Seventeenth Marcel Grossmann Meeting

Sunday, July 7, 2024 - Friday, July 12, 2024

Aurum, the 'Gabriele d'Annunzio' University and ICRANet

Book of Abstracts

EXPLORING COMPACT OBJECT GRAVITATIONAL FIELDS WITHIN EINSTEIN'S GENERAL RELATIVITY FRAMEWORK

Authors: Amina Sadu[1]; Saken Toktarbay[1]

[1] *Al-Farabi Kazakh National University*

Corresponding Author: saduamina2003@gmail.com

In this research, we examine the gravitational behavior of dense astronomical bodies, specifically white dwarfs and neutron stars, using Einstein's gravitational theories. We explore the effects of deviations from spherical symmetry by applying a simplified mathematical model, incorporating the quadrupole moment to a first-order approximation 1.
Focusing on the interiors of white dwarfs, we use the Salpeter equation of state [2] to study how these stars maintain equilibrium between gravitational pull and internal pressure. We also compare the Chandrasekhar and Salpeter equations of state for ideal fluid solutions in general relativity to understand their influence on spherical objects.
This study provides new insights into the balance of forces within dense stars, enhancing our understanding of celestial mechanics under extreme conditions. Our future work will extend this analysis to non-spherically symmetric objects by adding parameters and refining the model for more accurate descriptions of complex geometries. This will improve our understanding of how different equations of state affect the properties and evolution of astrophysical objects in the universe.

High energy astrophysics / 457

Protoneutron star dynamos and magnetar formation

Authors: Alexis Reboul-Salze[1]; Jérôme Guilet[2]; Matteo Bugli[3]; Paul Barrère[2]; Raphaël Raynaud[4]

[1] *AEI*

[2] *CEA*

[3] *UniTO*

[4] *UPCité*

Corresponding Author: raphael.raynaud@cea.fr

Magnetars are isolated young neutron stars that exhibit the most intense magnetic fields known in the Universe and are characterized by a wide variety of high-energy emissions. The birth of rapidly rotating magnetars is also a promising scenario to power outstanding explosive transients. The formation process of these objects, as well as the origin of their ultra-strong magnetic fields, remains an open question, but the amplification of magnetic fields by MHD instabilities inside protoneutron stars seems inevitable. I will review the different dynamo scenarios that can explain magnetar formation, focusing on recent progress achieved with 3D-MHD HPC simulations, and discuss them in light of various observational constraints.

The SVOM mission in the time-domain era / 458

The SVOM mission for the study of the transient high-energy sources

Author: Andrea Goldwurm[1]

[1] *APC-Paris & CEA/IRFU-Saclay*

Galactic and extragalactic magnetars: recent observations and theoretical progress / 632

Nonlinear vacuum electrodynamic lensing on magnetars

Co-authors: A. Talkhat ; Medeu Abishev [1]; Tursynbek Yernazarov [2]

[1] *Al Farabi Kazakh National University*

[2] *al-Farabi Kazakh National University*

Corresponding Author: abishevme@gmail.com

We study numerically a combined gravitational and nonlinear magnetic lensing effect on electromagnetic flux. A magnetar with a dipole magnetic field and background gravitational field is considered to deflect the light rays which passed through its magnetosphere. We assume a square wave front as a grid with the dynamic step. At the nodes of this grid, the rays enter perpendicularly into the cubic area, which covers the main magnetic lensing region with a magnetar at the center. On the basis of general relativity (GR) and nonlinear vacuum electrodynamics, the distribution of rays by the deflection angle in the combined field of the magnetar was obtained. On the basis of the analysis of the obtained data, it is possible to assert that the magnetic field distorts the result of gravitational lensing. Therefore, the magnetar is regarded as a gravitational-magnetic lensing object, wherein the magnetic field induces axial distortion within 10e-6. These results are expected to be detectable by modern instruments.

Emission mechanisms in gamma-ray bursts / 633

Diffusion spectra and equitemporal surfaces of ultrarelativistic shell radiation as applied to gamma-ray bursts

Author: Aksana Kurhuzava[None]

Corresponding Author: kuppory@gmail.com

Large-scale cosmic emissions of explosive energy that occur during the explosions of certain supernovae or the merger of compact objects are called gamma-ray bursts. We study the radiation of the ultrarelativistic shell in the diffusion approximation, which takes place at the initial stage of a gamma-ray burst. We get the effective temperature, instantaneous and time-integrated spectra for the different distribution of the initial internal energy of the shell. The resulting time-integrated emission spectra of the shell photosphere contain a Band component and a thermal component. Also we considered the types of the equitemporal surfaces with a different type of the movement of the shell.

Theories of gravity: alternatives to the cosmological and particle standard models / 634

Status of Electromagnetic Accelerating Universe

Corresponding Author: paul.h.frampton@gmail.com

To describe the dark side of the Universe, we adopt a novel approach where dark energy is explained as an electrically charged majority of dark matter. Dark energy, as such, does not exist. The Friedmann equation at the present time coincides with that in a conventional approach, although the cosmological "constant" in the Electromagnetic Accelerating Universe (EAU) Model shares a time dependence with the matter component. Its equation of state is $\omega \equiv P/\rho \equiv -1$ within observational accuracy.

Geometrothermodynamics of (2 + 1)-Dimensional Black Holes with Scalar Fields

Nurzada Beissen[1*], Alimkulova Madina[1], Quevedo Hernando[1,2,3]

[1]al-Farabi Kazakh National University, Almaty, Kazakhstan
¶*[2]Instituto de Ciencias Nucleares, Universidad Nacional Autonoma de Mexico*
[3]Universitadi Roma "La Sapienza", I-00185 Roma, Italy

*e-mail: nurzada.beissen@gmail.com

Abstract

In this study, we explore a spherically symmetric exact solution of Einstein's gravity with a cosmological constant in (2 + 1) dimensions, where a scalar field is non-minimally coupled. This solution represents the gravitational field of a black hole devoid of curvature singularities throughout the entire spacetime. Using the framework of geometrothermodynamics, we examine the geometric properties of the corresponding space of equilibrium states and interpret these properties from a thermodynamic perspective. Our analysis reveals that the presence of thermodynamic interaction results in a curved equilibrium space with two possible configurations, determined by the value of a coupling constant. In the first configuration, the equilibrium space is entirely regular, indicating a stable thermodynamic system. The second configuration features two curvature singularities, which correspond to locations where the system experiences two distinct phase transitions: one arising from the failure of thermodynamic stability and the other due to a divergence in the response functions.

Keywords: geometrothermodynamics, black hole, equilibrium thermodynamics.

EXPLORING COMPACT OBJECT GRAVITATIONAL FIELDS WITHIN EINSTEIN'S GENERAL RELATIVITY FRAMEWORK

Authors: Amina Sadu[1]; Saken Toktarbay[1]

[1] *Al-Farabi Kazakh National University*

Corresponding Author: saduamina2003@gmail.com

In this research, we examine the gravitational behavior of dense astronomical bodies, specifically white dwarfs and neutron stars, using Einstein's gravitational theories. We explore the effects of deviations from spherical symmetry by applying a simplified mathematical model, incorporating the quadrupole moment to a first-order approximation 1.
Focusing on the interiors of white dwarfs, we use the Salpeter equation of state [2] to study how these stars maintain equilibrium between gravitational pull and internal pressure. We also compare the Chandrasekhar and Salpeter equations of state for ideal fluid solutions in general relativity to understand their influence on spherical objects.
This study provides new insights into the balance of forces within dense stars, enhancing our understanding of celestial mechanics under extreme conditions. Our future work will extend this analysis to non-spherically symmetric objects by adding parameters and refining the model for more accurate descriptions of complex geometries. This will improve our understanding of how different equations of state affect the properties and evolution of astrophysical objects in the universe.

High energy astrophysics / 457

Protoneutron star dynamos and magnetar formation

Authors: Alexis Reboul-Salze[1]; Jérôme Guilet[2]; Matteo Bugli[3]; Paul Barrère[2]; Raphaël Raynaud[4]

[1] *AEI*

[2] *CEA*

[3] *UniTO*

[4] *UPCité*

Corresponding Author: raphael.raynaud@cea.fr

Magnetars are isolated young neutron stars that exhibit the most intense magnetic fields known in the Universe and are characterized by a wide variety of high-energy emissions. The birth of rapidly rotating magnetars is also a promising scenario to power outstanding explosive transients. The formation process of these objects, as well as the origin of their ultra-strong magnetic fields, remains an open question, but the amplification of magnetic fields by MHD instabilities inside protoneutron stars seems inevitable. I will review the different dynamo scenarios that can explain magnetar formation, focusing on recent progress achieved with 3D-MHD HPC simulations, and discuss them in light of various observational constraints.

The SVOM mission in the time-domain era / 458

The SVOM mission for the study of the transient high-energy sources

Author: Andrea Goldwurm[1]

[1] *APC-Paris & CEA/IRFU-Saclay*