POSTER SESSION
“Fourth European Physical Society Conference on Gravitation: Black Holes”
Monday 13 November From 18:30 to 19:30

POSTER NUMBER: 1

“Thermodynamics of Black Holes with Born-Infeld-type Electrodynamics”

Speaker: Dr. Sharmanthie Fernando, Professor of Physics, Northern Kentucky University

In this work we present black holes with Born-Infeld type electrodynamics. There are two parameters to the theory and black holes could have up to two horizons. Thermodynamics is studied in the extended phase space where the pressure is proportional to the cosmological constant. First law and the Smarr formula are derived. There are phase transitions similar to Van der Waals liquid-gas phase transitions. Also, this black hole is studied as a heat engine.

This work is published in Modern Physics Letters A 36 (2021) 15, 2150102

Thermodynamics and Heat Engines of black holes in Born-Infeld type electrodynamics

Dr. Sharmanthie Fernando
Northern Kentucky University, Department of Physics, Geology, and Engineering Technology, USA

Abstract

In this work we present black holes with Born-Infeld type electrodynamics. There are two parameters to the theory and black holes could have up to two horizons. Thermodynamics is studied in the extended phase space where the pressure is proportional to the cosmological constant. First law and the Smarr formula are derived. There are phase transitions similar to Van der Waals liquid-gas phase transitions. Also, this black hole is studied as a heat engine. This work is published in Modern Physics Letters A 36 (2021) 15, 2150102. Co-author: Leo Balart.

Introduction to the black hole

$$S=\int d^4x\sqrt{-g}\left[\frac{(R-2\Lambda)}{16\pi G}+\mathcal{L}(\mathcal{F})\right]$$

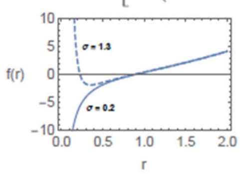
$$\mathcal{L}(F)=\beta^2\left[1-\left(1+\frac{\mathcal{F}}{\beta^2\sigma}\right)^{\sigma}\right]$$

Born Infeld electrodynamics when $\sigma=\frac{1}{2}$

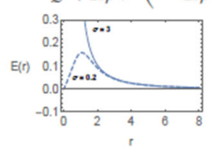
Black holes solutions

$$ds^2=-f(r)dt^2+\frac{dr^2}{f(r)}+r^2(d\theta^2+sin^2\theta d\phi^2)$$

$$f(r)=1-\frac{2M}{r}+\frac{r^2}{l^2}-\frac{2\beta^2r^2}{3}\left[{}_2F_1\left(-\frac{3}{4},-\sigma;\frac{1}{4};-\frac{Q^2}{2\sigma\beta^2r^4}\right)-1\right]$$



$$E(r)=\frac{2Qr^2\beta^2\sigma}{Q^2+2\sigma\beta^2r^4}\left(1+\frac{Q^2}{2\sigma\beta^2r^4}\right)^{\sigma}$$



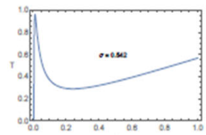
Thermodynamical quantities

Thermodynamics is studied in the extended phase space where the pressure is proportional to the cosmological constant.

Extended phase space

$$P=-\frac{\Lambda}{8\pi}$$

$$T=\frac{1}{4\pi}\left|\frac{df(r)}{dr}\right|_{r_+}=\frac{1}{4\pi r_+}\left[1+8\pi Pr_+^2+2r_+^2\beta^2\left(1-\left(1+\frac{Q^2}{2r_+^4\beta^2\sigma}\right)^{\sigma}\right)\right]$$



$$\Phi(r_+)=\int_{r_+}^{\infty}E(r)dr=\frac{\beta^2r_+^3}{2Q}\left[\left(1+\frac{Q^2}{2\sigma\beta^2r_+^4}\right)^{\sigma}-{}_2F_1\left(-\frac{3}{4},-\sigma;\frac{1}{4};-\frac{Q^2}{2\sigma\beta^2r_+^4}\right)\right]$$

$$V=\frac{4\pi r_+^3}{3}$$

$$S=\pi r_+^2$$

$$M(S,P,q,\beta)=\frac{\sqrt{S}}{6\sqrt{\pi}}\left[-\frac{2S\beta^2}{\pi}{}_2F_1\left(-\frac{3}{4},-\sigma;\frac{1}{4};-\frac{\pi^2Q^2}{2\sigma\beta^2S^2}\right)+8PS+\frac{2S\beta^2}{\pi}+3\right]$$

Mass is considered as enthalpy: M = U + P V

First law of thermodynamics

$$dM=TdS+\Phi dQ+VdP+Bd\beta$$

New thermodynamical quantity B:

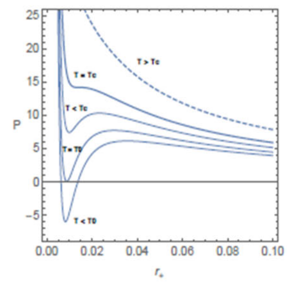
$$B=\left(\frac{\partial M}{\partial\beta}\right)_{S,q,P}=\frac{\beta r_+^3}{6}\left[4-{}_2F_1\left(-\frac{3}{4},-\sigma;\frac{1}{4};-\frac{Q^2}{2\sigma\beta^2r_+^4}\right)-3\left(1+\frac{Q^2}{2\sigma\beta^2r_+^4}\right)^{\sigma}\right]$$

Smarr formula

$$M=2TS-2VP+\Phi Q-B\beta$$

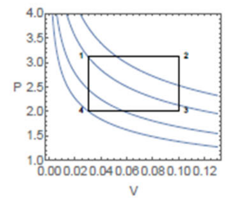
Equation of State

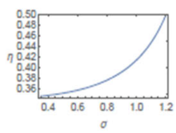
$$P=\frac{2r^2\beta^2\left[\left(1+\frac{Q^2}{2\sigma\beta^2r_+^4}\right)^{\sigma}-1\right]+4\pi r_+T-1}{8\pi r_+^2}$$



Van der Waals type of phase transition between small black holes and large black holes.

Black hole as a Heat engine





Efficiency

$$\eta=\frac{W_{net}}{Q_H}=1-\frac{M_3-M_4}{M_2-M_1}$$

References

1) S. I. Kruglov, Mod.Phys.Lett. A 32, no:36, 1750201 (2017)
2) L. Balart & S. Fernando, Mod. Phys. Lett A 36, no: 15, 2150102 (2021)

Acknowledgements

I would like to thank NKU Department of Physics, Geology, and Engineering Technology for its financial support.

POSTER NUMBER: 2

“Quantum gravity Effect in Binary Black Hole Merger”

Speaker: Parthasarathi Majumdar, Visiting Professor (after retirement), Indian Association for the Cultivation of Science, Kolkata, India

We present a semi-rigorous justification of Bekenstein’s Generalized Second Law of Thermodynam-ics applicable to a universe with black holes present, based on a generic quantum gravity formulation of a black hole spacetime, where the bulk Hamiltonian constraint plays a central role. Specializing to Loop Quantum Gravity, and considering the inspiral and post-ringdown stages of binary black hole merger into a remnant black hole, we show that the Generalized Second Law implies a lower bound on the non-perturbative LQG correction to the Bekenstein-Hawking area law for black hole entropy. This lower bound itself is expressed as a function of the Bekenstein-Hawking area formula for entropy. Using the analyses of LIGO-VIRGO-KAGRA data recently performed to verify the Hawking Area Theorem for binary black hole merger, this Loop Quantum Gravity-induced lower bound is shown to be entirely consistent with the data.

POSTER NUMBER: 3

“Beyond the Casimir Wormholes”

Speaker: Remo Garattini, Associate Professor, Università degli Studi di Bergamo

After a brief description of what is a traversable wormhole we describe the connection between traversability and the Casimir effect. With the help of an equation of state we also discuss different form of solutions generated by the Casimir source. Yukawa deformations and the addition of an electromagnetic field to the original energy density are also discussed.

POSTER NUMBER: 4

“Aspects of spontaneous symmetry breaking in Rindler and anti–de Sitter spacetimes for the O(N) linear sigma model”

Speaker: Haridev S R, Ph.D. Scholar, BITS Pilani Hyderabad Campus

The phenomenon of spontaneous symmetry breaking (SSB) is one of the cornerstone paradigms of modern physics. In this work, we address fundamental questions related to the role of observers and curvature in phase transitions associated with SSB. Our study involves scalar field theory with λφ4 interaction and the linear sigma model (LSM) at leading order in 1/N. Employing these models, we explore two distinct scenarios with different symmetry groups and perturbation approaches. The scalar field theory with λφ4 interactions involves a discrete Z2 symmetry and perturbation in small λ. At the same time, the LSM features a continuous N-dimensional rotation group O(N) and perturbation in 1/N , which includes a more non-linear structure. By general covariance, it is clear that a set of inertial observers would perceive the mechanism of SSB as universal. However, the situation is not so straightforward when we consider this phenomenon from the perspective of a uniformly accelerating observer. We demonstrate that the spontaneously broken symmetries can be restored from the viewpoint of an accelerating observer but only above a certain critical value of acceleration, thereby establishing that SSB is indeed an observer-dependent phenomenon. In the analysis, we introduce proper renormalization methods for calculating the one-loop effective potential in the Rinlder frame in arbitrary dimensions. Also, our findings support the ontic nature of the Unruh effect. To study the role of curvature, we focus on SSB in the Anti–de Sitter (AdS) space using LSM in the large N limit. We calculate a closed-form expression for the renormalized one-loop effective potential in various dimensions. In four-dimensional AdS space, the vacuum state of the theory is degenerate, and one needs to consider the global vacuum for studying SSB. We show that the O(N) symmetry is spontaneously broken in three-dimensional AdS space, and there is no SSB in four-dimensional AdS space for LSM in large N limit. As we have a quantum gravity theory in AdS space (AdS/CFT correspondence), our results may help better understand SSB using AdS/CFT correspondence.

POSTER NUMBER: 5

“Self-gravitating disks around rapidly spinning, tilted black holes: General-relativistic simulations”

Speaker: Milton Ruiz, , University of Valencia

We present general-relativistic simulations of self-gravitating black hole disks in which the spin of the black hole is significantly tilted with respect to the angular momentum of the disk. Such systems lead to black hole and disk precession, as well as to gravitational-wave emission via various modes beyond, but as strong as, the typical (2,2) mode. Our simulations suggest that any electromagnetic luminosity from our models may power relativistic jets, such as those characterizing short gamma-ray bursts. Depending on the black-hole-disk system scale the gravitational waves may be detected by LIGO/Virgo, LISA and/or other laser interferometers.

POSTER NUMBER: 6

"Simulations of magnetospheres of compact binary systems: study of approximate metrics and numerical implementation"

Speaker: Fabrizio Venturi Piñas, Investigador en Formación, Universidad de Valencia

In Compact binary systems, when at least one of the objects is a neutron star, a magnetosphere with tenuous plasma and intense magnetic fields is expected. In these environments due to the interaction between the plasma and the dynamic of the binary system part of the kinetic energy can be channeled to produce electromagnetic signals. ONION simulates the evolution of these binary systems in the last orbits before merger. With the code one can study the dynamic of plasma in a background space-time which is represented by a given metric. In the lasts simulations of binary black hole/ neutron star system made with ONION the curvature of the black hole was only taken into account in the background space-time, whereas the curvature of the neutron star wasn't taken into account. The aim of this work is to explore approximated metrics which represents the curvature of both objects. Then study the validity of these approximated metrics and implement the most representative metric in ONION to study how the curvature of the neutron star affects the properties of the magnetosphere which surrounds the system.

POSTER NUMBER: 7

"Gravitational Particle Production and Black Hole Evaporation"

Speaker: Michael Florian Wondrak, Radboud Universiteit Nijmegen, Holland

POSTER NUMBER: 8

“On the Generalization of the Kruskal-Szekeres Coordinates: A Global Conformal Charting of the Reissner–Nordström Spacetime”

Speaker: Mohamed, Student, SUNY at Buffalo

The Kruskal-Szekeres coordinates construction for the Schwarzschild spacetime could be viewed geometrically as a squeezing of the t-line associated with the asymptotic observer into a single point, at the event horizon $r=2M$. Starting from this point, we extend the Kruskal charting to spacetimes with two horizons, in particular the Reissner-Nordström manifold, $\mathcal{M}_{RN}$. We develop a new method for constructing Kruskal-like coordinates and find two algebraically distinct classes charting $\mathcal{M}_{RN}$. We pedagogically illustrate our method by constructing two compact, conformal, and global coordinate systems labeled $\mathcal{GK_{I}}$ and $\mathcal{GK_{II}}$ for each class respectively. In both coordinates, the metric differentiability can be promoted to C^∞. The conformal metric factor can be explicitly written in terms of the original t and r coordinates for both charts.

POSTER NUMBER: 9

“New black holes in General Relativity: Ehlers symmetries and Type I revolution.”

Speaker: Adolfo Cisterna, Researcher, Charles University, Institute of Theoretical Physics

In this talk we present a new family of algebraically general (Type I) black holes in Einstein-Maxwell theory. These solutions are constructed via the Ernst description of stationary and axially symmetric spacetimes in General Relativity, which allows to disclose, the otherwise hidden, Ehlers and Harrison maps, two Lie points symmetries of the Einstein-Maxwell system that allows for the construction of novel geometries starting from known spacetime seeds. We present the largest Type I generalisation of the Plebanski-Demianski metric (Type D), here dubbed as Enhanced-Plebanski-Demianski. This family is found by composing Ehlers and Harrison maps and studying their algebraic properties.

Then, we focus on two relevant sub cases: Accelerating Reissner-Nordstrom-Taub-NUT and Accelerating Rotating-NUT-Charged black holes.

We close by showing avenues to further explore these novel geometries.

This talk is based on the following two articles:

Phys.Rev.D 108 (2023) 2, 024059 • e-Print: 2305.03765 [gr-qc]

e-Print: 2309.13656 [gr-qc]

POSTER NUMBER: 10

“A new sub-grid model for magnetohydrodynamical turbulence”

Speaker: Miquel Miravet-Tenés, PhD student, Universitat de València

Insufficient numerical resolution of grid-based, direct numerical simulations (DNS) hampers the development of instability-driven turbulence at small (unresolved) scales. As an alternative to DNS, sub-grid models can potentially reproduce the effects of turbulence at small scales in terms of the resolved scales, and hence can capture physical effects with less computational resources. In this talk I will present the MHD-instability-induced-turbulence (MInIT) mean-field model, which is based on the evolution of the turbulent kinetic energy density.

POSTER NUMBER: 11

“Extreme mass-ratio inspirals into black holes surrounded by scalar clouds”

Speaker: Shreya Shah, , University of Tübingen

We study extreme mass-ratio binary systems in which a stellar mass compact object spirals into a supermassive black hole surrounded by a scalar cloud. Scalar clouds can form through superradiant instabilities of massive scalar fields around spinning black holes and can also serve as a proxy for dark matter halos. Our framework is fully relativistic and assumes that the impact of the cloud on the geometry can be treated perturbatively. As a proof of concept, here we consider a point particle in circular, equatorial motion around a non-spinning black hole surrounded either by a spherically symmetric or a dipolar non-axisymmetric scalar cloud, but the framework can in principle be generalized to generic black hole spins and scalar cloud geometries. We compute the leading-order power lost by the point particle due to scalar radiation and show that, in some regimes, it can dominate over gravitational-wave emission. We confirm the presence of striking signatures due to the presence of a scalar cloud that had been predicted using Newtonian approximations, such as resonances that can give rise to sinking and floating orbits, as well as “sharp features” in the power lost by the particle at given orbital radii. Finally, for a spherically symmetric scalar cloud, we also compute the leading-order corrections to the black-hole geometry and to the gravitational-wave energy flux, focusing only on axial metric perturbations for the latter. We find that, for non-compact clouds, the corrections to the (axial) gravitational-wave fluxes at high frequencies can be understood in terms of a gravitational-redshift effect, in agreement with previous works.

POSTER NUMBER: 12

“Follow-up Analyses to the O3 LIGO-Virgo-KAGRA Lensing Searches”

Speaker: Ángel Garrón, Justin Janquart, Mick Wright, Srashti Goyal, Juno C. L. Chan, Apratim Ganguly, David Keitel, Alvin K. Y. Li, Anna Liu, Rico K. L. Lo, Anuj Mishra, Anupreeta More, Hemantakumar Phurailatpam, Prasia Pankunni, Sylvia Biscoveanu, Paolo Cremonese, PhD student, Universitat de les Illes Balears

Gravitational waves have become a useful tool for studying the physics, formation, and evolution of black holes. Just as electromagnetic signals, they may be gravitationally lensed by massive objects. Searches for lensing effects on signals observed in the current detector network have already been carried out, though with no confident detections yet. In this work, we present follow-up analyses and strategies to assess the significance of such events and what information may be extracted about the lens-source system, applying them to candidates from the LIGO-Virgo-KAGRA O3 run, regardless of their probable unlensed nature. For strongly-lensed candidates, we verify their significance using a background of simulated unlensed events and statistics computed from lensing catalogs. We also showcase how one can look for electromagnetic counterparts and analyze a candidate for a strongly-lensed sub-threshold counterpart identified by a new method. For microlensing candidates, we perform model selection on several lens models to investigate our ability to determine the lens mass profile and constrain the lens parameters. We also look for millilensing signatures in one lensed candidate. Applying these analyses does not lead to additional evidence for lensing, but provides important insight into avenues to deal with significant candidates in future observations and demonstrates how lensed gravitational waves could be used as a new tool for studying black holes.

POSTER NUMBER: 13

“Study of Schwarzschild-Euler Equation in Gullstrand-Painlevé coordinates”

Speaker: Samuel Santos-Pérez, Substitute Teacher, Universitat de València

In this work, we investigate the Euler Equation within the Schwarzschild spacetime, employing Gullstrand-Painlevé coordinates. These coordinates enable us to cross the event horizon of a black hole. Our analysis focuses on understanding the characteristic curves by computing the Riemann invariants and wave speeds, culminating in the determination of the stationary solutions. These stationary solutions, in turn, serve as a foundation for the development of well-balanced methods, akin to what was achieved by LeFloch in 2016, employing Schwarzschild coordinates for the Euler Equation. It turns out that Schwarzschild coordinates impose constraints on the numerical radial domain, necessitating it to be strictly greater than the Schwarzschild radius. Our use of Gullstrand-Painlevé coordinates affords us the entire spatial domain, mitigating this constraint. Well-balanced methods for balanced laws have demonstrated their formidable efficacy, particularly in the presence of stationary solutions. They exhibit a remarkable ability to numerically recover these solutions or capture their behavior in the face of perturbations with a level of precision that surpasses other numerical schemes treating the fluxes differently. In the pursuit of developing these methods, it is highly advantageous to possess analytical expressions for the stationary solutions of the system of partial differential equations under consideration. Our investigation encompasses the exploration of all conceivable types of stationary solutions and the derivation of a well-balanced method tailored for the Schwarzschild-Euler Equation.

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POSTER NUMBER: 14

"Thermodynamics of the universes admitting isotropic radiation"

Speaker: Salvador Mengual, PhD Student, Universitat de València

The perturbation theory of the Friedmann-Lemaître-Robertson-Walker models seems to provide a good explanation of the observed degree of inhomogeneity in the universe, but the structure and evolution of galaxies, clusters, and voids require an analysis outside of the perturbative regime. They are often modeled by Newtonian N-body computations. However, the nonlinear effects of the Einstein field equations could be critical in the structure formation, and many studies have been devoted to providing exact inhomogeneous models for studying the formation of structures and for analyzing the effect of the nonlinear inhomogeneities on the cosmic microwave background radiation.

A family of such exact inhomogeneous models is that of the conformally flat solutions of the Barnes-Stephani metrics, the Stephani universes. They can also be characterized as the space-times verifying a weak cosmological principle without any hypothesis on the energy tensor. In this talk, the thermodynamic interpretation of the Stephani Universes is studied in detail. The general expression of the speed of sound and of the thermodynamic schemes associated with a thermodynamic solution is obtained. The constraints imposed on the solutions by considering some significant physical properties are analyzed. We focus on the models where the cosmological observer measures isotropic radiation. We consider some examples, and a solution that models an ultra-relativistic gas is analyzed in detail.

POSTER NUMBER: 15

"The Space Production Model of General Relativity"

Speaker: Richard Bowen, University of S. Carolina

Starting from the proviso that general relativity is the valid theory of gravitation, we propose that matter has the intrinsic property of permanent space emission and represents dark energy. We set up a matter model and derive its equation of state. Both matter and volume expansion remain tightly linked through the energy-momentum conservation law and the key-assumption of strict proportionality of the respective energy densities in time, associated with a two-component fluid model. In essence, the so-introduced 'Space Production Model' (SPM) posits that both 'matter' and 'dark energy' are two manifestations of the same entity. One realization of SPM leads to a fluid analogy of a scalar field matter model that is minimally coupled to gravity, and that resides in permanent virial equilibrium. This implies a constant ratio of 1/3 of matter energy and 2/3 of dark energy. While SPM causes expansion in the homogeneous case, it causes contraction in the inhomogeneous case. The implications regarding black holes are interesting. The mass of a black hole's singularity is associated with a specific volume thereby eliminating the infinite density associated with singularities. In this scenario, the event horizon is represented as the distance from the singularity whereby the rate of space emission has slowed to the speed of light. While we expect the positive curvature to remain, it is countered by the negative curvature from the singularity's emission of space. This prevents anything, including light, from crossing the event horizon, thereby eliminating the information paradox.

POSTER NUMBER: 16
“Quasinormal modes and shadow in Einstein Maxwell power-Yang-Mills black hole”
Speaker: Angel Rincon, Distinguished researcher, University of Alicante

In the present talk, we investigate the quasinormal modes of an Einstein-Maxwell power-Yang-Mills black hole in four dimensions, considering a specific value of the power parameter $p = 1/2$. This particular case represents a black hole with both Abelian and Non-Abelian charges and is asymptotically non-flat. We derive the effective potential for a neutral massless particle using the aforementioned black hole solution. Subsequently, employing the sixth-order WKB approximation method, we calculate the (scalar) quasinormal modes. Our numerical analysis indicates that these modes are stable within the considered parameter range. This result is also confirmed using the eikonal approximation. Furthermore, we calculate the shadow radius for this class of black hole and derive constraints on the electric and Yang-Mills charges ($Q,Q_{\rm YM}$) by using imaging observational data for Sgr A*, provided by the Event Horizon Telescope Collaboration. We observe that as the electric charge Q increases, the allowed range shifts towards negative values of $Q_{\rm YM}$. For instance, for the maximum value $Q\approx 1.1$ obtained, the allowed range becomes $-0.171 \lesssim Q_{\rm YM} \lesssim -0.087$ consistent with KECK and VLTI data, while still retaining a non-vanishing horizon.

POSTER NUMBER: 17
“Unraveling the Connection: Eccentric Binary Black Holes and Microlensed Signals”
Speaker: Anuj Mishra, Research Scholar (PhD student), The Inter-University Centre for Astronomy and Astrophysics (IUCAA)

We investigate potential biases in gravitational wave (GW) microlensing searches when the source is an eccentric binary black hole system. Microlensing searches help us constrain compact dark matter, while studying the eccentric population can shed light on the formation mechanisms of binary black holes. Despite originating from different astrophysical phenomena, our research demonstrates that microlensed templates outperform quasi-circular unlensed templates in recovering eccentric signals. Both the fitting factor and Bayesian analyses indicate that the preference for microlensing recoveries increases with higher eccentricities, longer waveforms, and higher signal-to-noise ratios. Lastly, we show that using eccentric recoveries can break degeneracy in the case of eccentric signals, underscoring the need for eccentric analysis before claiming any erroneous microlensing effects.

POSTER NUMBER: 18

“Models for gravitational waves of neutron star merger remnants”

Speaker: Theodoros Soultanis, postdoctoral researcher, GSI Darmstadt

We discuss two template models for the gravitational waves emitted by neutron star merger remnants. Such models are critical for gravitational wave data analysis and thus the detection and parameter estimation of neutron star merger events. We introduce an analytic model for the post-merger phase GW emission which is based on the various oscillation modes of the remnant. We assess the model's performance in terms of fitting factors (FFs) using a sequence of equal-mass simulations of varying mass. All parameters of the analytic model correlate with the total binary mass of the system. Lastly, we present results of a new post-merger GW template model which is based on supervised learning techniques. To construct this model, we created the largest ever library of GW signals for a single equation of state (EOS), with 150 simulations of binary neutron star mergers.

POSTER NUMBER: 19

“Magnetized accretion disks around Yukawa-like black holes: initial data and numerical evolutions”

Speaker: Sergio Gimeno-Soler, Postdoctoral researcher, University of Aveiro

The Yukawa black hole solution is a non-rotating black hole exact solution that appears when a certain class of f(R) theories of gravity is considered. This solution depends on three parameters (mass, length scale and strength of the modification) and it reduces to the standard Schwarzschild solution when the parameter controlling the strength of the modification is set to zero. In this talk, I will describe how the equilibrium configurations of thick accretion disks built on top of the metric are affected by the deviations from GR. After that, I will present new results on the time evolution of magnetized accretion disks around different Yukawa BH models.

POSTER NUMBER: 20

“Collapse of a neutron star into a black hole under scalar-tensor theories of gravity”

Speaker: Jose Carlos Olvera Meneses, PhD student, Tübingen University

In this work, we investigate the phenomenon of neutron star collapse into a black hole within the framework of modified theories of gravity, exploring the consequences of departures from General Relativity (GR), specifically, under massive scalar-tensor theories that allow for scalarization in order to understand the effect of these modifications in the astrophysical process. To accomplish this, we employ advanced numerical techniques and high-performance computing to accurately model the dynamics of the star's core as it approaches the critical density for collapse and the posterior stage when the black hole is formed. We will also compute the gravitational radiation and compare our findings with observational data to constrain the parameters of these alternative gravity theories.

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POSTER NUMBER: 21

"Delayed collapse of hypermassive neutron stars"

Speaker: Paweł Szewczyk, , University of Warsaw

After a binary neutron star merger or a core-collapse of a massive star, the remnannt can collapse to a black hole if its mass is too high. However, due to temporary differential rotation in the freshly formed neutron star, it can be stabilized for some time, delaying the collapse. This may lead to adittional gravitational wave emission after the main event.

We present results of a numerical study of stability of hypermassive neurton stars, showing what properties we could expect from such objects. We discuss the limits of dynamical stability of hypermassive neutron stars against a prompt collapse to a black hole. We study stability against quasi-radial and non-axisymmetrical perturbations.

POSTER NUMBER: 22

"Cerenkov radiation from a moving, charged black hole"

Speaker: Anslyn John, Lecturer, Stellenbosch University

A charged particle traveling at a constant velocity in a dielectric will emit Cerenkov radiation if its speed is greater than the speed of light in the medium. We consider the possibility of Cerenkov radiation from a moving Reissner-Nordstrom black hole. A Lorentz-invariant formulation of Maxwell's equations in a material medium, as opposed to a vacuum, is presented. We outline a procedure to generalize this formalism to curved spacetimes. We discuss the form of the inhomogeneous Maxwell equations and a relativistic version of the Frank-Tamm formula describing the energy spectrum.

POSTER NUMBER: 23

"IMPRS-GW in Hannover"

Speaker: Fumiko Kawazoe, Education Manager, AEI Hannover

The International Max Planck Research School on Gravitational Wave Astronomy started in 2006. It began as a structured educational program for doctoral students in the AEI. It won extension proposals twice and is now in the final phase. I will show what we have achieved in the past 17 years and what lies beyond our future.