in scientific resources are not so encouraging, having one of the lowest budgets in scientific and technological activities as well as a low number of full time researchers when compared to other countries of the continent (14 million of habitants). Efforts are being made from several institutions and this is expected to be reflected in the upcoming years. In recent years Guatemala has held conferences like SILAFAE 2016 and three editions of the Guatemalan School of Astrophysics (GUASA 2013, 2015, 2017). These scientific meetings detonated scientific collaborations as well as encouraged students to pursue major degrees in Astrophysics. In this talk I present Guatemala as a proposal to receive IWARA in the 2023's edition, intended to be held at Antigua Guatemala, UNESCO world heritage site, a perfect place to hold meetings. We expect that IWARA could become an important activity in order to grow the local scientific community which in time could become the critical mass to trigger strong research groups.

ARCHAEOASTRONOMY, BHs, GRBs, SNOVAE / 51

Inka's Worldview in Astronomy

Author: Milton Rojas Gamarra[1]

[1] *UNSAAC Universidad de San Antonio Abad del Cusco*

Each civilization, since immemorial times, has developed their own culture, their own ethos and their own worldview. It was no different in the Inka culture. The man, in the different regions of the Inca empire (in Quechua, Tawantinsuyo), in his evolutionary process, also developed customs, habits, ways of being, ways of behavior. Finally, they sought to answer fundamental questions in the spirit of Imaymana Wiracocha, the eldest of the two sons of the god Ticci Wiracocha, he who inquires and seeks the truth. Among those questions we emphasize: how to be? (Imaynakay) or how to live? (Imaynakawsay). Like other ancient civilizations, the inkas also sought to interpret and understand the Cosmos, from its primordial stages, and even yhey sought to seek a sense for the Cosmos. In this process, the Inkas developed their own worldview (kawaypacha). Moreover, they built their own principles of life (Kawsay), standing out among them, gratitude and reprocity (Ayni - the force of reciprocity) and the creative life force of Pachamama (Kawsaypacha - everything in the Cosmos lives). Ayni is a reflection of the reality that exists in the energetic world. Kawsaypacha corresponds moreover to the energy present in time and space. In this lecture, we will address these principles, concluding that the Andean culture is based on a rationality which is distinct from Western cultures: the principles that govern the Andean worldview are based on transversal concepts and principles that can be synthesized in rationality, integrality and cyclicality. Thus, the proper understanding and interpretation of the Inka legacy in the fields of Astronomy, Archeoastronomy and Astronomy requires a change of perspective, based on the Inka worldview instead of a look based on the Western perspective. In this lecture we will also cover other principles, such as Duality and Convergence (Tinkuy - point of convergence) and complement the discussion with a study applied to Astronomy.

ARCHAEOASTRONOMY, BHs, GRBs, SNOVAE / 52

The Astronomy of Teotihuacan

Author: Steven Gullberg[1]

[1] *University of Oklahoma*

Northeast of Mexico City are the extant remains of one of the largest urban centers of the ancient world. Built long before, the Aztecs later adopted the site and named it "the place where the gods were created", or Teotihuacan. They considered this to be the location where time began.
Elements of the vast complex were created with astronomical alignments, a common practice with many ancient cultures. The sophistication found in the urban planning design demonstrates the level of understanding of celestial movements that had been amassed by those who constructed the massive temples, and the importance that they assigned to this knowledge. Teotihuacan's Pyramid of the Sun and Pyramid of the Moon were built with intriguing alignments, and interesting orientations have been as well identified at the Temple of Quetzalcoatl, or La Ciudadela, the name given to it by the Spaniards.
These important features are examined with cultural context. Cyclical patterns are prominent, and as in many cultures the alignments would have been used to assist with calendrical needs and crop management. It is also significant that certain elements of astronomy found at Teotihuacan exhibit similarities with those at other sites in the greater region. This presentation will illustrate the fascinating level of astronomical knowledge and prowess exhibited in the region and will explore visual effects of archaeoastronomy displayed at Teotihuacan.

ARCHAEOASTRONOMY, BHs, GRBs, SNOVAE / 53

Teotihuacán, its cultural links with southern Mesoamerica

Author: Veronica Ortega Cabrera[1]

[1] *INAH*

The Pre-Hispanic city of Teotihuacán was the scene of multiple social dynamics, in which groups originating from various regions of Mesoamerica were involved. This is because the cosmopolitan nature of the city allowed the daily coexistence of people who came to it, either for reasons of exchange of objects and goods, such as the religious, political and cultural prestige that distinguished it from its beginnings and for more than five centuries. Archaeological investigations carried out since the sixties of the last century in the pre-Hispanic remains have provided information about the permanent relationships that various groups in the city had with those who lived in other cities. Among these we highlight Monte Albán, in the current state of Oaxaca, Kaminaljuyú in the Maya area or Matacapan in Veracruz, in such a way that archaeological contexts have been located that indicate the residence of people with customs and traditions originating from said areas. In this talk I will address in a general way the conformation of the city and the evidence of the cultural ties that were established between its residents and those of other cities in southern Mesoamerica, particularly Monte Albán, in the current state of Oaxaca. We show in particular the archaeological evidence of the most recent excavations in Tlailotlacan, the Oaxacan neighborhood of Teotihuacán.

ARCHAEOASTRONOMY, BHs, GRBs, SNOVAE / 55

Discovery of energy extraction from a Kerr Black Hole by discrete "Black-Holic" quanta in GRB 190114C, GRB 130427A, GRB 160509A and GRB 160625B

Author: Remo Ruffini[1]

[1] *ICRANet, ICRA, INAF*

Almost fifty years after the paper "Introducing the Black Hole" by Ruffini and Wheeler and the Black Hole (BH) mass energy formula by Christodoulou, Ruffini and Hawking, we can finally assert that we have been observing the moment of creation of a BH in the BdHN I in GRB 190114C, GRB 130427A, GRB 160509A and GRB 160625B, with the corresponding rotational energy extraction process. The first appearance of the Supernova, the SN-rise, triggering the BdHN has been identified. The hypercritical accretion on the SN ejecta on the new NS (νNS) created in the SN, is shown to originate the X-ray afterglow observed by the NASA Niels-Gehrels SWIFT satellite (SWIFT). The hypercritical accretion of the SN on the NS binary companion in the BdHN I model leads to the formation of the newly formed BH. The onset of the GeV radiation coinciding with the BH formation has revealed self similar structures in the time resolved spectral analysis of all sources. Consequently, we find evidence for quantized-discrete-emissions in all sources, with energy quanta of 1037 ergs with repetition time of 10-14 sec. GRBs are the most complex systems ever successfully analyzed in Physics and Astrophysics, and they may well have a role in the appearance of life in the Cosmos. These results have been made possible by a long-lasting theoretical activity, a comprehensive unprecedented high quality data analysis, an observational multi- messenger effort by the astronomical, the physical and the space research communities. This observational effort is well epitomized by the original Vela Satellites, the NASA Compton space mission (CGRO), the Italo-Dutch Beppo SAX satellite, the Russian Konus Wind Satellite, the SWIFT satellite, the Italian AGILE satellite, the NASA FERMI mission and most recently the Chinese satellite HXMT. These space missions have been assisted by radio and optical equally outstanding observational facilities from the ground.

QM, PARTICLES, ATOMS, NUCLEI, SNOVAE MERGERS, QED, BHS, GRBS, COMPACT STARS / 30

Very Significant Revision Required for Electron Densities in White Dwarfs Deduced from Widths of Hydrogen Spectral Lines

Author: Eugene Oks[1]

[1] *Auburn University*

In strongly magnetized plasmas of DA white dwarfs, where the magnetic field B could be as high as ~ (10^2 –10^5) Tesla, electrons move along strongly helical trajectories. The allowance for helical trajectories of plasma electrons dramatically changes the Stark width of hydrogen spectral lines compared to all previous calculations. We show analytically that without allowance for this effect, the electron densities deduced from all previous and future observations of hydrogen lines in DA white dwarfs can be erroneous by up to one order of magnitude. Thus, a very significant revision of electron densities deduced from all observations of hydrogen lines in DA white dwarfs, is required.

QM, PARTICLES, ATOMS, NUCLEI, SNOVAE MERGERS, QED, BHS, GRBS, COMPACT STARS / 117

Astrophysics of multi-state fuzzy dark matter

Author: Francisco S. Guzmán[1]

[1] *Universidad Michoacana de San Nicolás de Hidalgo*

Going beyond the fuzzy dark matter model, we present the construction of multi-state configurations of the Gross-Pitaevskii-Poisson system that rules the dynamics of this matter, their stability, mechanism of formation and application in galactic astrophysics.

QM, PARTICLES, ATOMS, NUCLEI, SNOVAE MERGERS, QED, BHS, GRBS, COMPACT STARS / 165

Einstein and Møller Energies of a Particular Asymptotically Reissner-Nordström Non-Singular Black Hole Solution

Author: Irina Radinschi[1]

[1] *Gheorghe Asachi Technical University of Iaşi –TUIASI*

The localization of energy-momentum for a four-dimensional charged, static, and spherically symmetric, non-singular black hole solution that asymptotically behaves as a Reissner-Nordström solution, is studied. The space-time geometry is distinguished by a distribution function entering the mass function m(r). The non-singular character of the metric is warranted by the coupling of general relativity with a non-linear electrodynamics, whereby the resulting electric field is everywhere non-singular and asymptotically tends to the Maxwell field. The energy and momentum distributions are computed by applying the Einstein and Møller energy-momentum complexes. It is found that all the momenta vanish, while the energies depend on the electric charge, the mass, and the radial coordinate. Finally, the behavior of the energies near the origin, near infinity, as well as in the case of a vanishing electric charge is examined.

QM, PARTICLES, ATOMS, NUCLEI, SNOVAE MERGERS, QED, BHS, GRBS, COMPACT STARS / 46

The blazar sequence revised

Authors: Jesús M. Rueda-Becerril[1]; Amanda Harrison[1]; Dimitrios Giannios[1]

[1] *Purdue University*

We propose and test a fairly simple idea that could account for the blazar sequence: all jets are launched with similar energy per baryon, independently of their power. For instance, FSRQs, the most powerful jets, manage to accelerate to high bulk Lorentz factor, as observed in the radio. As a result, the emission region will have a rather modest magnetization which will induce a steep particle spectra therein and a rather steep emission spectra in the gamma-rays; particularly in the Fermi-LAT band. For the weaker jets, namely BL Lac objects, the opposite holds true; i.e., the jet does not achieve a very high bulk Lorentz factor, leading to more magnetic energy available for non-thermal particle acceleration and harder emission spectra. Moreover, this model requires but a handful of parameters. By means of numerical simulations we have accomplished to reproduce the spectral energy distributions and light-curves from fiducial sources following the aforementioned model. With the complete evolution of the broadband spectra we were able to study in detail the spectral features at any particular frequency band at any given stage. Finally numerical results are compared and contrasted with observations.

QM, PARTICLES, ATOMS, NUCLEI, SNOVAE MERGERS, QED, BHS, GRBS, COMPACT STARS / 164

Symmetry energy and neutron pressure of finite nuclei using the relativistic meanfield formalism

Author: Mrutunjaya Bhuyan[1]

[1] *Department of Physics, Faculty of Science University of Malaya*

In this theoretical study, we establish a correlation between the neutron skin thickness and the nuclear symmetry energy for the even-even isotones for magic neutron N = 20, 40, 82, 126, 172 (expected) within self-consistent relativistic mean-field formalism for non-linear NL3* and density-dependent DD-ME2 parameter sets [1-3]. The local density approximation is used to formulate the symmetry energy, and its co-efficient, namely, neutron pressure of finite nuclei over the isotonic chains [4]. We find a few moderate signatures of pick and/or depth over the isotonic chains at and/or near the proton magic for symmetry energy and neutron pressure, which is a manifestation of the persistence of shell/sub-shell closure. Furthermore, we show the symmetry energy as a function of neutron-proton asymmetry, which results in similar behavior as persisted in the mass-dependence curve. The obtained results are of considerable importance since due to shell closure over the isotonic chain, will act as awaiting point in nucleosynthesis of the r-process. These results are also further strengthened the experimental investigations for the existence of magicity in the drip-line region of the nuclear chart [1].

Reference:
[1] M. Bhuyan and S. K. Biswal, Phys. Rev. C (Communicated) (2020).
[2] G. Lalazissis, S. Karatzikos, R. Fossion, D. P. Arteaga, A. Afanasjev and P. Ring, Physics Letters B 671, 36 (2009).
[3] G. A. Lalazissis, T.Nikc, D. Vretenar and P. Ring, Phys. Rev. C 71, 024312 (2005).
[4] B. K. Agrawal, J. N. De, and S. K. Samaddar, Phys. Rev. Lett. 109, 262501 (2012).

QM, PARTICLES, ATOMS, NUCLEI, SNOVAE MERGERS, QED, BHS, GRBS, COMPACT STARS / 142

Hadron properties under strong magnetic fields in the NJL model

Author: Norberto Scoccola[1]

Co-authors: Maximo Coppola [2]; Daniel Gomez Dumm [3]; Santiago Noguera [4]

[1] *Comision nacional energia atomica*

[2] *CNEA, Argentina*

[3] *UNLP, Argentina*

[4] *Univ. Valencia, España*

We study the magnetic field dependence of the masses of pions, diquarks and nucleons in the context of the Nambu-Jona-Lasinio model. Eigenvalue equations associated with charged particles are obtained using the Ritus formalism. In this way we fully take into account the existence of non-vanishing Schwinger phases. Our results are compared with those available in the literature obtained using Lattice QCD and/or Chiral Perturbation Theory.

QM, PARTICLES, ATOMS, NUCLEI, SNOVAE MERGERS, QED, BHS, GRBS, COMPACT STARS / 166

Magnetic field decay in neutron stars

Author: Sergei Popov[1]

[1] *Sternberg Astronomical Institute –SAI, Lomonosov Moscow State University –LMSU*

We analyse physical grounds for large braking indices of some young radio pulsars and investigated four hypothesis explaining origin of large braking indices: (1) binarity, (2) magnetic field decay, (3) evolution of the obliquity angle, and (4) complicated multipole structure of the poloidal magnetic field. We find that the magnetic field decay is the only plausible explanation for the majority of large braking indices. The evolution of the obliquity angle can cause large n for certain initial obliquity angles only in the nonphysical case of vacuum magnetosphere. Plasma-filled magnetosphere gives

n˜3 for all initial obliquity angles. Although large multipoles l=3,4 can explain unusual braking indices of some objects, these surface fields need to have strength well in excess of physical limits for a NS stability. Magnetic field decay can proceed with different speed in different NSs depending on the crust composition (crust impurity parameter Q) or cooling of NSs. It is derived from our simplified model that if a fraction of 10-20˜per˜cent of NSs are low-mass M˜1.1˜M⊙, the poloidal magnetic field decays fast due to large phonon resistivity causing the braking index to reach values n=10-100. The same effect can be obtained if a similar fraction of NSs have extreme crustal impurities Q˜20-200, however, then they are doomed to loose their magnetic field rapidly. Observations of NSs in HMXBs do not support such high fraction of low-field relatively young compact objects.

QM, PARTICLES, ATOMS, NUCLEI, SNOVAE MERGERS, QED, BHS, GRBS, COMPACT STARS / 167

Transient phenomena powered by a newborn neutron star: GRBs, SLSNe, mergernovae, and AICs

Author: Yun-Wei Yu[1]

[1] *College of Physical Science and Technology, Central China Normal University –CCNU*

The formation of neutron stars (NSs), both from collapses of massive stars and mergers of compact objects, can usually be indicated by a bright transient emission that is generated from the explosively-ejected material. In particular, as the newborn NSs can rotate very quickly and have a sufficiently high magnetic field, the spin-down of the NSs would provide a remarkable amount of energy to the emitting material. As a result, internal-origin GRB afterglow emission or super-luminous supernovae can be produced in the massive stellar collapse cases, while fast blue optical transients including the so-called mergernovae/kilonovae can arise from NS mergers and accretion-induced collapses of white dwarfs. Some multi-wavelength emission features can be used to identify and classify these NS-powered transient phenomena.

COSMOLOGY, DE, DM, COMPACT STARS, GRAVITY, BHs, GWs / 60

Black holes at cosmic dawn

Author: I. F. Mirabel[1]

[1] *IAFE-UBA-Argentina*

Theoretical models and observations suggest that primordial stellar Black Holes (Pop III-BHs) were prolifically formed in HMXBs, which are powerful jet-sources of synchrotron radiation called Microquasars (MQs). Possible signatures of large populations of BH-HMXB-MQs at cosmic dawn are: a synchrotron cosmic radio background (CRB) observed with ARCADE 2, and the unpredicted large excess amplitude of HI absorption at z=17 reported by EDGES, believed to be boosted by the CRB of ARCADE 2. Pop III BH-HMXB-MQs precede supernovae, neutron stars and dust. BH-HMXB-MQs promptly inject hard X-rays and relativistic jets into the IGM, which overtake the HII regions ionized by progenitor Pop III stars, heating and partially ionizing the IGM over larger distance scales. BH-HMXBs are channels for the formation of BBHs. The large masses of GW-BBHs relative to X-ray-BHs, and the high rates of BBH-mergers, are consistent with a high formation rate of BH-HMXBs and BBHs at cosmic dawn.

COSMOLOGY, DE, DM, COMPACT STARS, GRAVITY, BHs, GWs / 49

Computer Simulations of the Early Universe

Author: David Garrison[1]

Co-author: Joshua Barrera [1]

[1] *University of Houston Clear Lake*

We are now able to simulate much of the early universe from the time of the Electro-Weak Phase Transition through the end of primordial nucleosynthesis. This simulation is performed using a General Relativistic Magnetohydrodynamic code based on the Cactus framework. It solves both the relativistic magnetohydrodynamic equations and Einstein's equations of General Relativity. As a result, it can simulate: magnetogenesis, primordial gravitational waves, turbulence, primordial perturbations and the role of dark matter in the early universe. Future work will involve extrapolating this work to the present epoch.

COSMOLOGY, DE, DM, COMPACT STARS, GRAVITY, BHs, GWs / 79

Mass load of magnetically-dominated jets

Author: Gustavo Esteban Romero[1]

[1] *Instituto Argentino de Radioastronomía*

Relativistic jets in active galactic nuclei start as a Poynting flux produced in the ergosphere of rapidly rotating black holes. However, at distances of a few tens of gravitational radii from the black hole these jets produce synchrotron and inverse Compton radiation, a clear indication that they have a significant content of charged particles. In this talk I discuss the origin of such particles with emphasis on the role played by the hot accretion flows in the process of jet generation.

COSMOLOGY, DE, DM, COMPACT STARS, GRAVITY, BHs, GWs / 58

Precision Cosmology for Modified and Extended Theories of Gravity

Author: Celia Escamilla-Rivera[1]

[1] *Instituto de Ciencias Nucleares ICN-UNAM*

In this talk we present current cosmological results about Modified and Teleparallel Gravity Cosmology. We demonstrate that according the current astrophysical data (CC+Pantheon+BAO+GW samplers with late universe measurements SH0ES+H0LiCOW) these theories can provide another interpretation to the oscillatory behaviour of the dark energy equation of state when applied to late times and alleviate the tension issues related to H0 and σ8.

COSMOLOGY, DE, DM, COMPACT STARS, GRAVITY, BHs, GWs / 59

Brief review on ultra light bosons as dark matter

Author: Luis Ureña-Lopez[1]

[1] *University of Guanajuato*

The model of ultra light bosons to conform the dark matter of the Universe has been under strong scrutiny in the last two decades, and has of lately become an alternative reference model to the cold dark matter one of the standard cosmological model. In this talk we will present the general results of the model and a summary of the observations that can constrain its physical parameters. In addition to the mass of the boson, we will also consider a parameter of self-interaction that in turn influences the cosmological observables. We finally comment on upcoming tests that may or may not validate the model.

COSMOLOGY, DE, DM, COMPACT STARS, NSs, BHs, GWs, GRAVITY / 96

Timeless state of gravity: one observer Universe

Author: Ahmed Farag Ali[1]

[1] *Benha University*

We consider spacetime foliation, at every given moment according to canonical observers, each with its speed at that moment. Consider a black hole spacetime as a spacetime with horizon. The Universe in that sense look like a sequence of frozen moments like a cartoon movie. The Rindler observer would analyze the ADM formalism as if the shift function Ni equal zero. Therefore, the normal vector to the spatial slice is proportional to the time basis of Rindler frame field with proportionality factor that is equal to the lapse function. This is the only way to make special relativity preferred frames match with general relativity Rindler frame.

COSMOLOGY, DE, DM, COMPACT STARS, NSs, BHs, GWs, GRAVITY / 168

Magnetized Strange Stars versus Magnetized BEC stars

Authors: Aurora Perez Martinez[1]; Gretel Quintero Angulo[2]; Daryel Manreza Paret[3]; Diana Alvear Terrero[4]; Samantha López[5]

[1] *Instituto de Cibernética, Matemática y Física –ICIMAF*

[2] *Facultad de Física, Universidad de La Habana*

[3] *Universidad de La Habana –UH*

[4] *ICIMAF & University of Wroclaw*

[5] *ICIMAF*

We study the spheroidal magnetized Quark and Bose–Einstein Condensate (BEC) Stars. The former are supposed composed by strange quark matter while the later by the pairing of two-neutrons forming an interacting spin-one bosons. We calculate the equation of states (EoS) of the magnetized strange stars matter using Bag model while the corresponding EoS for magnetized BEC stars are doing considering the particle-magnetic field interaction and particle-particle interaction as two independent quantities. For Strange Stars we study first the stability of strange quark matter and we get stable configurations of the corresponding Strange Stars. Self-magnetized BEC may be possible so it allows to get inner magnetic field profiles of the stars as a function of the equatorial radii. The values obtained for the core and surface magnetic fields are in agreement with those typically found in compact objects.

COSMOLOGY, DE, DM, COMPACT STARS, NSs, BHs, GWs, GRAVITY / 40

Supercritically charged objects and electron-positron pair creation

Authors: Cheng-Jun Xia[1]; She-Sheng Xue[2]; Ren-Xin Xu[3]; Shan-Gui Zhou[4]

[1] *Zhejiang University Ningbo Institute of Technology*

[2] *Sapienza University of Rome*

[3] *Peking University*

[4] *Institute of Theoretical Physics, Chinese Academy of Sciences*

We investigate the stability and e^+e^- pair creation of supercritically charged superheavy nuclei, udQM nuggets, strangelets, and strangeon nuggets based on the Thomas-Fermi approximation. The model parameters are fixed by reproducing masses and charge properties of these supercritically charged objects reported in earlier publications. It is found that udQM nuggets, strangelets, and strangeon nuggets may be more stable than ^{56}Fe at the baryon number $A \geq 315$, 5×10^4, and 1.2×10^8, respectively. For those stable against neutron emission, the most massive superheavy element has a baryon number $\sim$965, while udQM nuggets, strangelets, and strangeon nuggets need to have baryon numbers larger than 39, 433, and 2.7×10^5. The e^+e^- pair creation will inevitably start for superheavy nuclei with charge numbers $Z \geq 177$, for udQM nuggets with $Z \geq 163$, for strangelets with $Z \geq 192$, and for strangeon nuggets with $Z \geq 212$. A universal relation $Q/R_e = (m_e - \bar{\mu}_e)/\alpha$ is obtained at a given electron chemical potential $\bar{\mu}_e$, where Q is the total charge and R_e the radius of electron cloud. The maximum number of Q without causing e^+e^- pair creation is then fixed by taking $\bar{\mu}_e = -m_e$. For supercritically charged objects with $\bar{\mu}_e < -m_e$, the decay rate for e^+e^- pair production is estimated based on the Jeffreys-Wentzel-Kramers-Brillouin (JWKB) approximation. It is found that most positrons are emitted at $t \leq 10^{-15}$ s, while a long lasting positron emission can be observed for large objects with $R \geq 1000$ fm. The emission of positrons and electron-positron annihilation from supercritically charged objects may be partially responsible for the short γ-ray burst during the merger of binary compact stars, the 511 keV continuum emission, as well as the narrow faint emission lines in X-ray spectra from galaxies and galaxy clusters.

COSMOLOGY, DE, DM, COMPACT STARS, NSs, BHs, GWs, GRAVITY / 169

Dynamical black hole in a bouncing universe

Author: Daniela Perez[1]

[1] *Instituto Argentino de Radioastronomía*

In this talk, I analyze the dynamical evolution of a black hole that is immersed in a universe that goes through a classical bounce. The black hole is represented by the McVittie metric, an exact solution of Einstein Field Equations for an inhomogeneity embedded in a Friedmann-Lemaître-Robertson-Walker cosmological background. I present a full analysis of the causal structure of the spacetime. This includes the calculation of trapping horizons, radial null geodesics, and curvature invariants throughout the cosmic time. I close the presentation with a possible interpretation of this spacetime and a discussion of the implications of the results obtained for classical bouncing cosmologies.

COSMOLOGY, DE, DM, COMPACT STARS, NSs, BHs, GWs, GRAVITY / 170

Pulsar kick velocity and strong magnetic fields

Author: Daryel Manreza Paret[1]

[1] *Universidad de La Habana –UH*

We study the anisotropic neutrino emission from the core of neutron stars induced by the star's magnetic field. We model the core as made out of a magnetized ideal gas of strange quark matter and implement the conditions for stellar equilibrium in this environment. The calculation is performed

without resorting to analytical simplifications and for temperature, density and magnetic field values corresponding to typical conditions for a neutron star's evolution. The anisotropic neutrino emission produces a rocket effect that contributes to the star's kick velocity. We find that the computed values for the kick velocity lie within the range of the observed values. We also show that neutrino quirality flip during the birth of a neutron star, with a strange quark matter core, is an efficient mechanism to allow neutrinos to anisotropically escape, thus providing a plausible explanation for the observed neutron star kick velocities.

COSMOLOGY, DE, DM, COMPACT STARS, NSs, BHs, GWs, GRAVITY / 48

Using triangles to test gravity in galaxy surveys

Author: Gustavo Niz[1]

[1] *Universidad de Guanajuato*

We model the 3PCF of General Relativity (GR) and a representative model of Modified Gravity (f(R)) using Cosmological Perturbation Theory and compare it with the non-linear evolution of N-body simulations.

COSMOLOGY, DE, DM, COMPACT STARS, NSs, BHs, GWs, GRAVITY / 113

Simulated X-ray Emission in Galaxy Clusters with AGN Feedback

Author: Rudrani Kar Chowdhury[1]

Co-authors: Soumya Roy [2]; Suchetana Chatterjee [1]; Nishikanta Khandai [3]; Craig Sarazin [4]; Tiziana Di Matteo [5]

[1] *Presidency University*

[2] *Inter-University Centre for Astronomy and Astrophysics*

[3] *National Institute of Science Education and Research*

[4] *University of Virginia*

[5] *Carnegie Mellon University*

Several studies suggest that active galactic nuclei (AGN) play a significant role in the cosmological evolution of their host galaxies and dark matter halos. There is considerable evidence that the formation and evolution of the central AGN and the diffuse gas in the halo are coupled together by the activity of the supermassive blackhole (SMBH), usually termed as AGN feedback in the literature. To investigate this effect, we study the diffuse X-ray emission from galaxy groups and clusters by coupling the Astrophysical Plasma Emission Code (APEC) with the highest resolution cosmological hydrodynamic simulation involving feedback from AGN. We then construct a statistical sample of synthetic Chandra X-ray photon maps to observationally characterize the effect of AGN on the surrounding medium. By examining the flux and photon maps, we validate a recently used technique of X-ray stacking to study the effect of feedback on the intra-cluster medium (ICM) from high redshift AGN. Our results show that AGN are indeed effective in displacing the hot X-ray emitting gas from the centers of groups and clusters, and that these signatures remain evident in observations of the X-ray surface brightness profiles. Through this study we provide a robust method to extract the fraction of total energy output of the AGN that couples to the surrounding gas as feedback. This technique is applied to 200 ks Chandra X-ray observations of the ICM. We further discuss this detection feasibility in the light of current and upcoming X-ray missions.

COSMOLOGY, DE, DM, COMPACT STARS, NSs, BHs, GWs, GRAVITY / 171

Strong Lensing of a Regular Black Hole with an Electrodynamics Source

Author: Tuhina Manna[1]

[1] *St. Xavier's College*

In this paper we have investigated the gravitational lensing phenomenon in the strong field regime for a regular, charged, static, non-linear black hole having a electrodynamics source. We have obtained the angle of deflection and compared it to a Schwarzschild black hole and Reissner Nordstrom black hole with similar properties. We have also done a graphical study of the relativistic image positions and magnifications. We hope that this method may be useful in the detection of non-luminous bodies like this current black hole.

MMA, DE, DM, CCGG, X-RAYS, MWA, NSs, SNOVAE, GRAVITY / 61

X-ray Polarization in Supernova Remnants

Author: Patrick Slane[1]

[1] *Harvard-Smithsonian Center for Astrophysics*

The fast shocks in supernova remnants are known to accelerate particles to extremely high energies. The acceleration process is closely tied to the magnetic field structure in the shock region. This, in turn, can be modified considerably by the shock. Synchrotron emission from the shock regions provides crucial details about the magnetic field strength and orientation through its polarization. Radio polarization studies of several SNRs have provided important maps of the field orientation, and these provide clues about the connection with particle acceleration. Due to the rapid losses of the highest-energy particles, however, X-ray polarization measurements provide magnetic field information from particles much closer to the acceleration sites. Here I discuss how X-ray polarization observations can be used to investigate the magnetic fields in SNRs in order to address questions about acceleration efficiency dependence on shock obliquity, levels of turbulence in the fields, and acceleration of particles at the reverse shock.

MMA, DE, DM, CCGG, X-RAYS, MWA, NSs, SNOVAE, GRAVITY / 82

Canonical gauge theory of gravitation for fermions

Author: Juergen Struckmeier[1]

[1] *FIAS*

For gauge theories based on the action principle, the covariant Hamiltonian formalism is the description of choice as one can then take advantage of the canonical transformation framework. The latter restricts transformations of the dynamical variables to exactly those that follow from a generating function, which entails by construction that the form of the action principle is maintained and hence that the transformation is physically admissible. On that basis, the canonical gauge theory of gravitation was successfully worked out for scalar (spin-0) and vector (spin-1) matter fields. Compared to scalar fields, vector fields were confirmed to exhibit additional couplings to a dynamic spacetime. As a result, Einstein's General Relativity turned out to apply to particles without internal degrees of freedom (spin-0) only. In this talk it is shown that novel couplings of spin-1/2 particles to spacetime emerge. In particular, fermions acquire an additional effective mass term and a torsion-dependent correction of their dynamics.

MMA, DE, DM, CCGG, X-RAYS, MWA, NSs, SNOVAE, GRAVITY / 57

Dark Energy and Inflation as effects of torsion and geometry in the Covariant Canonical Gauge theory of Gravity (CCGG)

Author: David Vasak[1]

[1] *FIAS*

CCGG is a mathematically rigorous derivation of the coupling of matter and spacetime geometry from a few basic postulates. The framework, based on the canonical transformation theory in the covariant de Donder-Hamiltonian formulation, yields a classical Palatini field theory extending the Einstein-Hilbert ansatz by an admixture of quadratic gravity. That term, quadratic in the Riemann-Cartan curvature tensor, endows space-time with inertia and generates geometrical modifications of the stress-energy tensor. Its relative contribution is determined by a dimensionless coupling constant, facilitating a new free parameter for gravity. Applied to the Friedman model of the universe, CCGG gives rise to scale dependence of both, the cosmological constant and the curvature contribution to the Hubble function. Numerical analysis on the basis of the LCDM set of cosmological parameters shows, depending on the choice of the new parameter, three distinct solution types: Non- singular (bouncing), singular Big Bang with following inflationary periods, and a standard Big Bang scenario. All solutions share a graceful exit into the late dark energy era. Our preliminary analysis presented here indicates that the modified Hubble function alleviates the Hubble tension between the SNeIa and the CMB data. Moreover, the cosmological constant problem is resolved as the cosmological term replacing Einstein's cosmological constant is a composite entity.

MMA, DE, DM, CCGG, X-RAYS, MWA, NSs, SNOVAE, GRAVITY / 64

Studying the onset of deconfinement with multi-messenger astronomy of neutron stars

Author: David Blaschke[1]

[1] *University of Wroclaw*

One of the most intriguing questions in the astrophysics of neutron stars is whether their interiors harbour deconfined quark matter. With the first multi-messenger observation of a binary neutron star merger (GW170817) new constraints became available for masses and radii of neutron stars. In this lecture, I will discuss what we may infer for their mass and the central density at the onset of deconfinement under
certain assumptions that may become testable in the near future. First, I will give an overview on the scenarios discussed in the literature, involving variations of hadronic as well as quark matter equations of state and commenting on their reliability. Then I will focus on the implications that precise simultaneous measurements of mass and radius in certain regions of the mass radius diagram will have for disentangling the onset of deconfinement and the characteristics of the phase transition. Such measurements are expected in near future from the NICER experiment. I will discuss Bayesian analyses with the presently available data as well as fictitious mass radius data that could in principle be the outcome of the NICER observations. Finally I will give an outlook on possible consequences for the structure of the QCD phase diagram, in particular for the existence of one or more critical endpoints of first-order phase transitions.

MMA, DE, DM, CCGG, X-RAYS, MWA, NSs, SNOVAE, GRAVITY / 123

A virtual tour of the recent results of the Pierre Auger Observatory

Author: Lucas Nellen[1]

[1] *National Autonomous University of Mexico - UNAM*

The Pierre Auger Observatory, covering an area of 3000 km^2 is currently the larges observatory to study the highest energy cosmic rays, with energies above 10^{18} eV. The main part observatory consists of a surface detector with about 1600 stations, spaced 1.5 km apart, and 4 fluorescence detector sites with a total of 17 telescopes, overlooking the surface detector. We will start our tour of the Observatory and the underlying detection techniques. A significant part of the tour will be spend on the highlights of the recent results from the Pierre Auger Observatory. We will conclude our tour presenting the upgrade of the Observatory which is currently being installed, and how it will extend the
science reach of the Observatory.

X- & CR RAYS, QM, SNOVAE, GRAVITY, DM, COSMOLOGY, PARTICLES, COMPACT STARS, GALAXIES / 126

BH Mass, Jet and Accretion Disk Connection: An Analysis of Radio-loud and Radio-quiet Quasars

Author: Avinanda Chakraborty[1]

Co-author: Anirban Bhattacharjee [2]

[1] *Presidency University*

[2] *Sul Ross State University*

Surveys have shown radio-loud (RL) quasars constitute 10%-15% of the total quasar
population and rest are radio-quiet (RQ). However, it is unknown if the radio-loud fraction or RLF (RL quasars/Total quasars) remains consistent among different parameter spaces. This study shows that RLF increases for increasing full width half maximum (FWHM) velocity of the Hβ and MgII broad emission line. Our data has been obtained from Shen et al. (2011) catalogue. Our sample consists of quasars with magnitude less than 19.1 and limited upto redshift 0.75 for Hβ and 1.9 for MgII. We are getting RLF for the Hβ and MgII broad emission line FWHM greater than 15000km/s is 0.577 and 0.408 respectively. To investigate the reason, in this preliminary study we analyse various properties like bolometric luminosity, optical continuum luminosity, black hole (BH) mass and accretion rate of RL quasars (RLQs) and RQ quasars (RQQs) sample which have FWHM greater than 15000km/s (High Broad Line or HBL). From the distributions we can conclude for all the properties in HBL,RLQs are having higher values than RQQs. We have predicted RLQs are intrinsically brighter than RQQs and also predicted BH mass-jet connection and accretion disk-jet connection from our results but to conclude anything more analysis is needed.

X- & CR RAYS, QM, SNOVAE, GRAVITY, DM, COSMOLOGY, PARTICLES, COMPACT STARS, GALAXIES / 182

Thermo-dynamical effects on FRW cosmological model for various Dark Energy

Author: Bishnukar Nayak[1]

[1] *National Institute of Science, Technology Institute Park*

In this discussion, we have analysed the thermo-dynamical effects of a cosmological model using Einstein Theory. To study the model, we have considered several time varying dark energy states in two different assumptions, from which we found a phantom phase during spatially open universe

for $\Lambda \propto$ ⊠⊠–⊠ and all remaining results indicates a quintessence phase. The temperature and entropy density of the model remain positive for both the cases. In view of Energy Conditions, the assumptions yields identical result. The Strong Energy Condition violates, that indicates an accelerating expansion of the Universe.

X- & CR RAYS, QM, SNOVAE, GRAVITY, DM, COSMOLOGY, PARTICLES, COMPACT STARS, GALAXIES / 177

Dark photons in a Higgs Stueckelberg model for dark matter

Author: Dimiter Hadjimichef[1]

[1] *Federal University of Rio Grande do Sul –UFRGS*

An extension of the Standard Model (SM) is studied, in which two new vector bosons are introduced, a first boson (Z') coupled to the SM by the usual minimal coupling, producing an enlarged gauge sector in the SM and a second boson field, in the dark sector of the model, remains massless and originates a dark photon, in a hybrid mixing scenario based on a combined Higgs and Stueckelberg mechanisms. An astrophysical application is evaluated obtaining an estimate of the impact on stellar cooling of white dwarfs.

X- & CR RAYS, QM, SNOVAE, GRAVITY, DM, COSMOLOGY, PARTICLES, COMPACT STARS, GALAXIES / 173

Quantum magnetic collapse of a partially bosonized npe-gas: implications for astrophysical jets

Authors: Gretel Quintero Angulo[1]; Ricardo Gonzalez Felipe[2]; Aurora Perez Martinez[3]; Hugo Pérez Rojas[4]

[1] *Facultad de Física, Universidad de La Habana*

[2] *ISEL and CFTP/IST*

[3] *ICIMAF*

[4] *Instituto de Cibernética, Matemática y Física –ICIMAF*

We study the quantum magnetic collapse of a partially bosonized npe-gas and obtain that this type of collapse might be one of the mechanisms behind matter expulsion out of compact objects. We check also that this gas might form a stable stream of matter whose collimation is due to its strong self-generated magnetic field. Possible astrophysical applications of these results, in particular related to jet formation and its maintenance, are discussed.

X- & CR RAYS, QM, SNOVAE, GRAVITY, DM, COSMOLOGY, PARTICLES, COMPACT STARS, GALAXIES / 176

Thermodynamic consequences for modified Rastall gravity

Author: José Alberto Casto Nogales Vera[1]

[1] *Federal University of Lavras –UFLA*

We studied thermodynamic aspects of modified Rastall gravity; recently, we proposed a modified Rastall gravity related to unimodular gravity. In this context, we study the non-conservation of the

energy-momentum tensor; we develop covariant formalism of the first and second laws of thermodynamics. The second law implies a non-zero entropy flow and it is necessary to introduce particle production as part of the laws of thermodynamics, we show the consequences for the FLRW cosmological model.

X- & CR RAYS, QM, SNOVAE, GRAVITY, DM, COSMOLOGY, PARTICLES, COMPACT STARS, GALAXIES / 172

Possible role of fragmentation and accretion on the stellar Initial Mass Function?

Author: Rafeel Riaz[1]

[1] *Facultad de Ciencias Físicas y Matemáticas, Universidad de Concepción –UdeC*

The stellar Initial Mass Function (IMF) appears to be close to universal within the Milky Way galaxy. However, it is strongly suspected to be different in the primordial Universe, where molecular hydrogen cooling is less efficient and the gas temperature can be higher by a factor of 30. In between these extreme cases, the gas temperature varies depending on the environment, metallicity and radiation background. We explore if changes of the gas temperature affect the IMF of the stars considering fragmentation and accretion. We have good indications that typical features of the IMF such as the mean, minimum and maximum stellar mass are regulated by the two key physical processes of fragmentation and mass accretion. Our simulations indicate the presence of two distinct regimes of protostellar mass growth, one where the protostellar masses are dominated by the initial fragmentation, and one where they are dominated by the accretion process. In the fragmentation dominated regime one expects at best a very weak dependence on the initial temperature of the gas, as the Jeans mass is very similar at the transition point from an approximately isothermal to an adiabatic equation of state (EOS). In the accretion dominated regime, on the other hand, we find that the average mass correlates with the gas temperature. We have quantified the role of these processes with numerical simulations, varying the initial gas temperature from 10 to 50 K, assuming transonic turbulence and a ratio of rotational to gravitational energy of 1 %. We pursued two sets of models with different random seeds to initialize the turbulence, corresponding to different realizations with the same statistical properties. Before the transition to the regime dominated by accretion, there is no evidence of a temperature dependence, confirming previous reported findings. As a result, one may expect a rather universal IMF if the star formation efficiency (SFE) is low enough. If higher SFEs are reached, our simulations show that one would expect a dependence of the accretion process on temperature. This could be caused by local radiation backgrounds that heat up the gas. The minimum temperature of the gas is expected to increase with cosmic redshift, as cooling becomes inefficient below the CMB temperature. The temperatures explored here correspond to a redshift range from 2.7 to 17.3, if interpreted to be due to the temperature of the CMB, thus covering a significant range in redshift, while in the presence of a sufficiently strong radiation background heating the gas, the models can be applied at lower redshift as well. Our approach implicitly assumes the presence of dust, as the latter regulates the transition from an approximately isothermal to an adiabatic regime. The effective mass accretion phase helps the protostars to grow in mass as well as in number which lead to the eventual higher mean masses associated to the warmer clouds until the SFE reaches $\xi = 15$ % at the end of our simulations. The total number of protostars in each of our models and the associated protostellar mergers as a function of SFE also provide an insight which support the existence of a transition from a fragmentation dominated to an accretion dominated phase inside collapsing gas clouds. Despite the lesser number of mergers the warmer gas clouds show a higher mean mass after a critical SFE of about $\xi = 5$ to 7 %. Our analysis of mass accretion for the longest surviving protostar in each model provides a demonstration of the transition from the fragmentation dominated regime to accretion dominated regime in star forming gas clouds.

X- & CR RAYS, QM, SNOVAE, GRAVITY, DM, COSMOLOGY, PARTICLES, COMPACT STARS, GALAXIES / 183

Gravitational memory effects and Bondi-Metzner-Sachs symme-

tries in scalar-tensor theories

Author: Shaoqi Hou[1]

[1] *Wuhan University*

The relation between gravitational memory effects and Bondi-Metzner-Sachs symmetries of the asymptotically flat spacetimes is studied in the scalar-tensor theory. For this purpose, the solutions to the equations of motion near the future null infinity are obtained in the generalized Bondi-Sachs coordinates with a suitable determinant condition. It turns out that the Bondi-Metzner-Sachs group is also a semi-direct product of an infinitesimal dimensional supertranslation group and the Lorentz group as in general relativity. There are also degenerate vacua in both the tensor and the scalar sectors in the scalar-tensor theory. The supertranslation relates the vacua in the tensor sector, while in the scalar sector, it is the Lorentz transformation that transforms the vacua to each other. So there are the tensor memory effect similar to the one in general relativity, and the scalar memory effect, which is new. The evolution equations for the Bondi mass and angular momentum aspects suggest that the null energy fluxes and the angular momentum fluxes across the null infinity induce the transition among the vacua in the tensor and the scalar sectors, respectively.

X- & CR RAYS, QM, SNOVAE, GRAVITY, DM, COSMOLOGY, PARTICLES, COMPACT STARS, GALAXIES / 89

The Graphical Presentation of 4-Dimensiona Spacetime Worldline and the Existence of Objects Inferred from the Worldline

Author: Yuxiang Wu[1]

[1] *retired*

Since we do not know how to draw a 4-dimensional graph, Minkowski compressed his (x,y,z,t) model to (x,y,t), and using spacetime light cone to represent 4-dimensional space graph. But such light cone brings lots of problems and errors. We showed some in the paper. To overcome that, we developed a new method to draw a real 4-dimensional spacetime graph. From the application of such method to draw multi-world lines in one graph, we were hinted to develop the Law of Existence of Objects: an object only exists at the "present" moment.

COMPACT STARS, DM, GWs, PARTICLES, ϒ-RAYS, QGP QCD, HIC, SNOVAE / 65

The highest gamma ray energy sources observed by HAWC and the Galactic Pevatrons

Author: Andrés Sandoval[1]

[1] *Instituto de Física, UNAM*

The HAWC gamma ray observatory situated at 4200 m altitude in the Volcan Sierra Negra, Central Mexico, has observed several sources that emit gamma rays of energies greater than 50 TeV. What are they? What is the production mechanism? How do they look in other frequencies? How do they relate to the sources of energetic cosmic rays? These are some of the questions that will be discussed.

COMPACT STARS, DM, GWs, PARTICLES, ϒ-RAYS, QGP QCD, HIC, SNOVAE / 66

The Southern Wide Field Gamma Ray Observatory (SWGO)

Author: Ulisses Barres[1]

[1] *Centro Brasileiro de Pesquisas Físicas*

The scientific potential of a wide field of view, and very high duty cycle, ground based gamma ray detector has been demonstrated by the current generation of instruments, such as HAWC and ARGO, and will be further extended in the Northern hemisphere by LHAASO. Nevertheless, no such instrument exists in the southern hemisphere yet, where a great potential lies uncovered for the mapping of Galactic large scale emission as well as providing access to the full sky for transient and variable multi-wavelength and multi-messenger phenomena. Access to the Galactic Centre and complementarity with the CTA-South are other key motivations for such a gamma ray observatory in the south. There is also significant potential for cosmic ray studies, including investigation of cosmic ray anisotropy. In this talk I will present the concept for the future Southern Wide-Field Gamma-ray Observatory (SWGO), now formally established as an international Consortium (www.swgo.org) and starting its R&D phase, as well as its scientific perspectives.

COMPACT STARS, DM, GWs, PARTICLES, ϒ-RAYS, QGP QCD, HIC, SNOVAE / 67

Can gravitational waves prove the existence of the quark- gluon plasma?

Author: Matthias Hanauske[1]

[1] *Institut für Theoretische Physik*

The long-awaited detection of a gravitational wave (GW) from the merger of a binary neutron star (BNS) in August 2017 (GW170817) marked the beginning of the new field of multi-messenger gravitational wave astronomy. By exploiting the extracted tidal deformations of the two neutron stars from the late inspiral phase of GW170817, it was possible to constrain several global properties of the equation of state of neutron star matter. With future gravitational wave detections we will be able to investigate the hadron-quark phase transition (HQPT) by analyzing the spectrum of the post-merger GW of the differentially rotating hypermassive hybrid star (HMHS). In contrast to hypermassive neutron stars (HMNS) these highly differentially rotating objects contain deconfined strange quark matter in their slowly rotating and rather cold inner region. HMHS live only a view seconds and during the collapse of the HMHS to a Kerr Black the color degrees of freedom of the pure quark core get macroscopically confined by the formation of an event horizon.

COMPACT STARS, DM, GWs, PARTICLES, ϒ-RAYS, QGP QCD, HIC, SNOVAE / 68

NS 1987A in SN 1987A

Author: Dany Page[1]

[1] *Universidad Nacional Autonoma de Mexico*

The possible detection of a compact object in the remnant of SN 1987A presents an unprecedented opportunity to follow its early evolution. The suspected detection stems from an excess of infrared emission from a dust blob near the compact object's predicted position. The infrared excess could be due to the decay of isotopes like 44Ti, accretion luminosity from a neutron star or black hole, magnetospheric emission or a wind originating from the spindown of a pulsar, or thermal emission from an embedded, cooling neutron star (NS 1987A). It is shown that the last possibility is the most

plausible as the other explanations are disfavored by other observations and/or require fine-tuning of parameters.
Not only are there indications the dust blob overlaps the predicted location of a kicked compact remnant, but its excess luminosity also matches the expected thermal power of a 30 year old neutron star. Furthermore, models of cooling neutron stars within the Minimal Cooling paradigm readily fit both NS 1987A and Cas A, the next-youngest known neutron star. If correct, a long heat transport timescale in the crust and a large effective stellar temperature are favored, implying relatively limited crustal n-1S0 superfluidity and an envelope with a thick layer of light elements, respectively. If the locations do not overlap, then pulsar spindown or accretion might be more likely, but the pulsar's period and magnetic field or the accretion rate must be rather finely tuned. In this case, NS 1987A may have enhanced cooling and/or a heavy-element envelope.

COMPACT STARS, DM, GWs, PARTICLES, ϒ-RAYS, QGP QCD, HIC, SNOVAE / 70

Properties of the QGP created in heavy-ion collisions

Author: Elena Bratkovskaya[1]

[1] *GSI, Darmstadt & GU, Frankfurt*

We review the properties of the strongly interacting quark-gluon plasma (QGP) created in heavy-ion collisions at ultrarelativistic energies, i.e. out-of equilibrium, and compare them to the equilibrium case.
The description of the strongly interacting (non-perturbative) QGP in equilibrium is based on the effective propagators and couplings from the Dynamical QuasiParticle Model (DQPM) that is matched to reproduce the equation-of-state of the partonic system above the deconfinement temperature Tc from lattice QCD. We study the transport coefficients such as the ratio of shear viscosity and bulk viscosity over entropy density, diffusion coefficients, electric conductivity etc. versus temperature and baryon chemical potential. Based on a microscopic transport description of heavy-ion collisions we discuss which observables are sensitive to the QGP creation and its properties.

COMPACT STARS, DM, GWs, PARTICLES, ϒ-RAYS, QGP QCD, HIC, SNOVAE / 76

The nuclear equation of state at highest compression - from gravitational waves and high energy heavy ion collisions

Author: Horst Stoecker[1]

[1] *GSi*

Compressed hot nuclear matter can be produced in high energy heavy ion collisions and in supernova collapse and binary neutron star mergers. Relativistic numerical nuclear fluid dynamics demonstrates that the densities and temperatures reached in these cosmic environments match neatly those reached at the new international FAIR facility in Europe. The gravitational wave spectrum of the former and the flow signatures of the latter can yield information about phase transitions in the nuclear equation of state into resonance matter and strange quark matter.

COMPACT STARS, DM, DE, GWs, ϒ RAYS, QGP, QCD, HIC, SNOVAE, BHs, PARTICLES, GALAXIES / 180

A Minimal Length Uncertainty Approach to Cosmological Constant Problem

Author: Abdel Magied Abdel Diab[1]

[1] *Modern University for Information –MTI*

Based on quantum mechanical framework for the minimal length uncertainty, we demonstrate that the generalized uncertainty principle (GUP) parameter - on one hand - could be best constrained by recent gravitational waves observations, and - on other hand - suggest modified dispersion relations (MDRs) to calculate the difference between the group velocity of gravitons and that of photons. Utilizing features of the UV/IR correspondence and the obvious similarities between GUP (including non-gravitating and gravitating impacts on Heisenberg uncertainty principle) and the discrepancy between the theoretical and the observed cosmological constant (apparently manifesting gravitational influences on the vacuum energy density), we suggest a possible solution for the cosmological constant problem.

COMPACT STARS, DM, DE, GWs, ϒ RAYS, QGP, QCD, HIC, SNOVAE, BHs, PARTICLES, GALAXIES / 179

Quantization consequences on the metric tensors

Author: Abdel Nasser Tawfik [1]

[1] *Nile University –NU*

When minimal length uncertainty emerging from generalized uncertainty principle (GUP) is thoughtfully implemented, it is of great interest to consider its impacts on Einstein's gravitational field equations (EFE) and to find out whether the corresponding modification in the metric manifests properties of quantum geometry due to quantum gravity. GUP takes into account the gravitational impacts on the noncommutation relations of the distance and momentum operators and of the time and energy operators, etc. On the other hand, the EFE relates classical geometry or gravity to the energy-momentum tensors, i.e. quantum equations of state. Despite the technical difficulties, we confront GUP to the metric tensors so that the line metric, geodesic equation, Christoffel connection, etc. are accordingly modified. We illustrate our idea on approaching quantum gravity by focusing the discussion on the corresponding modified geodesic equation, which apparently encompasses acceleration, jerk, and snap (jounce) of a particle in the quasi-quantized gravitational field.

COMPACT STARS, DM, DE, GWs, ϒ RAYS, QGP, QCD, HIC, SNOVAE, BHs, PARTICLES, GALAXIES / 185

Static EKG stars and matter-scalar field interactions

Author: Alejandro Cabo Montes de Oca[1]

[1] *Instituto de Cibernética, Matemática y Física –ICIMAF*

Static (not stationary) solutions of the Einstein-Klein-Gordon (EKG) equations including matter are obtained for real scalar fields. The scalar field interaction with matter is considered. The introduced coupling allows the existence of static solutions in contraposition with the case of the simpler EKG equations for real scalar fields and gravity. Surprisingly, when the considered matter is a photon-like gas, it turns out that the gravitational field intensity at large radial distances becomes nearly a constant, exerting an approximately fixed force to small bodies at any distance. The effect is clearly related with the massless character of the photon-like field. It is also argued that the gravitational field can generate a bounding effect, that could avoid the unlimited increase in mass with the radius of the obtained here solution. This effect, if verified, furnishes a possible mechanism for explaining how the increasing gravitational potential associated to dark matter finally decays at large distances from the galaxies. A method for evaluating these photon bounding effects is just formulated in order to be further investigated.

COMPACT STARS, DM, DE, GWs, ϒ RAYS, QGP, QCD, HIC, SNOVAE, BHs, PARTICLES, GALAXIES / 187

Primordial Black Holes and their Formation

Author: Encieh Erfani[1]

[1] *Institute for Advanced Studies in Basic Sciences*

With the discovery of gravitational waves from merging pairs of massive black holes, the interest in the question of whether Primordial Black Holes (PBHs) could constitute the Dark Matter (DM) has recently been revived. In this talk, I will review the different mechanisms for (DM) PBHs formation with a focus on inflation which can source the required large density fluctuations for PBHs formation. I will also explain the excursion set theory as a new formalism for the formation of DM PBHs.

COMPACT STARS, DM, DE, GWs, ϒ RAYS, QGP, QCD, HIC, SNOVAE, BHs, PARTICLES, GALAXIES / 32

A new code for the numerical simulation of relativistic flows on supercomputers by means of a low-dissipation scheme

Author: Igor Kulikov[1]

[1] *ICMMG SB RAS*

A new code to simulate special relativistic hydrodynamic flows on supercomputer architectures with distributed memory is described. The code is based on a combination of Godunov's method and a piecewise parabolic method with a local stencil. This approach has good conservation properties, correctly reproduces shock waves, and ensures high accuracy on smooth solutions and low dissipation on discontinuities. Only a local computation stencil is needed for the piecewise parabolic reconstruction of the solution. The code scalability is 94% on a cluster, Intel Xeon X5670 NKS-30T, with 768 cores. The results of code verification using a relativistic jet problem and computational experiments on the evolution of a galactic jet are presented.

COMPACT STARS, DM, DE, GWs, ϒ RAYS, QGP, QCD, HIC, SNOVAE, BHs, PARTICLES, GALAXIES / 181

New Graviton Mass Bound from Binary Pulsars

Author: Lijing Shao[1]

[1] *Peking University*

In Einstein's general relativity, gravity is mediated by a massless metric field. The extension of general relativity to consistently include a mass for the graviton has profound implications for gravitation and cosmology. Salient features of various massive gravity theories can be captured by Galileon models, the simplest of which is the cubic Galileon. The presence of the Galileon field leads to additional gravitational radiation in binary pulsars where the Vainshtein mechanism is less suppressed than its fifth-force counterpart, which deserves a detailed confrontation with observations. We choose a set of well-timed binary pulsars, and from their intrinsic orbital decay rates we put a new bound on the graviton mass. Furthermore, we extensively simulate times of arrival for pulsars in orbit around stellar-mass black holes and the supermassive black hole at the Galactic center, and investigate their prospects in probing the cubic Galileon theory in the near future.

COMPACT STARS, DM, DE, GWs, ϒ RAYS, QGP, QCD, HIC, SNOVAE, BHs, PARTICLES, GALAXIES / 34

A Reconstruction scheme for f(T) gravity through interacting variable-generalized Chaplygin Gas form of dark energy and its thermodynamics

Author: Surajit Chattopadhyay[1]

[1] *Amity University, Kolkata*

Late time accelerated expansion of the Universe is well documented in the literature. An exotic matter, characterized by negative pressure is considered to be the driving force behind this late time acceleration of the Universe and it is dubbed as dark energy (DE). The negative pressure p leads to negative equation of state (EoS) parameter w = p/ρ, where ρ is the density of the Universe. In order the acceleration to occur, we require w < −1/3. If w is above −1 then we consider it to be quintessence and if below, then phantom. If there is a transition from quintessence to phantom, then we consider it to be quintessence. Although the cosmological constant Λ characterized by w = −1 happens to be the simplest candidate of DE, other models with time varying w have also been reported in the literature. These include scalar field models, Chaplygin gas models and holographic dark energy models. This study reports a study on a type of Chaplygin gas model, namely variable-generalized Chaplygin gas (VGCG) whose equation of state is $p = -A_0\, a^n/\rho$. In this study an interacting scenario is considered, where the VGCG interacts with pressureless dark matter (DM) and Q is chosen as Q = 3Hδρ, where ρ represents the VGCG density. Interacting VGCG has been studied for detailed cosmology and the EoS parameter has been observed. Attainment of ΛCDM fixed point has also been observed. Replacement of the scalar Lagrangean R with a function f(R) of the scalar curvature is the simplest way of modifying the Einstein's general relativity (GR). Another interesting sort of modified theories is the so-called f(T) gravity (T is torsion). In the second part of the study, a reconstruction scheme for f(T) gravity is demonstrated with power-law form of the scale factor. The EoS parameter corresponding to the reconstructed f(T) has shown quintom behavior. Finally, the generalized second law (GSL) of thermodynamics has been investigated under the purview of the reconstructed f(T) cosmology, where the universe is considered as a closed bounded system with future event horizon as the cosmological boundary. We have associated two different entropies with the cosmological horizons with a logarithmic correction term and a power-law correction term. We have studied the validity of the GSL for both of these corrections.

COMPACT STARS, DM, DE, GWs, ϒ RAYS, QGP, QCD, HIC, SNOVAE, BHs, PARTICLES, GALAXIES / 47

Dark-matter admixed neutron stars

Authors: Violetta Sagun[1]; Oleksii Ivanytskyi[2]; Ilidio Lopes[3]

[1] *University of Coimbra*

[2] *University of Salamanca*

[3] *CENTRA-IST*

We study an impact of asymmetric dark matter on properties of the neutron stars and their ability to reach the two solar masses limit, which allows us to present a new range of masses of dark matter particles and their fractions inside the star. Our analysis is based on the observational fact of the existence of three pulsars reaching this limit and on the theoretically predicted reduction of the neutron star maximal mass caused by the accumulation of dark matter in its interior. We also demonstrate that light dark matter particles with masses below 0.2 GeV can create an extended halo around the neutron star leading not to decrease, but to increase of its visible gravitational mass. By using recent results on the spatial distribution of dark matter in the Milky Way, we present an estimate of its fraction inside the neutron stars located in the Galaxy center. We show how the detection of a 2M neutron star in the most central region of the Galaxy will impose an upper constraint on the mass of dark matter particles of ~ 60 GeV. Future high precision measurements of

the neutron stars maximal mass near the Galactic center, will put a more stringent constraint on the mass of the dark matter particle. This last result is particularly important to prepare ongoing, and future radio and X-ray surveys.

COMPACT STARS, DM, DE, GWs, ϒ RAYS, QGP, QCD, HIC, SNOVAE, BHs, PARTICLES, GALAXIES / 95

The electrical conductivity, magnetic parameter, plastic flow and toroidal magnetic field decay in magnetars

Authors: Zhi-Fu Gao[1]; Hao Shan[2]

[1] *Xinjiang Astronomical Observatory, Chinese Academy of Sciences*

[2] *.Xinjiang Astronomical Observatory, Chinese Academy of Sciences*

Magnetars are a kind of pulsars powered mainly by superhigh magnetic fields. They are popular sources with many unsolved issues in themselves, but also linked to various high-energy phenomena, such as Quasi-periodic oscillation, giant flares, fast radio bursts and super-luminous supernovae. In this presentation, combining with the latest EoSs, we first introduce the eigen equations of Ohmic dissipation of high-order toroidal magnetic fields in general relativity, then calculate the electrical conductivity, give a specific relation between the magnetization parameter, defined as the ratio of Ohmic dissipation timescale to Hall drift timescale, and magnetic field in the crust, and apply this specific relation to the magnetic field evolution of high braking-index magnetars. Finally, using verified transition state theory and quantum plasticity theory, we investigate the temperature-dependent shear (strain) rates as well as temperature-dependent (shear) viscosity considering magnetically driven plastic flows in the crust of magnetars, the onset of the soft gamma repeater outburst maybe controlled by magnetospheric dissipation induced by the plastic motions of the crust, according to our results and analysis of relevant energy scales.

DENSE MATTER, QCD, QFT, HIC, GWs, DM, COSMOLOGY / 71

Galaxy - Dark matter connection in cosmology

Author: Sebastien Fromenteau[1]

[1] *ICF - UNAM*

While the large scale structures formation is dominated by Cold Dark Matter (CDM) field evolution, we generally have only access to baryonic tracer like galaxies. In particular, Mexico is involved in three of the most important galaxy surveys of next decade: DESI, SDSS-V and LSST. The usual method is to link the galaxy distribution to the CDM density field using a linear bias. We propose to use a luminosity-based methodology in order improve this mapping in order enhance the galaxy-CDM connection using different galaxy tracers. Moreover, I will present how this methodology can improve the standard reconstruction method which allows to enhance the Baryonic Acoustic Oscillation Peak position, one of the most important probe for the cosmic expansion acceleration.

DENSE MATTER, QCD, QFT, HIC, GWs, DM, COSMOLOGY / 72

Hybrid star construction with the extended linear sigma model

Author: Gyorgy Wolf[1]

[1] *Wigner RCP*

The interior of compact stars is usually divided into two major parts, the outer part called crust and the inner part called core. There are several possibilities for the composition of these parts. One is a hybrid star, in which the crust contains nuclear matter, while the inner core contains quark matter. Since at large baryon densities one can work with effective models, and nuclear and quark matter are usually described by different models, some unification of the two parts is needed. We show two different approaches for a composite model and some recent developments in hybrid star constructions using the extended linear sigma model for modeling the quark matter at the core.

DENSE MATTER, QCD, QFT, HIC, GWs, DM, COSMOLOGY / 84

Gravitational waves signatures and magnetars

Author: Debora Menezes[1]

[1] *UFSC*

A neutron star was first detected as a pulsar in 1967. It is one of the most mysterious objects in the universe, with a radius of the order of 10 km and masses that can reach two solar masses. In 2017, a gravitational wave was detected (GW170817) and its source was identified as the merger of two neutron stars. The same event was seen in X-ray, gamma-ray, UV, IR, radio frequency and even in the optical region of the electromagnetic spectrum, starting the new era of multi- messenger astronomy. To understand neutron stars, an appropriate equation of state that satisfies bulk nuclear matter properties has to be used and GW170817 has provided some extra constraints to determine it. On the other hand, some neutron stars have strong magnetic fields up to 10^{15} Gauss on the surface as compared with the usual 10^{12} Gauss normally present in ordinary pulsars. They are called magnetars. While the description of ordinary pulsars is not completely established, describing magnetars poses a real challenge because the magnetic fields can produce an anisotropic equation of state. One elegant way to circumvent this problem is the use of the chaotic field approximation. It is also known that low magnetic fields do not affect the equation of state and the resulting star macroscopic properties but they do affect the crust-core transition and the crust thickness with many consequences, as the explanation of glitches and the calculation of the Love number that enters the quadrupole tidal polarizabilities. Moreover, just before the merging, tidal interactions can excite the star crust fluid modes by resonance and the fundamental mode can be greatly excited with a strong influence on the gravitational wave emission. I will talk about the importance of the new constraints imposed by GW170817 in the determination of appropriate equations of state, in the calculation of the fundamental mode and possible ways to describe hadronic and quark matter subject to strong magnetic fields.

DENSE MATTER, QCD, QFT, HIC, GWs, DM, COSMOLOGY / 74

The equation of state of strongly interacting matter and the consequences for transport approaches

Author: Joerg Aichelin[1]

[1] *Subatech/CNRS*

The equation of state (EoS) of strongly interacting matter for finite chemical potentials cannot be calculated from first principles (lattice QCD) so one have to rely on effective theories like the Polyakov-Nambu-Jona-Lasinio model. Recently it has been shown that they can reproduce the lattice calculations at vanishing chemical potential and provide therefore a solid basis for the extrapolation to finite chemical potentials. The knowledge of the EoS at finite chemical potentials is necessary to understand neutron stars, neutron star collisions but also relativistic heavy ion collisions. We present the current status of this development and discuss the consequences for transport approaches.

DENSE MATTER, QCD, QFT, HIC, GWs, NSs, DM, COSMOLOGY , FTH-INFLATION / 195

General relativistic mass and spin of a Kerr black hole in terms of redshifts

Author: Alfredo Herrera Aguilar[1]

[1] *Meritorious Autonomous University of Puebla –BUAP*

In this talk we derive closed general relativistic formulas for the mass M and the spin parameter a of a Kerr black hole in terms of observational data: the red- and blue-shifts of photons emitted by massive particles (stars or gas) geodesically orbiting around the black hole, and their respective orbital radius. It turns out that given a set of two (three) stars revolving around the Kerr black hole, the aforementioned formulas involve just eight (twelve) observational data: the redshift in six (nine) positions and the corresponding two (three) orbital radii. We also analyze the case of a single star orbiting the black hole, for it we need a minimal set of four observational measurements to analytically determine both black hole mass and spin parameters in closed form. Applications to astrophysical systems are briefly discussed.

DENSE MATTER, QCD, QFT, HIC, GWs, NSs, DM, COSMOLOGY , FTH-INFLATION / 189

The role of quark matter surface tension in dense compact star matter

Author: Ana Gabriela Grunfeld[1]

[1] *National Commission of Atomic Energy –CNEA, National Scientific and Technical Research Council –CONICET*

Quark matter surface tension plays a key role in the understanding of neutron star (NS) interiors. However, despite its relevance for NS physics, the surface tension is still poorly known for quark matter. We focus on the thermodynamic conditions prevailing in NSs, hot lepton-rich protoneutron stars (PNSs), and binary NS mergers. We explore the role of temperature, baryon number density, trapped neutrinos, droplet size, and magnetic fields within the multiple reflection expansion formalism (MRE), assuming that astrophysical quark matter can be described as a mixture of free Fermi gases composed of quarks u, d, s, electrons, and neutrinos, in chemical equilibrium under weak interactions. Finally, we discuss some astrophysical consequences of our results.

DENSE MATTER, QCD, QFT, HIC, GWs, NSs, DM, COSMOLOGY , FTH-INFLATION / 191

The Challenge of Calibrating a Laser Interferometric Gravitational Wave Detector

Author: Carlos Frajuca[1]

[1] *Federal Institute of Education, Science and Technology of São Paulo –IFSP*

In 2015 the first detection of gravitational waves was made, gravitational waves from the violent collision of two black holes. This collision sent waves through space-time as Einstein predicted. This detection was made possible by many advances in measurement technology, mainly vibration isolation for the detector optics; at 10 Hz, the motion of the laser interferometer detector mirrors is at least on billion times smaller than the seismic motion of the ground and also makes the laser locked-in the detection configuration in a large band of the spectrum. This was made possible by using many feedback and feedforward control loops. But, to reach such requirements more than 100 of such active systems are included in the detectors to allow lock acquisition, lock stability, and

sensitivity of the instrument. In this work, the challenges of reaching these requirements will be addressed and how this makes the calibration of these detectors very challenging.

DENSE MATTER, QCD, QFT, HIC, GWs, NSs, DM, COSMOLOGY , FTH-INFLATION / 190

Mapping Stellar Mass in the local universe —a crucial step towards understanding dark matter distribution in Nearby Galaxies

Author: Karín Menéndez-Delmestre[1]

[1] *Observatório do Valongo, Universidade Federal do Rio de Janeiro –UFRJ*

Local galaxies are the endpoint of all cosmological evolution: to understand how galaxies evolve through cosmic time, we need a careful characterization of galaxy structures in the local universe. The Spitzer Survey of Stellar Structure in Galaxies (S4G) is one of the major legacy surveys of the post-cryogenic campaign of the Spitzer Space Telescope. With deep mid-infrared (3.6/4.5um) imaging of > 2300 nearby galaxies with the IRAC camera probing stellar surface densities down to « 1 Msun/pc2, S4G is the largest, deepest and most homogenous mid-infrared survey of the nearby Universe to date and provides the ultimate inventory of the distribution of stellar mass and structure in local galaxies. Combined with deep optical follow-up, an unprecedented opportunity opens up to complement a stellar mass census with a detailed analysis of the stellar populations in stellar structures. With this in mind we have initiated the Census of Austral Nearby GAlaxies (or CANGA survey), an observational campaign using the Goodman imager on the SOAR telescope to go after local galaxies in the southern sky. With a projected sample of >1000, CANGA will represent the deepest mapping ever of a complete sample in this hemisphere, providing a spatially-resolved analysis of stellar populations at the 10s-to-100 pc-scale of key stellar structures in nearby galaxies. CANGA complements the exquisite work that has been performed by the Sloan Digital Sky Server (SDSS) in the northern hemisphere, but largely surpasses its sensitivity. Combining the spatially-resolved analysis of stellar populations from CANGA with the stellar mass mapping from S4G, this program represents a meticulous probe of the baryonic component required for the decomposition of galaxy rotation curves. This, in turn, allows for the subsequent isolation of the dark matter (DM) component, with important inputs (DM profile for our galaxy, as well as an estimate of the local DM density) for direct detection experiments of DM. As one of the original members of the S4G collaboration and PI of CANGA, I intend to provide a brief review of discoveries we have made within this combined data set, placing them within the broad context of galaxy evolution over cosmic times.

DENSE MATTER, QCD, QFT, HIC, GWs, NSs, DM, COSMOLOGY , FTH-INFLATION / 184

Cosmic inflation without inflaton

Author: Luisa Jaime[1]

[1] *Instituto Nacional de Investigaciones Nucleares*

During this talk I will present a novel proposal to explain cosmic inflation in the Universe with the following features: (i) its vacuum spectrum solely consists of a graviton and is ghost-free, (ii) it possesses well-behaved black hole solutions which coincide with those of Einsteinian cubic gravity, (iii) its cosmology is well-posed as an initial value problem and, most importantly, (iv) it entails a geometric mechanism triggering an inflationary period in the early universe (driven by radiation) with a graceful exit to a late-time cosmology arbitrarily close to ΛCDM. In the frame of these theories, we compute the inflationary predictions of the theory and we show that all models considered here produce inflation and, most of them coincide, some better than others, with the marginalized 95% CL region given by Planck's collaboration.

DENSE MATTER, QCD, QFT, HIC, GWs, NSs, DM, COSMOLOGY , FTH-INFLATION / 37

Reheating and Post-inflationary Production of Dark Matter

Author: Marcos A. Garcia Garcia[1]

[1] *Instituto de Fisica Teorica UAM*

In this talk I will present a systematic analysis of dark matter production during post-inflationary reheating. The damped oscillations of the inflation as it decays, the thermalization rate of its decay products, and the evolution of the temperature of the subsequently thermalized radiation determine the production rate of dark matter, and they are in turn dependent on the shape of the inflation potential. I will show that dark matter production is sensitive to the inflation potential, and depends heavily on the thermalization rate when the potential is not quadratic near the minimum. I will also discuss how to exploit dark matter as a probe of the dynamics during reheating, through smoking-gun signals such as monochromatic neutrinos or gamma ray lines for super-GeV dark matter masses, or through Lyman-alpha data for sub-GeV dark matter.

DENSE MATTER, QCD, QFT, HIC, GWs, NSs, DM, COSMOLOGY , FTH-INFLATION / 161

Strong decay of hybrid mesons

Authors: Atael Matos Machado[1]; Mario Luiz Lopes da Silva[1]; Daniel Tavares da Silva[None]

[1] *Universidade Federal de Pelotas*

In this work, we calculate the decay rates of some resonances that can be considered as hybrid mesons. This study was carried out using the constituent gluon model. We specifically studied the resonances $\pi_1(1400)$ and $\pi_1(1600)$, since the lightest hybrid meson, with quantum numbers $J^{PC} = 1^{-+}$, is expected to be in this region of hadronic spectrum. The constituent gluon model considers that the hybrid meson is composed by a quark-antiquark pair and a gluon. Thus, the decay occurs via the gluon breaking in a quark-antiquark pair. The constituent gluon model is established in the theory of strong interaction through the coupling between quarks and gluons fields, considering that the force between both is mediated by gluon exchange.

DENSE MATTER, QCD, QFT, HIC, GWs, NSs, DM, COSMOLOGY , FTH-INFLATION / 160

Angular momentum conservation and core superfluid dynamics for the pulsar J1734-3333

Authors: Nadja Magalhaes[1]; Heitor O. Oliveira[None]

[1] *Federal University of Sao Paulo*

Pulsars emit pulsed radiation in well-defined frequencies. In the canonical model, a pulsar is assumed to be a rotating, highly magnetized sphere made mostly of neutrons that has a magnetic dipole misaligned with respect to its rotation axis, which would be responsible for the emission of the observed pulses. The measurement of the pulse frequency and its first two derivatives allows the calculation of the braking index, n. One limitation of the canonical model is that for all pulsars it yields n = 3, a value that does not correspond to observational values of n. In order to contribute to the solution of this problem we proposed a model for pulsars'rotation frequency decay assuming that the star's total moment of inertia would vary with time due to mass motions inside the core. As a result, we found that the pulsar J1734-3333 has total angular momentum practically conserved, a phenomenon that we explain relating the motion of neutron superfluid vortices in the core to torques associated to radiation emission.

DENSE MATTER, QCD, QFT, HIC, GWs, NSs, DM, COSMOLOGY , FTH-INFLATION / 29

Energy Conditions in Non-minimally Coupled f(R,T) Gravity

Author: Pradyumn Kumar Sahoo[1]

[1] *Birla Institute of Technology and Science-Pilani, Hyderabad Campus*

In today's scenario, going beyond Einstein's theory of gravity leads us to some more complete and modified theories of gravity. One of them is the f(R,T) gravity in which R is the Ricci scalar, and T is the trace of energy-momentum tensor. A well-motivated f(R,T) gravity model, $f(R,T) = R + \alpha RT$ where α is the model parameter is considered here. In this work, we studied the strong energy condition (SEC), the weak energy condition (WEC), the null energy condition (NEC), and the dominant energy condition (DEC) under the simplest non-minimal matter geometry coupling with a perfect fluid distribution. The model parameter α is constrained by energy conditions and the equation of state parameter $\omega = p/\rho$, resulting in the compatibility of f(R,T) models with the accelerated expansion of the universe. It is seen that the EoS parameter ω illustrate the quintessence phase $0 \geq \omega > -1$ in a dominated accelerated phase, $\omega = -1$ pinpoint to the cosmological constant, i.e., ΛCDM model and $\omega < -1$ yields the phantom era. Also, the present values of $H0 = 67.9$ and $q0 = -0.503$ are used to check the viability of f(R,T) gravity. It is observed that the positive behavior of DEC, WEC indicates the validation of the model. In contrast, SEC is violating the condition resulting in the accelerated expansion of the universe.

DENSE MATTER, QCD, QFT, HIC, GWs, NSs, DM, COSMOLOGY , FTH-INFLATION / 188

Thermodynamics of f(R) Theories

Author: Sergio Jorás[1]

[1] *Universidade Federal do Rio de Janeiro –UFRJ*

This work starts from a toy model for inflation in a class of modified theories of gravity in the metric formalism. Instead of the standard procedure – assuming a non-linear Lagrangian f(R) in the Jordan frame – we start from a simple φ^2 potential in the Einstein frame and investigate the corresponding f(R) in the former picture. The addition of an ad-hoc Cosmological Constant in the Einstein frame leads to a thermodynamical interpretation of this physical system, which allows further insight on its (meta)stability and evolution.

DENSE MATTER, QCD, QFT, HIC, GWs, DM, COSMOLOGY / 101

GW 170817 and other mergers. What happened? What are the implications? What should we expect now?

Author: Tsvi Piran[1]

[1] *The Hebrew University*

The detection of gravitational waves and accompanying EM signals from a binary neutron star merger, GW 170817 was one of the most remarkable scientific achievements of the last decade. The discovery confirmed numerous long standing predictions, ranging from the mergers being the cosmic foundries of r-process elements to the origin of short gamma-ray bursts. It also revealed the potential of these events to serve as tools to explore new physics, ranging from the measurement of the Hubble constant on the largest scales to the estimations of the equation of state at ultra high densities at the smallest. I describe current understanding of what have we seen, I summarize some

of the new understanding that has emerged and I discuss the prospects for future discoveries. Interestingly many of these ideas had to be revised following the late observations of the EM signals from GW 170817 and gravitational waves observations of other mergers during the O3 campaign.

DM, DE, GWs, BHs, GRAVITATION, GALAXIES, EROSITA / **78**

Magnetic field effect on early universe events

Author: Gabriella Piccinelli Bocchi[1]

[1] *Universidad Nacional Autónoma de México*

An outlook of different aspects of the incidence of magnetic fields on early universe events is presented. The events we will focus on include inflation and the electroweak phase transition. The guideline of the study is mainly the effect of the magnetic field on the effective potential of phase transitions and the decay process of the field leading the phase transition to other fields. We will consider both weak and strong magnetic field approximations, since this issue seems to make some important differences in the results. Besides presenting the results of our working group, we will also discuss other works that can be found in the literature.

DM, DE, GWs, BHs, GRAVITATION, GALAXIES, EROSITA / **77**

A crucial test of the fermion dark matter constituency of our Galactic core from the geodesic motion of S2 and G2

Author: Jorge Rueda[1]

[1] *ICRANet*

The motion of the S stars around the Galactic center implies the existence of a central gravitational potential dominated by a compact source, Sagittarius A*(Sgr A)*, with a mass of four million solar masses. Traditionally, it has been assumed that such a gravitational potential is produced by a supermassive black hole (SMBH) sitting at the center of our Galaxy. It is particularly important for this hypothesis, and for any alternative model, the explanation of the multiyear, accurate astrometric data of S2. With an orbital period of nearly 16 years, it is one of the closest stars to Sgr A*. The accuracy of the S2 data has allowed the GRAVITY Collaboration to recently verify the gravitational redshift of light predicted by general relativity Another important object is G2 whose most recent data challenges the SMBH scenario its post pericenter radial velocity is lower than the expectation from a Keplerian orbit around the putative SMBH. This scenario has been reconciled by introducing a drag force on G2 by an accretion flow. Alternatively, I discuss here the consistency of the "dense core diluted halo" fermionic dark matter (DM) profile, obtained from the general relativistic treatment of the Ruffini-Argüelles-Rueda (RAR) model, with the data of S2 and G2. It has been already shown that for a fermion mass in the range 48-345 keV, the RAR DM profile accurately fits the rotation curves of the Milky Way halo. It is here shown that, without invoking a central SMBH, the solely gravitational potential of such DM profile explains: 1) all the available data of the orbit and radial velocity of S2; 2) the general relativistic redshift measured in S2; 3) the currently available data on the orbit and radial velocity of G2 and 4) its deceleration after its pericenter passage, without introducing a drag force, hence a purely geodesic motion. All this for the same fermion mass of 56 keV. A DM core made of these fermions is expected to collapse into a BH if it gets a mass of about million solar masses, thereby providing formation scenario for the observed central SMBH in active galaxies such as M87.

DM, DE, GWs, BHs, GRAVITATION, GALAXIES, EROSITA / **80**

News from Gravitational Waves Astronomy

Author: Dorota Rosinska[1]

[1] *University of Zielona Gora*

Gravitational waves astrophysics is a new and promising field of research of the Universe. In contrast to the observations of the electromagnetic waves (radio waves, visible light, X rays and gamma), which are the main source of our current knowledge, we ''listen" to the Universe by registering minor disturbances of the space time curvature using the LIGO and Virgo laser interferometric detectors. Gravitational waves are emitted during the largest cosmic cataclysms mergers of binary systems of neutron stars or black holes, explosions of supernovae, and by other sources, eg unstable or deformed rotating neutron stars. The direct detection of gravitational waves allows the study of objects that are dark (do not shine in electromagnetic waves), testing the theory of gravity in the dynamic regime of strong gravitational field, and the direct study of the interior of neutron stars which contain the densest and most extreme matter existing currently in the Universe. These information cannot be currently obtained using other methods. In this talk we present an overview about recent discoveries on this so promising field of research.

DM, DE, GWs, BHs, GRAVITATION, GALAXIES, EROSITA / 45

eROSITA observations of the Narrow-Line Seyfert 1 Galaxy 1H 0707-495: Discovery of an ultra-soft flaring X-ray light curve

Author: Thomas Boller[1]

[1] *MPE Garching*

One of the most prominent AGNs, the ultrasoft Narrow-Line Seyfert 1 Galaxy 1H 0707-495, has been observed with eROSITA as one of the first CAL/PV observations on October 13, 2019 for about 60.000 seconds. 1H 0707-495 is a highly variable AGN, with a complex, steep X-ray spectrum, which has been the subject of intense study with XMM- Newton in the past. Large amplitude variability with a factor of more than 50 has been detected in the eROSITA light curve. The soft band is dominating the variability, while in the hard band the variability is much less extreme. No significant variability has been detected in the UV in the XMM-Newton OM observations, indicating that the primary source for the soft X-ray variability is the soft X-ray excess itself, originating from the innermost regions around the central black hole. 1H 0707-495 entered the lowest hard flux state of all 20 years of XMM-Newton observations. In the eRASS1 observations taken in April 2020 the X-ray light curve is still ultrasoft, with an increase in soft and hard band count rates going back to previously observed flux states. A changing partial coverer spectral model with relativistic reflection provides a physical interpretation which is also in agreement with the observed light curve.

DM, DE, GWs, BHs, GRAVITATION, GALAXIES, QCD, LIFE, GRBs, COSMOLOGY, OA, KT / 178

21 cm cosmology and the BINGO radio telescope

Author: Carlos Alexandre Wuensche[1]

[1] *National Institute for Space Research –INPE*

Cosmology in the XXI century is experiencing a "Golden Age", with observations and theoretical models contributing to a large-scale description of the Universe. The current view is that it can be well described by the so-called Lambda-CDM model, but some open problems challenge physics and cosmology, including the origin and properties of so-called dark energy. The so-called baryonic

acoustic oscillations (BAO), detected for the first time in 2005, are considered one of the most effective probes to understand the properties of dark energy. However, given the implications of these measurements, it is important that they are confirmed at other wavelengths and measured over a wide range of redshifts. The radio band provides a unique and complementary observation window, by emitting 21 cm of neutral hydrogen. The redshifted 21 cm (1420 MHz) emission of the hyperfine transition of neutral hydrogen is measured at lower frequencies, so that the observation frequency is converted directly into information about the source's redshift. The BINGO radio telescope (BAO from Integrated Neutral Gas Observations) is a new instrument, designed specifically to observe BAO, mapping a redshift band between 0.13 and 0.45. This seminar will present the basics of 21 cm BAO cosmology, the intensity mapping technique used and describe the current development status of the BINGO radio telescope.

DM, DE, GWs, BHs, GRAVITATION, GALAXIES, QCD, LIFE, GRBs, COSMOLOGY, OA, KT / 109

Accretion-induced collapse to third family compact stars as trigger for eccentric orbits of millisecond pulsars in binaries

Authors: David Edwin Alvarez Castillo[1]; Noshad Khosravi[2]; David Blaschke[2]; Alexander Ayriyan[3]; Hovik Grigorian[None]; John Antoniadis[4]; Victor Danchev[5]; Fridolin Weber[6]

[1] *JINR*

[2] *University of Wroclaw*

[3] *JINR & AANL*

[4] *Max-Planck-Institut für Radioastronomie and Argelander Institut für Astronomie*

[5] *Department of Physics, Sofia University*

[6] *Department of Physics, San Diego State University*

A numerical rotating neutron star solver is used to study the temporal evolution of accreting neutron stars using a multi-polytrope model for the nuclear equation of state named ACB5. The solver is based on a quadrupole expansion of the metric, but confirms the results of previous works, revealing the possibility of an abrupt transition of a neutron star from a purely hadronic branch to a third-family branch of stable hybrid stars, passing through an unstable intermediate branch. The accretion is described through a sequence of stationary rotating {stellar} configurations which lose angular momentum through magnetic dipole emission while, at the same time, gaining angular momentum through mass accretion. The model has several free parameters which are inferred from observations. The mass accretion scenario is studied in dependence on the effectiveness of angular momentum transfer which determines at which spin frequency the neutron star will become unstable against gravitational collapse to the corresponding hybrid star on the stable third-family branch. It is conceivable that the neutrino burst which accompanies the deconfinement transition may trigger a pulsar kick which results in the eccentric orbit. A consequence of the present model is the prediction of a correlation between the spin frequency of the millisecond pulsar in the eccentric orbit and its mass at birth.

DM, DE, GWs, BHs, GRAVITATION, GALAXIES, QCD, LIFE, GRBs, COSMOLOGY, OA, KT / 186

The magnetized photon: properties and astrophysical applications

Author: Elizabeth Rodriguez Querts[1]

[1] *Instituto de Cibernética, Matemática y Física –ICIMAF*

We study the properties of photon propagation both in QED vacuum and medium, taking into account radiative corrections, in an external magnetic field. We explore possible applications of the results in an astrophysical context.

DM, DE, GWs, BHs, GRAVITATION, GALAXIES, QCD, LIFE, GRBs, COSMOLOGY, OA, KT / 174

Hybrid star with non interacting dark matter fermion core

Author: Fábio Köpp[1]

[1] *Universidade Federal do Rio Grande do Sul –UFRGS*

In this work we study the influences of the dark matter fermion mass on the structure of the hybrid star. We fixed the Fermi momentum of dark matter and considered the mass of dark matter from 0.1 GeV to 100 GeV, since the mass of dark matter is more uncertain than its density approximation related to ordinary matter. Further, we used the Maxwell construction to make the phase transition between DD2 EoS and vMIT EoS. The implementation of DM is made in a simple way, i.e. considering it as a fermion with mass M_x without interactions. Finally, we compared our results with the latest observed masses > $2M_\odot$ and similar approaches considering interactions in the current literature.

DM, DE, GWs, BHs, GRAVITATION, GALAXIES, QCD, LIFE, GRBs, COSMOLOGY, OA, KT / 194

Study of diffractive gluon jet production in electron-ion collisions

Author: Guilherme Peccini[1]

[1] *Universidade Federal do Rio Grande do Sul –UFRGS*

In this work we investigate the diffractive gluon jet production in electron-ion collisions at the energies of the EIC, LHeC, HE-LHeC and FCC-eA, assuming that the diffractive mass is much larger than the photon virtuality. In addition, we apply a model inspired in the GBW parametrization to describe the dipole amplitude, showing that the diffractive cross section is highly sensitive to the saturation scale. Furthermore, we verify that it is possible to extract this scale from the experiment.

DM, DE, GWs, BHs, GRAVITATION, GALAXIES, QCD, LIFE, GRBs, COSMOLOGY, OA, KT / 192

Hawking-Bekenstein temperature and entropy from uncertainty principle

Author: Hugo Pérez Rojas[1]

[1] *Instituto de Cibernética, Matemática y Física –ICIMAF*

We give an alternative way for deducing the Hawking-Bekenstein black hole temperature and entropy by using the Heisenberg uncertainty principle. We consider as known the black hole mass as M and consequently its energy. Quantities as temperature T and entropy S can be found under the hypothesis that incoming radiation and matter leads to a thermodynamic equilibrium state. Obviously

this is not seen by an external observer, who may know only the horizon temperature T´. The results are obtained theoretically, by using the convergence of general relativity, thermodynamics and quantum mechanics. We start by assuming small black holes, although the resulting equations have a more general validity. It can be shown that reciprocally, starting from the Hawking-Bekenstein temperature, uncertainty relation equations can be obtained. Examples are given for small and large blackhole masses.

DM, DE, GWs, BHs, GRAVITATION, GALAXIES, QCD, LIFE, GRBs, COSMOLOGY, OA, KT / 196

Axial ring down modes in General Relativity and in its pseudo-complex extension

Author: Peter Hess[1]

[1] *National Autonomous University of Mexico - UNAM*

We calculate the axial ring-down frequencies of the merger of two black holes, using a modified version of the pseudo-complex General Relativity (pc-GR) and comparing it with the standard General Relativity (GR).

DM, DE, GWs, BHs, GRAVITATION, GALAXIES, QCD, LIFE, GRBs, COSMOLOGY, OA, KT / 193

Modeling Dark Matter Halos With Nonlinear Field Theories

Author: Pedro Henrique Ribeiro da Silva Moraes[1]

[1] *Instituto de Astronomia, Geofísica e Ciências Atmosféricas –IAG, Universidade de São Paulo –USP*

In the present work we show that it is possible to model galactic dark matter from nonlinear scalar field theories coupled to the gravity sector. In order to obtain analytical solutions for the scalar fields we consider a spherically symmetric space-time. We also assume a theoretical framework where dark matter consists of a complex scalar field, which is responsible for producing galactic halos through Bose condensation coupled to gravity. The developed approach is able to predict a good theoretical fit for the rotation curves in both dwarf and low surface brightness late-type galaxies.

DM, DE, GWs, BHs, GRAVITATION, GALAXIES, QCD, LIFE, GRBs, COSMOLOGY, OA, KT / 175

The Physics of twin stars

Author: Rosana Oliveira Gomes[1]

[1] *Frankfurt Insitute for Advanced Studies*

In this contribution, we investigate the possibility of a third family of compact stars under different scenarios. First, we will focus on the microscopic description of stars and discuss how different properties of matter can influence the rising of twin stars. For doing so, we carry out an analysis of different parameters used to describe hadronic and quark matter with relativistic mean field models. Next, we discuss how macroscopic properties of stars, such as magnetic fields and rotation can also

play a role in the creation and elimination of twin stars scenarios. Finally, we briefly present results for cooling of such stars, highlighting its importance as another observable for identifying third families scenarios.

DENSE MATTER, SNOVAE, DM, COMPACT STARS, DE, BHs, COSMOLOGY / 39

Near-horizon structure of escape zones of electrically charged particles around weakly magnetized rotating black hole: case of oblique magnetosphere

Author: Vladimir Karas[1]

Co-author: Ondrej Kopacek [2]

[1] *Astronomical Institute, Czech Academy of Sciences*

[2] *Astronomical Institute*

We study the effects of large scale magnetic field on the dynamics of charged particles near a rotating black hole. We consider a scenario in which the initially neutral particles on geodesic orbits in the equatorial plane are destabilized by a charging process. Fraction of charged particles are then accelerated out of the equatorial plane and then follow jet-like trajectories with relativistic velocities. We explore non-axisymmetric systems in which the magnetic field is inclined with respect to the black hole spin. We study the system numerically in order to locate the zones of escaping trajectories and compute the terminal escape velocity. By breaking the axial symmetry we notice increasing fraction of unbound orbits which allow for acceleration to ultrarelativistic velocities.

DENSE MATTER, SNOVAE, DM, COMPACT STARS, DE, BHs, COSMOLOGY / 73

Three flavors in a triangle

Author: Renxin Xu[1]

[1] *School of Physics, Peking University*

As for strong condensed matter, normal nuclei are 2-flavored (u, d), but what if matter is squeezed so great that nuclei come in close contact to form giant strong matter? The latter could be 3-flavored (u, d, s) because of leptonic asymmetry (i.e., electron and positron), since both the strong and the weak interactions play an important role there. Therefore, one should focus on three flavors to discuss the nature of strong matter, both small and giant, taking advantage of a triangle diagram as explained this presentation.

DENSE MATTER, SNOVAE, DM, COMPACT STARS, DE, BHs, COSMOLOGY / 85

Deconfinement Phase Transition in Neutron-Star Mergers

Author: Veronica Dexheimer[1]

[1] *Kent State University*

We study in detail the nuclear aspects of a neutron-star merger in which deconfinement to quark matter takes place. For this purpose, we make use of the Chiral Mean Field (CMF) model, an effective relativistic model that includes self-consistent chiral symmetry restoration and deconfinement to

quark matter and, for this reason, predicts the existence of different degrees of freedom depending on the local density/chemical potential and temperature. We then use the out-of- chemical-equilibrium finite-temperature CMF equation of state in full general-relativistic simulations to analyze which regions of different QCD phase diagrams are probed and which conditions, such as strangeness and entropy, are generated when a strong first-order phase transition appears. We also investigate the amount of electrons present in different stages of the merger and discuss how far from chemical equilibrium they can be.

DENSE MATTER, SNOVAE, DM, COMPACT STARS, DE, BHs, COSMOLOGY / 86

Unraveling the Universe with spectroscopic surveys: Final results of eBOSS, present and future with DESI

Author: Mariana Vargas Magaña[1]

[1] *Instituto de Física UNAM*

One of the most important open questions in cosmology today is the understanding of the accelerated expansion of the Universe. Spectroscopic surveys provided a unique opportunity to explore the expansion history of the Universe as well as to measure the growth of structure through the analysis of the large-scale structure in the Universe. Cosmic Acceleration can be explained by either modifying General Relativity on cosmological scales, or within the framework of the standard cosmological model introducing an unknown new component called "dark energy". During the last 2 decades, SDSS have been operating a succession of spectroscopic surveys: SDSS, BOSS and eBOSS, all of them driven by the same science goal of decrypting the mysterious cosmic expansion. Just after eBOSS finishes its program, the next generation stage IV ground-based dark energy experiment, Dark Energy Spectroscopic Instrument (DESI) will start their science operations for 5 years. DESI will revolutionize dark energy constraints improving the precision by at least one order of magnitude current stage III experiments.

In this talk I will present the final analysis of eBOSS and their cosmological results released this summer that represents a culmination of 20 years of clustering analysis with spectroscopic surveys in SDSS. I will also review the DESI dark energy experiment that had turn of the first light in Fall 2019, carry on their commissioning program and started the survey validation programs this year, both programs preceding the science survey programmed to start next year 2021. I will review DESI instrument, the current status and a summary of the forecast for the key observables of the survey (BAO and RSD).

DENSE MATTER, SNOVAE, DM, COMPACT STARS, DE, BHs, COSMOLOGY / 87

Neutron star origins and masses

Author: Jorge Horvath[1]

[1] *IAG-USP*

We present a brief general view of the issue of neutrons star births and current masses. We argue that there are reasons to expect very massive objects in Nature, in particular those in "spider" binary systems that undergo very long accretion histories. A maximum value of 2.5 M_{max} is obtained directly from the observed mass distribution using a simple Bayesian analysis. This is consistent with the recent report of a very asymmetric GW 190814 smallest component, which may be the heaviest neutron star ever detected. If so, the dense matter equation of state will be challenged to be stiff enough to explain these masses.

DENSE MATTER, SNOVAE, DM, COMPACT STARS, DE, BHs, COSMOLOGY / 88

A Review on Algebraic Extensions in General Relativity

Author: Peter Hess[1]

[1] *Universidad Nacional Autónoma de México*

A brief review on algebraic extensions of General Relativity will be given. After a short summary of first attempts by Max Born and Albert Einstein, all possible algebraic extensions will be discussed, with the pseudo-complex extension left as the only viable one, because it does not contain ghost solutions. Some predictions of the pseudo-complex extension are given.

DENSE MATTER, QCD, QFT, HIC, GWs, NSs, DM, COSMOLOGY , FTH-INFLATION / 128

Red dwarf stars as a new source type of Galactic Cosmic Rays

Authors: Vera Y. Sinitsyna[1]; Vera G. Sinitsyna[1]; Yurii I. Stozhkov[1]

[1] *P.N. Lebedev Physical Institute, RAS*

The experimental data obtained with Pamela, Fermi, AMS-02, spectrometers cannot be explained using the diffusive models of propagation of cosmic-rays accelerated at the supernova shocks and require the existence of nearby sources of cosmic rays at the distances less than one kpc. These sources could explain the growth of the ratio of galactic positrons to electrons with an increase of their energy, the complex dependence of the exponent of the proton and alpha spectra from the energy of these particles, the appearance of anomaly component in cosmic rays. We consider active dwarf stars as possible sources of galactic cosmic rays in the energy range up to $\sim 10^{14}$ eV. These stars produce powerful stellar flares sometimes with energy release more than 10^{36} erg. The generation of high-energy cosmic rays should be accompanied by high-energy gamma-ray emission, which may be detected. Here we present the SHALON long-term observation data aimed to search for gamma-ray emission above 800 GeV from the active red dwarf stars: V388 Cas, V547 Cas, V780 Tau, V962 Tau, V1589 Cyg, GJ 3684, GJ 1078 and GL 851.1. The TeV gamma-ray emission mostly of flaring type from these sources was detected. This result confirms that active dwarf stars are also the sources of high-energy galactic cosmic rays.

DM, DE, GWs, BHs, GRAVITATION, GALAXIES, QCD, LIFE, GRBs, COSMOLOGY, OA, KT / 163

Identifying Protoclusters in Distant Universe

Authors: Mariana Costa[1]; Karín Menéndez-Delmestre[1]

[1] *Federal University of Rio de Janeiro*

Properties of galaxies, such as color, age and star formation activity, appear to be associated with the environment in which they are immersed. To investigate how environment influences galaxy evolution, astronomers study galaxies in dense regions (i.e., galaxy clusters), where the environmental effects become more intense and evident. However, to study how the environment-galaxy relation is established, we need to study the early stages of cluster formation. This can be done through the study of protoclusters, which are numerically dense environments of galaxies in the early Universe, and which give rise to galaxy clusters today. In these environments we can find galaxies with intense star formation, and often heavily obscured by dust, resulting in great luminosities in the

infrared bands. A class of objects that draws our attention due to their extreme star formation capacity is that of the submillimetric galaxies (SMGs). SMGs are very dusty and distant galaxies with their copious infrared emission redshifted to the submillimetric region of the electromagnetic spectrum. Less extreme star-forming galaxies also inhabit protoclusters and can be identified through Hydrogen emission of the Lyman alpha (Lyα) line. These galaxies are referred to as Lyα emitters (LAEs). In this work, we use SMGs as lampposts to identify potential sites for protocluster regions. We undertook deep observations of the environment of SMGs with well-established spectroscopic redshifts in the range of z˜1-5. We made a combination of deep imaging and spectroscopic observations to identify LAEs as a means to asses the more typical star-forming galaxies in these regions. We identified more than 300 LAEs candidates in 4 potential protocluster regions. Of these, ˜ 200 have already been spectroscopically confirmed to be at the SMGs redshifts. This is consistent with them being part of the same structure. By probing the redshift range z ˜ 1-5, which corresponds to a time interval of more than 4 Giga years, we seek insights on the evolution of protoclusters over this time interval. Furthermore, we seek to use the broad wavelength coverage in these regions to gauge galaxy properties as a function of protocluster maturity, in an effort to understand how does the galaxy-environment relation evolves within a growing cluster structure.

X- & CR RAYS, QM, SNOVAE, GRAVITY, DM, COSMOLOGY, PARTICLES, COMPACT STARS, GALAXIES / 157

A method to design mechanical transducers for resonant mass gravitational wave detectors

Authors: Fabio da Silva Bortoli[1]; Carlos Frajuca[2]; Nadja Magalhaes[3]

[1] *IFSP - Sao Paulo Federal Institute*

[2] *IFSP*

[3] *Federal University of Sao Paulo - Brazil*

In this work a method to design two mechanical modes transducers for spherical resonant mass gravitational wave detectors is presented. Applied for SCHENBERG detector that uses microwave multiparametric sensors. The detector has 17 mechanical modes and more 6 electromagnetic modes for the microwave cavities. Here these aspects of the mechanical design that should allow amplification in amplitude around 10000 times. For this to be possible, these transducers, when placed on the spherical surface of the detector, must meet conditions that involve: size limitations, can be manufactured with a high mechanical and electrical Q, have an effective mass ratio between their modes to provide the intended amplification and compose a resonant system that has characteristics necessary for the detection of gravitational waves (GW). To meet this last aspect, the transducers must form a resonant system with the sphere around the quadrupole frequencies of the sphere. This work describes how these transducers were designed to be able to meet all these conditions. In this project, the use of simulations using the finite element method (FEM) was essential.

QM, PARTICLES, ATOMS, NUCLEI, SNOVAE MERGERS, QED, BHS, GRBS, COMPACT STARS / 156

Study of Ultracompact Stars in General Relativity

Author: Luan Costa[1]

Co-authors: Dimiter Hadjimichef ; Kepler Oliveira [2]

[1] *UFRGS*

[2] *u*

It is usually considered 2.16 $M_{\odot}$ as the upper limit mass for a neutron star. Objects with masses between this value and 5 $M_{\odot}$ could be weakly interacting black holes or very massive neutron stars.

Motivated by this, the present paper's aim is to investigate the so-called ultracompact stars. This analysis is performed taking into consideration influences both in the metric and in the matter structure, through deformed geometries, anisotropies in the energy-momentum tensor, and adequate equations of state, with the purpose of guaranteeing the correct inspection when studying this class of atypical neutron stars. These caracteristics are required since ultracompact stars almost certainly will exhibit, besides the undeniable very high density, intense magnetic fields and high rotation. To this extent, the stars are studied using non-spherical models. Accordingly, through the employment of modified Tolman-Oppenheimer-Volkoff equations and selected equations of state, significant results are achieved. Interesting propects - like the comparison to models which possess magnetic fields or rotation in their own structures - can begin to be outlined.

X- & CR RAYS, QM, SNOVAE, GRAVITY, DM, COSMOLOGY, PARTICLES, COMPACT STARS, GALAXIES / **155**

Looking for signs of supermassive black hole growth in ultra-compact UV-luminous galaxies using mid-infrared spectroscopy

Authors: Rayssa Guimarães Silva[1]; Karín Menéndez-Delmestre[1]; Thiago S. Gonçalves[1]; Antara Basu-Zych[2]

[1] *Valongo Observatory, Federal University of Rio de Janeiro*

[2] *NASA/Goddard, USA*

The formation of supermassive black holes (SMBHs) and their co-evolution with the host galaxy is poorly understood in the early Universe. How is the growth of the stellar bulge related to the growth of the SMBH? Looking at the coexistence of star formation activity and SMBHs in high redshift galaxies is critical to address this question.

At high redshifts, it is hard to study galaxies as their distance renders them small and faint. This is especially true for Lyman Break Galaxies (LBGs), typical star-forming galaxies in the early ($z > 2$) Universe. There are galaxies at intermediate redshifts that share the properties of those at higher redshifts and can work as a proxy for detailed studies. Such is the case of Lyman Break Analogs (LBAs), local ultra-compact UV-luminous galaxies which have similar properties to LBGs. They may provide a great laboratory to investigate the relationship between star formation and SMBHs.

Some LBAs contain a single, dominant luminous point-like source at or near the center of the galaxy, which appears to be an ideal site for the formation of an SMBH. About 20% of the LBAs have optical emission line spectra that are intermediate between those of pure starbursts and those of active galactic nuclei (AGNs) —growing SMBHs. Unfortunately, the optical spectra alone do not unambiguously establish the presence of an AGN. The mid-infrared (mid-IR) offers a way to eradicate this ambiguity.

In this work, we analyze the mid-IR spectra of 25 LBAs ($0.1 < z < 0.3$) taken with the InfraRed Spectrograph (IRS) on the Spitzer Telescope. We use the mid-IR slope and the prominence of polycyclic aromatic hydrocarbons (PAHs) emission features to find signs of AGNs and quantify the contribution of the underlying power sources, be it AGN or star formation. Our preliminary results are consistent with the presence of obscured AGN in our sample. This work is a preparation for the spatially resolved studies that will be done with de James Webb Space Telescope (JWST).

COMPACT STARS, DM, DE, GWs, ϒ RAYS, QGP, QCD, HIC, SNOVAE, BHs, PARTICLES, GALAXIES / **154**

Triaxially-deformed Freely-precessing Neutron Stars: Continuous electromagnetic and gravitational radiation

Authors: Yong Gao[1]; Lijing Shao[1]; Rui Xu[1]; Ling Sun[2]; Chang Liu[1]; Ren-Xin Xu[1]

[1] *Peking University*

[2] *California Institute of Technology*

A rapidly rotating, asymmetric neutron star (NS) in the Milky Way undergoes free precession,making it a potential source for multi-messenger observation. The free precession could manifest in (i) the spectra of continuous gravitational waves (GWs), and (ii) the timing behavior and pulse-profile of radio and/or X-ray pulsars. We extend previous work and investigate in great detail the free precession of a triaxially deformed NS with analytical and numerical approaches. In particular, its associated continuous GWs and pulse signals are derived. Explicit examples are illustrated for the continuous GWs, as well as timing residuals in both time and frequency domains.

COSMOLOGY, DE, DM, COMPACT STARS, NSs, BHs, GWs, GRAVITY / 153

Study of Mg ion fragmentation cross-sections for shielding purposes using GEANT4

Author: Nitika Sangwan[1]

Co-author: Ashavani Kumar [2]

[1] *NIT Kurukshetra*

[2] *National Institute of Technology Kurukshetra*

The spectrum of high energy ions (HZE) is very broad in space and contributes the most to the accumulation of the radiation dose to the shielding infrastructure of the space mission. The partial fragmentation cross-sections (PFXS) and linear energy deposition are two very significant factors to estimate the dose deposition and risk possibilities due to space radiation exposure when preparing a space exploration. In this study, the PFXS are calculated for 24Mg ions of energy 370 MeV/n and ˜470 MeV/n in carbon (C) material. The study utilized the QMD and the INCL++ physics model for simulation to compute the PFXS by the three-dimensional Monte Carlo toolkit Geant4. The comparative analysis is carried out between the simulated outcome of Geant4, the experimental data, and the results generated by the PHITS code system. It is noted that the QMD model offers the best agreement for PFXS with an odd-even effect for fragments of C target. The INCL++ regenerate results with an inline agreement and with a few percent of deviation depending on which fragment and projectile energy is considered.

DENSE MATTER, QCD, QFT, HIC, GWs, NSs, DM, COSMOLOGY , FTH-INFLATION / 129

Cyg X-3 –gamma-ray binary

Authors: Vera G. Sinitsyna[1]; Vera Y. Sinitsyna[1]

[1] *P.N. Lebedev Physical Institute, RAS*

Cyg X-3 is the famous binary system containing a black hole. It is actively studied through the wide range of electromagnetic spectrum from radio band up to ultrahigh energies. Cyg X-3 has long been considered as an object for very high energy gamma-ray observations. We present the results of more than 20-year-long studies of Cyg X-3 in the range of 800 GeV–100 TeV with the SHALON telescope. The results are presented with images, spectra during the periods of flaring activity and at low flux periods. The identification of detected TeV gamma-ray source with Cyg X-s is performed with analysis revealed the very high energy emission modulation corresponding to an orbital period of 4.8 h, which is a signature of Cyg X-3. The correlation of TeV flux increases with the flaring activity of Cyg X-3 at X-ray and radio ranges are found. As well as correlation of increases of high and very high energy gamma-ray fluxes with soft stay of Cyg X-3 at X-rays. Detected modulation of TeV gamma-ray emission with orbit together with the high luminosity of the companion star of Cyg X-3 and the close orbit leads to an efficient generation of the part of gamma-ray emission in the

inverse Compton scattering. The correlation of activity at TeV energies with the flares of Cyg X-3 at radio band could be associated with powerful mass ejections from the central regions around the black hole.

DENSE MATTER, QCD, QFT, HIC, GWs, NSs, DM, COSMOLOGY , FTH-INFLATION / 148

The influence of deceleration in the bracking index of Pulsars

Authors: Carlos Frajuca[1]; Nadja Simao Magalhaes[2]

[1] *IFSP*

[2] *Unifesp*

Pulsars are stars from which electromagnetic radiation is observed to pulsate in well-defined time intervals as the star rotates and the emission of eletromagnetic signal is located in a place different from the rotation center. The frequencies of the pulses decay with time, quantified by the braking index (n). In the canonical model n= 3, in general, for all pulsars, but observational data shows that n is lower than 3. In this work this model is modified, based on modification of the canonical one incorporating the influence of the deceleration of the neuton star as it looses energy by emmiting electromagnetic radiation and decelerates, as it decelerates, the shape of the star changes because of the smaller centrifugal force decreasing its inertia moment, what in normal conditions would accelerate the star rotation, as it decreses because of loss in energy, the star would decelerate less making the bracking index smaller than three. The model really decreases the bracking index but not at a factor needed to explain the experimental data. Only the bracking index close to three can be described by this model. The authors believe that the complete explanation for to bracking index is due to a series of fenomena incorporated in the process.

COSMOLOGY, DE, DM, COMPACT STARS, NSs, BHs, GWs, GRAVITY / 146

Investigation of the nature of a massive vector mediator for Dark Matter through e^+e^- collisions

Author: Márcio Mateus Jr[1]

Co-author: Gustavo Gil Da Silveira [2]

[1] *Universidade Federal do Rio Grande do Sul*

[2] *Universidade do Estado do Rio de Janeiro (BR)*

Several studies have been dedicated to study the nature of dark matter (DM) and to try to discover its origin. Different approaches have been employed to understand how DM interacts and what are possible mechanisms to detect it. Theories beyond the Standard Model of Elementary Particles (SM) could achieve this by employing effective, simplified, or more complete models. Direct, indirect, and collider searches have excluded much of the parameter space for DM, however still indicating that DM can be made up of particles and mediators of high mass, the latter believed to be of the order of TeV. Hence, this work aims to investigate the interaction between fermions, more specifically electron-positron pairs, and DM particles through interaction of a new massive vector mediator, Z'. The production of scalar, fermionic, and vector DM pairs via electron-positron annihilation to this new boson was investigated, evaluating the total cross section in terms of the Mandelstam variables in the center of mass frame and in function of the decay width and the couplings to the massive mediator. This approach is based on the opportunities of observing such production mechanism in electron-positron accelerators. As a result, the possible values of the coupling constants between the DM and the SM are mapped according to the exclusion limits obtained by the Compact Muon Solenoid (CMS) experiment and the Planck satellite. Furthermore, we show that there are several

possibilities for mass ranges of this new massive mediator and for the particles of DM which are not excluded by the collider and astrophysical limits.

X- & CR RAYS, QM, SNOVAE, GRAVITY, DM, COSMOLOGY, PARTICLES, COMPACT STARS, GALAXIES / 144

Fusion dynamics of ^{12}C+^{12}C reaction: An astrophysical interest within the relativistic mean-field approach

Author: Shilpa Rana[1]

Co-authors: Raj Kumar [1]; Mrutunjaya Bhuyan [2]

[1] *School of Physics and Materials Science, Thapar Institute of Engineering and Technology, Patiala 147004, India*

[2] *Department of Physics, Faculty of Science, University of Malaya, Kuala Lumpur 50603, Malaysia*

The ^{12}C+^{12}C fusion reaction holds a great significance in the later phases of stellar evolution. To get involved in this evolution, one must understand the corresponding fusion-fission dynamics and reaction characteristics. In the present analysis, we have studied the fusion cross-section along with the S-factor for this reaction using the well-known M3Y and recently developed R3Y nucleon-nucleon (NN) potential along with the relativistic mean-field densities in double folding approach [1]. The density distributions and the microscopic R3Y NN potential are calculated using the NL3* parameter set. The ℓ-summed Wong formula is employed to investigate the fusion cross-section, with ℓ_{max}-values from the sharp cut-off model. The calculated results are also then compared with experimental data [2, 3]. It is found that the R3Y interaction gives a nice fit to the data. So it would be of interest to study the details of this fusion reaction in a microscopic approach.

References:

[1] M. Bhuyan, Raj Kumar, Shilpa Rana, D. Jain, S. K. Patra, B. V. Carlson, Phys. Rev. C **101**, 044603 (2020); and references therein.
[2] J. R. Patterson, H. Winkler, and C. S. Zaidins, Ast. Jour. **157**, 367 (1969).
[3] E. F. Aguilera *et al.*, Phys. Rev. C **73**, 064601 (2006).

COSMOLOGY, DE, DM, COMPACT STARS, NSs, BHs, GWs, GRAVITY / 143

Properties of magnetized neutral pions at zero and finite temperature in nonlocal chiral quark models

Authors: María Florencia Izzo Villafañe[1]; Daniel Gomez Dumm[2]; Norberto Scoccola[1]

[1] *Comision nacional energia atomica*

[2] *UNLP, Argentina*

The behavior of π^0 meson properties in the presence of a uniform external magnetic field is studied in the context of a nonlocal extension of the Polyakov-Nambu-Jona-Lasinio model which predicts the existence of inverse magnetic catalysis at finite temperature. The analysis includes the π^0 mass, the effective π^0-quark coupling and the pion-to-vacuum hadronic form factors, both at zero and finite temperature. Numerical results are compared with previous calculations carried out within the local NJL model, when available.

DM, DE, GWs, BHs, GRAVITATION, GALAXIES, QCD, LIFE, GRBs, COSMOLOGY, OA, KT / 141

The way of entropy: From Big-Bang to infinite

Author: Nilo Serpa[1]

Co-author: Gisele Alves [1]

[1] *Centro Universitário ICESP*

In principle, our model serves to reopen the discussion on possible metrics in a thermodynamic manifold, since we can speak of an extensive variable, the "distance" (duration) in a temporal manifold. Furthermore, the multiplier equilibrium constant β is inherited from the power of the time interval in kets, in such a way that we could, so to speak, associate entropy with a "metric index" derived from the time confinement of thermal energy established by the Lagrangian functional.

QM, PARTICLES, ATOMS, NUCLEI, SNOVAE MERGERS, QED, BHS, GRBS, COMPACT STARS / 140

On the behavior of the black hole candidate 1E 1740.7−2942's corona based on long-term INTEGRAL database

Authors: Paulo Eduardo Stecchini[1]; Jurandi Leão Santos[2]; Manuel Castro[1]; Flavio D'Amico[3]

[1] *Instituto Nacional de Pesquisas Espaciais*

[2] *IFSP*

[3] *INPE*

One of the most straightforward ways to explain the hard X-ray spectra observed in X-ray binaries is to assume that comptonization of soft photons, originated in the disk, is occurring. The region in which such comptonization takes place, called the corona, is commonly characterized by only two parameters: its thermal energy kT and its optical depth τ. Thus, hard X-ray spectra analysis is an important tool in diagnosing the behavior of these parameters.

In this work we analyzed a large number (>300) of hard X-ray spectra (20−200 keV) of the black hole candidate 1E 1740.7−2942 (1E, henceforth). Data were retrieved from the INTEGRAL satellite public database. By applying simple and widely used models to fit these data, we were able to verify that thermal comptonization describes the spectra of 1E in these energies very well, regardless of the source's luminosity. The Compton parameter y values, computed from kT and τ provided, show that 1E remains in the unsaturated comptonization regime for almost the entire sample; moreover, the predicted power-law indices calculated from y are in agreement with the indices found when a phenomenological power-law model is applied to the spectra. We believe, then, that the spectral changes observed in 1E for this energy range, attributed to different power-law indices, may be explained by means of only these two corona parameters' variations.

X- & CR RAYS, QM, SNOVAE, GRAVITY, DM, COSMOLOGY, PARTICLES, COMPACT STARS, GALAXIES / 137

Proton acceleration in the active galactic nuclei

Authors: Alexey Gunya[1]; Yakov Istomin[2]

[1] *The P.N. Lebedev Physical Institute, Moscow LPI*

[2] *The P. N. Lebedev physical institute*

Acceleration of the high energy cosmic rays protons in the active galactic nuclei is considered.

The major acceleration stage is the centrifugal acceleration in a magnetosphere of the central machine light cylinder surface. In the during to calculations, the received dependence of the maximum energy on the parameter of the magnetization κ and relation parameter α of toroidal and poloidal magnetic fields led to the conclusion that achievement of a theoretical maximum limit of value L-factor isn't possible for the accelerated particle in the magnetosphere of a black hole due to restrictions of the topology of toroidal and poloidal magnetic fields imposed by features of the relation. The analysis of special cases of the relation of a toroidal and poloidal magnetic field showed what in the presence of the toroidal magnetic field which is significantly more poloidal (case AGN with jet) the maximum L-factor value reaches $\gamma_{max}^{2/3}$, in the case when toroidal field to become smaller in comparison to the poloidal field (case non-active galaxy nuclei) the maximum L-factor value doesn't exceed $\gamma_{max}^{1/2}$.

The relativistic jet is the finishing area of the high energy proton acceleration. Here acceleration is carried out generally with a radial electric field. During the calculations was discover 3 acceleration regimes. The untrapped regime occurring in the case of the proton acceleration from the initial L-factor from the magnetosphere $\gamma_{max}^{2/3}$ to the theoretical maximum L-factor γ_{max}. The proton starts near the jet axis and moves directly inside out of the jet surface. In this case dimensionless parameter of the electric field β significantly more than the parameter of the magnetic field α. In the case of the trapped regime, the proton acceleration occurring by moving along the jet with oscillations in the radial direction. In the case of a strong toroidal magnetic field proton preaccelerated in the magnetosphere are pressed to the jet axis and practically is not accelerated in the jet.

For a number of the active galactic nucleus, such as M87 the maximum values L-factor for accelerated protons for scenarios of existence or lack of a toroidal magnetic field were defined. For special cases, there was a defined value of the maximum energy of the protons accelerated in object Sgr. A* magnetosphere that was confirmed by the experimental data obtained on the massive HESS of Cherenkov telescopes. Also, for cases microquasar such as SS433 was calculated proton acceleration energy and derived the acceleration regime.

X- & CR RAYS, QM, SNOVAE, GRAVITY, DM, COSMOLOGY, PARTICLES, COMPACT STARS, GALAXIES / 134

Simulation of Transit Method for detection of exoplanets

Authors: Sarvesh Bhogaokar[1]; Jatin Rathod [2]; Tejas Sonawane[1]

[1] *St. Xavier's College, Autonomous, Mumbai.*

[2] *Nehru Planetarium Mumbai*

The transit method is one of the most effective and reliable methods to detect the exoplanets around other stars in our galaxy. As an exoplanet passes in front of its host star along our line of sight, it causes a periodic dimming of the system's brightness. This follows as the exoplanet blocks a portion of the host star's radiant flux. Consequently, light curves of the system are generated, which are then studied in search of periodic dips corresponding to planetary transits. Students only get to read about the theory part of the concept but some of them lack visualization and most importantly the hands-on experience. We present the simulation of a transit method for the detection of exoplanets. Our aim is to explore the easier approach to teach this concept to Undergrad and advanced high school students and also to give them hands-on experience. For simplicity, here we only consider one planet around the target star. We simulate the star-planet system using 'Vpython'and analyse it through 'Tracker'to produce lightcurves and the respective data file in terms of Time and Flux. Light Curves and the Data files are analysed by Tracker and Python algorithms. We then estimate the Radius of the exoplanet and orbital radius using observables such as transit depth, transit duration, and the Orbital period. Finally, these values are compared with the input parameters of the Vpython simulation to calculate the errors and to state the conclusion. We clearly see that both approaches produce similar results and are pretty close to the input values of the Vpython simulation. We also saw huge deviations in orbital radius values from python as well as tracker. We showed these methods to undergraduates and high school students. We found the second-year undergraduates with basic python knowledge were able to follow the python programming approach on the other

hand high school students found it confusing and difficult since they don't have a background of OOP.

DM, DE, GWs, BHs, GRAVITATION, GALAXIES, QCD, LIFE, GRBs, COSMOLOGY, OA, KT / 133

Observational Constraints on the possibility that Sterile Neutrinos cause Anti-gravity

Authors: Priyamvada Kameshwar[1]; Patrick Das Gupta[1]; Varun Srivastava[2]

[1] *University of Delhi*

[2] *IISER Kolkata*

The origin of neutrino masses heralds new physics. Some theories that explain small neutrino masses, predict the existence of sterile neutrinos. Observationally, there is no evidence that neutrinos cause attractive gravity. Exploring a new idea, we study constraints posed by data as to what if sterile neutrinos cause repulsive gravity. We use an effective negative gravitational constant (-G') for the sterile neutrinos to constrain the extent of anti-gravity sourced by them. The case of an open universe is explored (in accordance with the positive value of H0^2), taking into account different combinations of parameters, and collating with observed values from Type Ia Supernovae datasets.

X- & CR RAYS, QM, SNOVAE, GRAVITY, DM, COSMOLOGY, PARTICLES, COMPACT STARS, GALAXIES / 130

The objects in observations of Perseus Cluster region

Authors: Vera G. Sinitsyna [1]; Vera Y. Sinitsyna[2]

[1] *P.N. Lebedev Physical Institue, RAS*

[2] *P.N. Lebedev Physical Institute, RAS*

The results of 20-year observations of the Perseus cluster centering on the NGC 1275 including IC 310 radio galaxy and extragalactic supernova SN 2006gy at energies 800 GeV - 45 TeV by the SHALON telescope are presented. Also, the emission from the galactic source of nonthermal radio and X-ray emission GK Per (Nova 1901) of classical nova type was found as it accompanied to the observations. The spectral energy distributions, light curve and images of NGC 1275 at energies > 800 GeV were determined. It was found, that the TeV gamma-ray emission has an extended structure with a distinct core centered at the source's position and well correlates with the photon emission regions viewed in X-rays by Chandra and anti-correlates with radio-structures. The emission component corresponding to the core of NGC 1275 and its spectral energy distribution was additionally identified. Also, the variations of TeV gamma-ray flux both at year- and day- scales were found. The obtained data indicate that the TeV gamma-ray emission is generated by a number of processes: a part of this emission is generated by relativistic jets in the nucleus of NGC 1275. Whereas, the presence of an extended structure around NGC 1275 and the slow rise of the gamma-ray flux is the evidence of the interaction of cosmic rays and magnetic fields generated in the jets at the galactic center with the gas of the Perseus cluster

DM, DE, GWs, BHs, GRAVITATION, GALAXIES, QCD, LIFE, GRBs, COSMOLOGY, OA, KT / 115

Kinematic Constraints on Spatial Curvature from Supernovae Ia and Cosmic Chronometers

Authors: Rodolfo Valentim[1]; José Fernando Jesus[2]; Manuel Malheiro[3]; P. H.R.S Moraes[4]

[1] *UNIFESP - Diadema*

[2] *Universidade Estadual Paulista - UNESP*

[3] *ITA*

[4] *IAG - USP*

This work has an interesting approach to estimate the spatial curvature Ω_k from data independently of dynamical models is suggested, it was done through three kinematic parameterizations of the comoving distance ($D_C(z)$) with second degree polynomial, of the Hubble parameter ($H(z)$) with a second degree polynomial and of the deceleration parameter ($q(z)$) with first order polynomial. All these parameterizations are done as function of redshift z. We used SNe Ia dataset from Pantheon compilation with 1048 distance moduli estimated on the range $0.01 < z < 2.3$ with systematic and statistical errors and a compilation of 31 $H(z)$ data estimated from cosmic chronometers. The spatial curvature found for $D_C(z)$ parametrization was $\Omega_k = -0.49^{+0.14+0.29}_{-0.14-0.27}$. The parametrization for deceleration parameter $q(z)$ resulted in $\Omega_k = -0.08^{+0.21+0.54}_{-0.27-0.45}$. The $H(z)$ parametrization had incompatibilities between $H(z)$ and SNe Ia data, so these analyses were not combined. The $q(z)$ parametrization is compatible with the spatially flat Universe as predicted by many inflation models and data from CMB, while the $D_C(z)$ parametrization favored a slightly closed Universe. This type of analysis may be interesting as it avoids any bias because it does not depend on assumptions about the matter content for estimating Ω_k.

DM, DE, GWs, BHs, GRAVITATION, GALAXIES, QCD, LIFE, GRBs, COSMOLOGY, OA, KT / 114

Gaussian Process Estimation of Transition Redshift

Authors: Rodolfo Valentim[1]; Anderson Almeida Escobal[2]; José Fernando Jesus[2]

Co-author: Saulo H. Pereira [2]

[1] *UNIFESP - Diadema*

[2] *Universidade Estadual Paulista - UNESP*

This poster aims to put constraints on the transition redshift z_t, which determines the onset of cosmic acceleration, in cosmological-model independent frameworks. In order to do that, we use the non-parametric Gaussian Process method with $H(z)$ and SNe Ia data. The deceleration parameter reconstruction from $H(z)$ data yields $z_t = 0.59^{+0.12}_{-0.11}$. The reconstruction from SNe Ia data assumes spatial flatness and yields $z_t = 0.683^{+0.11}_{-0.082}$. These results were found with a Gaussian kernel and we show that they are consistent with two other kernel choices.

DENSE MATTER, QCD, QFT, HIC, GWs, NSs, DM, COSMOLOGY , FTH-INFLATION / 107

Influence of a Galactic Gamma Ray Burst on Ocean Plankton

Authors: Lien Rodríguez López[1]; Mayrene Guimarais[2]; Lisdelys González[1]; Rolando Cárdenas[3]; Jorge Horvath[4]

[1] *Universidad de Concepción*

[2] *Universidad Nacional Autónoma de México*

[3] *Universidad Central Martha Abreu de las Villas*

[4] *Universidad de Sao Paulo*

The hypothesis that one or more biodiversity drops in the Phanerozoic eon, evident in the geological record, might have been caused by the most powerful kind of stellar explosion so far known (Gamma Ray Bursts) has been discussed in several works. These stellar explosions could have left an imprint in the biological evolution on Earth and in other habitable planets. In this work we calculate the short-term lethality that a GRB would produce in the aquatic primary producers on Earth. This effect on life appears because of ultraviolet (UV) re-transmission in the atmosphere of a fraction of the gamma energy, resulting in an intense UV flash capable of penetrating ˜ tens of meters in the water column in the ocean. We focus on the action of the UV flash on phytoplankton, as they are the main contributors to global aquatic primary productivity. Our results suggest that the UV flash could cause an hemispheric reduction of phytoplankton biomass in the upper mixed layer of the World Ocean of around 10%, but this figure can reach up to 25 % for radiation-sensitive picoplankton species, and/or in conditions in which DNA repair mechanisms are inhibited.

QM, PARTICLES, ATOMS, NUCLEI, SNOVAE MERGERS, QED, BHS, GRBS, COMPACT STARS / 105

Poisson type conformastat spherically symmetric spacetimes

Author: Gonzalo García-Reyes[None]

Static spherically symmetric solutions of the Einstein's field equations in isotropic coordinates from Newtonian potential-density pairs are investigated. The approach is used in the construction of a spherical matter distribution made of a perfect fluid starting with a seed potential-density pair corresponding to a massive spherical dark matter halo model with a logarithm potential. Moreover, the geodesic motion of test particles in stable circular orbits around such structures is studied. The models considered satisfy all the energy conditions.

DENSE MATTER, QCD, QFT, HIC, GWs, NSs, DM, COSMOLOGY , FTH-INFLATION / 138

The Exceptional X-ray Evolution of SN1996cr in High Resolution

Authors: Jonathan Quirola[1]; Franz Bauer[1]

[1] *Pontificia Universidad Católica de Chile*

We present X-ray spectra spanning 18 years of evolution for SN1996cr, one of the five nearest (˜4 Mpc) SNe detected in the modern era. HETG observations allow us to resolve spectrally the velocity profiles of Ne, Mg, Si, S, and Fe emission lines and monitor their evolution as tracers of the ejecta-circumstellar medium (CSM) interaction. To explain the diversity of X-ray line profiles, we explore several possible geometrical models. Based on the highest S/N 2009 epoch, we find that a polar geometry with two distinct opening angle configurations and internal obscuration can successfully reproduce all of the observed line profiles. We extend this model to seven further epochs with a lower S/N ratio and/or lower spectral-resolution between 2000-2018, yielding several interesting evolutionary trends.

DENSE MATTER, QCD, QFT, HIC, GWs, NSs, DM, COSMOLOGY , FTH-INFLATION / 94

Searching Extragalactic X-ray transients in the Chandra Catalog 2.0

Author: Jonathan Quirola-Vásquez[1]

Co-author: Franz Bauer [1]

[1] *Pontificia Universidad Católica de Chile*

We will present the detection of eight candidate extragalactic fast X-ray transients (+ XRT 170831 which was identified previously by Lin et al. 2019) from a parent sample of 214,701 sources in the Chandra Source Catalog Release 2.0 above $|b|>10^{\circ}$ (160.96 Ms over 592.4 deg^2). Our candidates have peak fluxes between 3.5×10^{-15} to 1.1×10^{-13} erg cm^{-2} s^{-1} and span hardness ratios between -0.70 and -0.10. We characterize their X-ray light curves and spectra in detail using broken power-law models with break times of 0.3 to 9.9 ks and spectral indices of 0.4 to 3.4. For the two candidates with visible counterparts in archival imaging, we assess their photometric redshifts ($z_{\rm ph}\sim$0.3-5.2) and host properties. Moreover, a subsample of FXRTs shows possible association with GRBs (because of a plateau in their X-ray light curves and similarities with another X-ray transient, called XT2, which could be related to an off-axis short GRB), particularly with a proto-magnetar emission remnant. Also, we study the properties of the potential magnetars such as the magnetic field, rotational kinetic energy, and initial rotational period. Finally, we calculate an event rate of the total sample and also the sub-sample of objects likely related with GRBs of $8.68^{+7.93}_{-5.68}\times10^2$ and $3.52^{+5.58}_{-3.38}\times10^2$ yr^{-1} Gpc^{-3}, respectively, and discuss implications for future understanding of this enigmatic population.

COMPACT STARS, DM, DE, GWs, ϒ RAYS, QGP, QCD, HIC, SNOVAE, BHs, PARTICLES, GALAXIES / 93

Neutron star cooling within the equation of state with induced surface tension

Authors: Tsiopelas Stefanos[None]; Violetta Sagun[1]

[1] *University of Coimbra*

We study the thermal evolution of neutron stars described within the equation of state with induced surface tension (IST) that reproduces properties of normal nuclear matter, fulfills the proton flow constraint, provides a high-quality description of hadron multiplicities created during the nuclear-nuclear collision experiments, and is equally compatible with the constraints from astrophysical observations and the GW170817 event. The model features strong direct Urca processes for the stars above 1.91 Msun. The IST equation of state shows a very good agreement with the available cooling data, even without introducing nuclear pairing. We also analysed an effect of the singlet proton/neutron and triplet neutron pairing on the cooling of neutron stars of different mass. We demonstrate a full agreement of the predicted cooling curves with the experimental data. Moreover, the IST EoS provides a description of Cas A with both paired and unpaired matter.

COMPACT STARS, DM, DE, GWs, ϒ RAYS, QGP, QCD, HIC, SNOVAE, BHs, PARTICLES, GALAXIES / 124

Study on the properties of a proto-neutron star with SU(6) symmetry

Author: Gao Zhifu[1]

Co-authors: Wang Hui [2]; Mu Xueling [3]

[1] *Xinjiang Astronomical Observatory, Chinese Academy of Sciences*

[2] *School of Physical Science and Technology, Southwest Jiaotong University*

[3] *School of information science and Engineering, Chengdu University,*

It is of great importance to study the properties of a proto-neutron star (PNS) because of its complex evolution into a cold NS. Under the framework of relativistic mean field theory, the repulsion and attraction between hyperons and hyperons are considered simultaneously. In addition, the hyperon-meson couplings satisfy SU(6) symmetry. By considering entropy, temperature and neutrino, respectively, we investigate the properties of a PNS, and find that compared with entropy and temperature, neutrino has more obvious influence on the star's mass. In fact, the proportion and interaction force of hyperons in different cases are different, which ultimately leads to different equations of state and properties of the star. The gravitational redshifts of PNSs in different cases are also presented.

DENSE MATTER, QCD, QFT, HIC, GWs, NSs, DM, COSMOLOGY , FTH-INFLATION / 44

Ground Level Muon Flux Variation in a Cosmic Rays Simulation : A study of tidal frequencies in muon flux ground level detection using Corsika simulations

Authors: Elisa Garcia Pereira[1]; Dimiter Hadjimichef[None]

[1] *UFRGS*

Recent experiments [1] have shown that cosmic rays cascades originate a periodic tidal frequency muon flux at the ground level. Using the Corsika (COsmic Ray SImulations for KAscade) tool kit [2], we simulate cascade scenarios, in a time scale of a year, which could be responsible for these frequencies, such as an atmospheric density variation and the incidence angle modification.

[1] H. Takai et al., "Tidal Frequencies in the Time Series Measurements of Atmospheric Muon Flux from Cosmic Rays", arXiv:1610.05983 [astro-ph.HE].

[2] https://www.ikp.kit.edu/corsika/