Gravitational Physics and Astronomy

Sunday, December 4, 2022 - Friday, December 9, 2022

Book of Abstracts

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Gravitational slip parameter and Gravitational Waves in Modified Gravity theories

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Despite the discovery of late-time accelerated expansion of the universe, we still have no clue about the physics behind that. Therefore, the answer might be lied in Modified Gravity theories. A modification in geometric structure of space-time causes noticeable differences in gravitational waves equation compared to the known form of gravitational waves in general relativity.
Various gravity theories have two general phenomenological effects at the level of linear and scalar perturbation:
1. A modification of the strength of gravity at large scales
2. An alteration of the weak gravitational lensing effect
Measurement of the two aforementioned effects allows us to obtain gravitational slip parameter η; which is the ratio of two scalar gravitational potentials $\eta=\Phi/\Psi$.
The existence of gravitational slip parameter ($\eta\neq1$) in the presence of perfect fluid matter is a clue of a modification in gravity. In addition, this parameter is a model independent quantity which distinguishes the groups of gravity models. In this research, we study the gravitational slip parameter and gravitational waves equation in the context of theories including torsion, such as Einstein-Cartan theory.

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Superfluids and local gravitational field

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We discuss the possible coupling between a superfluid and the local gravitational field. After introducing a quantum-gravity theoretical framework to describe the supercondensate-graviton coupling, we exploit an effective theory for generalized Maxwell-type fields to analyze quantum effects originating from the proposed interplay.

From an experimental point of view, it had been shown that generalized electric-type fields can be induced in (super)conductors by the presence of the Earth's weak gravitational field. These observations led to the theoretical, formal introduction of an effective modified electric-type field, determining detectable corrections to the free fall of charged particles.
The above remarkable experimental results can be combined to the theoretical weak-field gravity formulation, leading to a more general definition of new, generalized electromagnetic fields. The latter feature a component defined in terms of the weak gravitational perturbations, and satisfy a specific set of equations that can be put in a form closely analogous to Maxwell's equations.
The latter symmetry is then exploited to analyse the gravity/supercondensate interplay, the new generalized fields being involved in quantum effects originating from the interaction with the weak gravitational background (in analogy to what happens for gravity-induced electric fields in superconductors).
In particular, the emerging formal symmetry allows to use the Ginzburg–Landau model for the description of the physics, resulting in a mean-field theory for the system's thermodynamics, including the effects of thermal fluctuations. We then quantitatively analyse how the local gravitational field

could couple to the superfluid condensate in a superconductor, making use of the time-dependent Ginzburg–Landau equations in the regime of fluctuations.

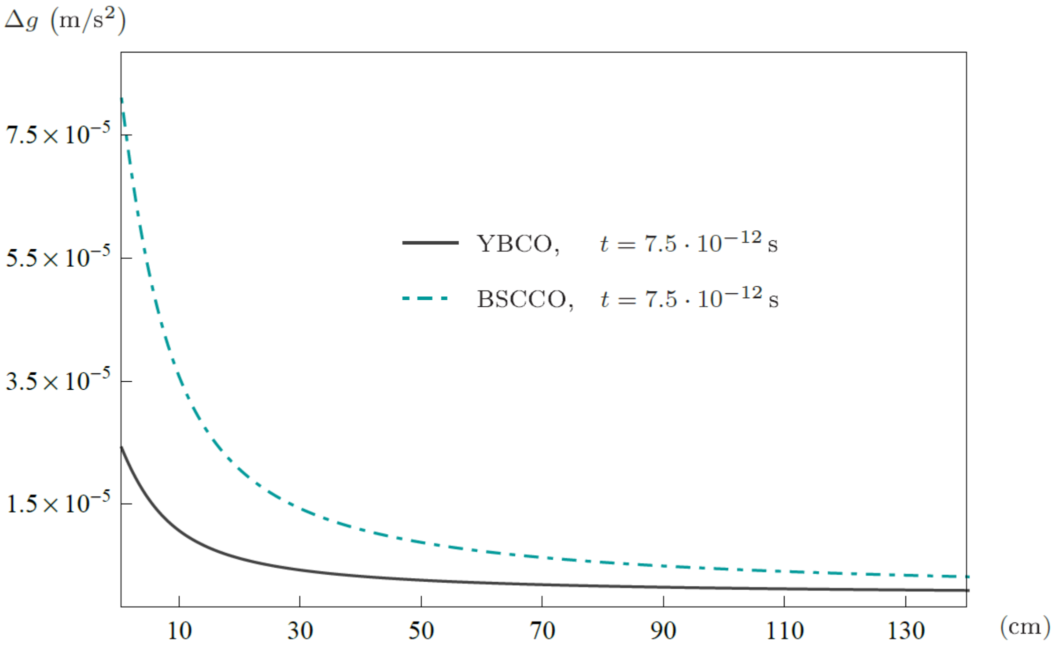

Figure 1: local field alteration

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Two-body freefall time in a matter dominant expanding universe

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Predicting freefall time is a major problem in galactic dynamics. The relaxation time of collisionless dark matter, which heavily influences galaxy evolution, is closely related to its freefall time. Calculating freefall time using Kepler's Third Law does not consider the effects of the universe's expansion. This paper proposes a new formula for calculating freefall time in an expanding background. The derivation of the formula starts from the governing equations of an N-body system in an expanding background. Two-body simulations were run using equations of motion with constant damping (to represent the effects of expansion) derived from the N-body equations. More than 5,200 different two-body systems with different separation distances, mass, and damping were simulated. The simulated freefall time was compared with good agreement against the proposed formula. The results demonstrate that two-body freefall time is dependent on the time at which collapse began. The earlier it began, the longer the freefall time. A weak gravitational attraction, caused by the small mass of the system or the great distances involved, exacerbates this effect. The galaxy that started to form earlier is expected to take longer to form. A better understanding of freefall time can lead to greater insight into galaxies' historical and future evolution.

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The informational physical model and fundamental physical prob-

lems

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This article is some review of results that were obtained at 2007-2021 years development of "The Information as Absolute" concept and the informational physical model, which is based on the concept; including a number of fundamental physical problems are briefly considered in framework of the conception and the model. Recently in physics there are several publications, that present lists of the problems. However, those lists are essentially incomplete, for at least two reasons. Firsts of all, a number of phenomena are studied traditionally by philosophy, and so corresponding problems are usually considered to be "metaphysical". However, they relate also to some concrete physical phenomena. For example, physics evidently studies Matter, and so the metaphysical problems "what is ontology of Matter", "what is "Space", "Time" and a few other physical phenomena and notions as well, are really a Meta-physical problem "what does physics study?" There are other fundamental physical problems, which are not considered as such in physics, and are absent in the "fundamental problems lists". Those include the problems, which really exist, yet are incorporated into standard physical theories, and so are fundamental "implicitly", which in physics are "solved by default". Note, though, that a number of "Meta-physical", and concrete fundamental, problems more in detail are considered in the paper "The Informational Conception and Basic Physics", https://arxiv.org/abs/0707.4657 , v5 (2021), so this paper is, in certain sense, an expanded conclusion of this paper, which includes, correspondingly, more in detail consideration of some more general physical problems. Besides, the concrete problem "What is Life", and the rational cosmological model, where a few vague points in standard cosmology rather probably are rationally clarified, while the fundamental problem "matter – antimatter asymmetry" in Matter is solved practically for sure, are considered, and one of recently published rather complete "lists of fundamental problems" is commented in Appendix.

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Eikonal quasinormal modes and photon orbits of deformed Schwarzschild black holes

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The geometric optics approximation provides an interpretation for eikonal correspondence that, in black-hole-containing spacetimes, connects high-frequency black hole quasinormal modes with closed photon orbits around said black hole. This correspondence has been identified explicitly for several GR black holes, violation of which can be a potential hint toward physics beyond GR. However, the identification of the correspondence seems largely relies on specific symmetries of the spacetimes that correspond to the separability of equations. One naturally asks how the eikonal correspondence would appear if the spacetime is less symmetric. In this talk, we consider a deformed Schwarzschild spacetime retaining only axisymmetry and stationarity. We show that up to the first order of spacetime deformations, the eikonal correspondence manifests through the definition of the averaged radius of trapped photon orbits along their one period. This averaged radius overlaps the potential peak in the master wave equation, which can be defined up to the first order of spacetime deformations, allowing the explicit identification of the eikonal correspondence. The talk is based on arXiv:2205.02433.

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The Gravitational Memory Effect

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In this dissertation we intend to study the background related to the memory effect that leads to "gravitational-wave memory effect" and two types of memory effect:(1) We intend to study a whole outline of what is memory effect.(2) We intend to solve the linear memory for N Gravitationally Unbound Particles where we will study different kinds of spherical harmonics,mass quadrapole leading to linear memory effect.\begin{equation}
\boxed{ {\Delta{h^{TT}*{jk}}}=\triangle{{\sum*{A=1}^{N}}}{\frac{4M_{A}}{r{\sqrt{1-v^{2}*{A}}}}[\frac{v^{j}*{A}v^{k}*{A}}{1-{{v*{A}.N}}}]^{TT}}}
\end{equation}(3)Then we try to examine the memory effect for the individual radiated neutrinos\cite{mukhopadhyay20
\begin{equation}
{h^{xx}*{TT}}={h(r,t)}={\frac{2G}{rc^{4}}{\int^{t-r/c}*{{-\infty}}}dt'L_{\nu}(t')}{\alpha(t')}
\end{equation}
(4) Then we will discuss briefly about the introduction of non linear memory effect.

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Energy spectrum for elementary particles

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This is an unified theory by using an energy model to explain mass, called the energy spectrum. To explain this theory, a multidimensional concept will be projected on plots. The energy spectrum model can explain from quantum level to universe level physic behaviors.

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The Gravitational Memory Effect

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In this dissertation we intend to study the background related to the memory effect that leads to "gravitational-wave memory effect" and two types of memory effect:(1) We intend to study a whole outline of what is memory effect.(2) We intend to solve the linear memory for N Gravitationally Unbound Particles where we will study different kinds of spherical harmonics,mass quadrapole leading to linear memory effect.

$$\Delta h_{jk}^{TT} = \triangle\sum_{A=1}^{N} \frac{4M_A}{r\sqrt{1-v_A^2}}[\frac{v_A^j v_A^k}{1-v_A.N}]^{TT}$$

(3)Then we try to examine the memory effect for the individual radiated neutrinos citemukhopadhyay2021memory h$_{TT}^{xx} = h(r,t) = \frac{2G}{rc^4}\int_{-\infty}^{t-r/c} dt' L_\nu(t')\alpha(t'), wherecisthespeedoflight, tisthetimep$
is the all-flavors neutrino luminosity α is the time-varying anisotropy parameter as mentioned in

\cite{mukhopadhyay2021neutrino}
(4) Then we will discuss briefly about the introduction of non linear memory effect.

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Gravitational entropy, cosmology and black holes

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The Weyl curvature hypothesis by Penrose describes the evolution of the universe according to the second law of thermodynamics using a form of gravitational entropy, described by the Weyl curvature tensor. Using this, the evolution of the universe is guided by a monotonically increasing Weyl curvature, and the proposal has several conditions, one of them being that the gravitational entropy reduces to the Hawking-Bekenstein entropy for black holes. In this talk, we will discuss some of the aspects of this proposal, formalisms and their structure wihh to respect to cosmology and black holes.

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Scalar Particles Creation by an External Electric Field in a Non-Commutative Space-time

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The phenomenon of scalar particles creation in a non-commutative space-time when an electric field is present, is analyzed. Our purpose is to study the effect of the electric field on the creation of particles from vacuum. We have used the Bogoliubov transformation technique to calculate the number density of the spin-0 created particles in a non-commutative space-time , it is necessary to specify the asymptotic behavior of " in " and " out " vacuum states. This method based on the exact mode functions.
According to the formalism of Klein-Gordon equation in non-commutative space-time, We investigated the mechanism of particles production from the solutions which are in terms of special functions. The results have been interpreted.
The obtained results confirm the fact that particle creation is a property of curved space-time, Our aim in the future is to study the process of Dirac particles creation in non-commutative spaces.

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The detection of gravitational waves new approach

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The gravitational waves appear as wave solution for the Einstein's equations of General Relativity. They were predicted by Einstein in 1916. These ripples of space time are generated by the punctual acceleration of matter in the Universe. The existence of gravitational waves was confirmed by the study of the Binary Pulsar PSR 1913+16 in 1980s. The first experimental discovery was on September 14, 2015, by the collaboration LIGO-Virgo, staging the fusion of two black holes. After a theoretical and historical description of the actual scientific research, we will propose a new detection method that is based on the presence of an electromagnetic field via several examples of applications.