Grav07: Congreso de Relatividad y Gravitación

La Falda, Córdoba

lunes 5 al miércoles 7 de noviembre, 2007

I. PROGRAMA

	Lunes	**Martes**	**Miércoles**
09:00-09:50	Diego Mazzitelli	Miguel Socolovsky	Ernesto Eiroa
09:55-10:45	Saulo Carneiro	Oscar Reula	Gustavo Dotti
10:45-11:10	C A F É		
11:10-12:00	Jorge Zanelli	Robert Geroch	Héctor Vucetich
12:05-12:55	Rafael Ferraro	Reinaldo Gleiser	Ricardo Troncoso
13:00-15:00	A L M U E R Z O		
15:00-15:40	Julio Oliva	Steve Willison	Florian Beyer
15:45-16:25	Hideki Maeda	Emanuel Gallo	Alex Giacomini
16:30-17:00	C A F É		
17:00-17:25	Lucila Kraiselburd		Cecilia Garraffo
17:30-17:55	Martín Richarte		Leonardo Amarilla

II. RESÚMENES

1. **Backreaction in trans-Planckian cosmology: renormalization, trace anomaly and self-consistent solutions**
Francisco Diego Mazzitelli

In the context of Quantum Field Theory in Curved Spaces, we analyze the semiclassical Einstein equations for scalar fields satisfying modified dispersion relations. We first discuss in detail the renormalization procedure based on adiabatic subtraction and dimensional regularization. Then we analyze the dependence of the trace of the renormalized energy momentum tensor with the scale of new physics, and we recover the usual trace anomaly in the appropriate limit. We also find selfconsistent de Sitter solutions for dispersion relations that contain up to the fourth power of the

momentum. Using this particular example, we also discuss the possibility that the modified dispersion relation can be mimicked at lower energies by an effective initial state in a theory with the usual dispersion relation.

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2. **Non-singular inflation with vacuum decay**
Saulo Carneiro

On the basis of a semi-classical analysis of vacuum energy in an expanding spacetime, we describe a non-singular cosmological model in which the vacuum density decays with time, with a concomitant production of matter. During an infinitely long period we have an empty, inflationary universe, with $H \approx 1$. This primordial era ends in a fast phase transition, during which H and Λ decrease to nearly zero in a few Planck times, with release of a huge amount of radiation. The late-time scenario is similar to the standard model, with the radiation phase followed by a long dust era, which tends asymptotically to a de Sitter universe, with vacuum dominating again. An analysis of the redshift-distance relation for SNe Ia, baryonic acoustic oscillations, the position of the first peak of CMB anisotropies and the mass power spectrum leads to cosmological parameters in agreement with current observations.

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3. **TBA**
Jorge Zanelli

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4. **Solutions for Born-Infeld field equations**
Rafael Ferraro

Born-Infeld theory is a non-linear electrodynamics which departs from Maxwell's electromagnetism for large values of the fields. We will show some solutions of Born-Infeld equations: i) a wave propagating in a background field (the propagation velocity is lower than c and the ray does not coincide with the wave vector), ii) a wave propagating in a waveguide (the dispersion relation depends on the amplitude), iii) the electrostatic multipoles in two dimensions, iv) the corrections to the Coulombian interaction between two charges. Some of these solutions are worked out by means of a suitable non-holomorphic transformation of the complex plane.

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5. **Generalized Misner-Sharp quasi-local mass in Einstein-Gauss-Bonnet gravity**
Authors (speaker): Hideki Maeda* and Masato Nozawa*

We investigate properties of a quasi-local mass in the higher- dimensional spacetime which has a symmetry corresponding to the isomerty of an $(n-2)$-dimensional maximally symmetric space in Einstein-Gauss- Bonnet gravity in the presence of a cosmological constant. The quasi- local mass was recently defined by one of the authors as a counterpart of the Misner-Sharp quasi-local mass in general relativity. The quasi- local mass is found to be a quasi-local conserved charge associated with a locally conserved current constructed from the generalized Kodama vector and exhibits the

unified first law corresponding to the energy- balance law. In the asymptotically flat case, it reduces to the Arnowitt-Deser-Misner mass at spacelike infinity. Under the dominant energy condition, we show the monotonicity of the quasi-local mass for any k, while the positivity is shown for $k = 1$ and for $k = 0$ with an additional condition, where $k = \pm 1, 0$ is the constant sectional curvature of each spatial section of equipotential surfaces. We also classify all the vacuum solutions by utilizing the generalized Kodama vector. Lastly, several conjectures on further generalization of the quasi-local mass in Lovelock gravity are proposed.

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6. **The breaking of the Equivalence Principle in theories with variable α**
Authors (speaker): Lucila Kraiselburd*, Hector Vucetich*

The standard model (SM) of fundamental interactions together with general relativity (GR) provides a consistent description of low-energy phenomena. It is possible to have results in good agreement with experiment by using a set of parameters called *fundamental constants*, which are reference-frame invariant. However, since 1937 when Dirac introduced his large-number hypotesis (LNH), theorical and experimental scientists have been studying the variations of fundamental constants, developing theories and methods to find restrictions to these possible changes. Some of them are: the comparison of atomic clocks, geophysics methods[3], quasars analysis, etc. Unifying schemes such as Kaluza-Klein, GUT and superstring theories predict space-time and simultaneous constants variations. This idea plays an important role in many science fields such as:

- Astronomy and cosmology,where the red shifts measures are obteined from the ¨past¨, so the view of the Universe is going to be different. Some other modifications appear too, orbits, radius, inertia´s moments, etc.
- Physics, the variations could give an explanation to the dynamics of the high energy and extra-dimensions theories. It is a good way to test the WEP. Although these variations are supposed to be very small, the effects should take modifications to other sciences like anthropology, chemistry, biology, etc.

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7. **Exact solutions for the Einstein-Gauss-Bonnet theory**
Authors (speaker): Gustavo Dotti, Julio Oliva* & Ricardo Troncoso*

The classification of certain class of static solutions for the Einstein-Gauss-Bonnet theory in vacuum is performed. The class of metrics under consideration is such that the spacelike section is a warped product of the real line with a nontrivial base manifold. It is shown that for generic values of the coupling constants the base manifold must be necessarily Einstein with an additional restriction containing its Weyl tensor. It is also shown that the base manifold admits a wider class of geometries for the special case when the Gauss-Bonnet coupling is properly tuned in terms of the cosmological and Newton constants. This freedom in the metric at the boundary, which determines the base manifold, allows the existence of three main branches of geometries in the bulk containing black holes and brand wormholes in vacuum.

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8. **Thin shell wormholes supported by ordinary matter in Einstein Gauss Bonnet gravity**
Authors (speaker): Martín Richarte, Claudio Simeone*

The generalized Darmois-Israel formalism within Einstein Gauss Bonnet theory is applied to construct thin-shell Lorentzian wormholes with spherical symmetry. We calculate the energy localized on the shell, and we find that for certain values of the parameters wormholes could be supported by matter not violating the energy conditions.

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9. **On Einstein-Podolsky-Rosen (EPR): Geometry, influence at a distance**
Miguel Socolovsky

We discuss: i) The modification at a distance of the probability distributions in individual events (collapse of the wave function), which, however, does not violate causality, so mantaining Quantum Mechanics as a complete, non local, causal and non separable theory. ii) Some geometrical aspects of this phenomenon.

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10. **The Einstein equations, boundaries and integration by parts**
H.-O. Kreiss, O. Reula, O. Sarbach, J. Winicour*

In recent work, we used pseudo-differential theory to establish conditions that the initial-boundary value problem for second order systems of wave equations be strongly well-posed in a generalized sense. The applications included the harmonic version of the Einstein equations. Here we show that these results can also be obtained via standard energy estimates, thus establishing strong well-posedness of the harmonic Einstein problem in the classical sense.

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11. **Faster than Light?**
Robert Geroch

It is widely believed that relativity – both special and general – requires that no physical signal can travel at a speed exceeding that of light. Indeed, there are well-known arguments to the effect that the assumption that there could be superluminal signals gives rise to certain paradoxes. We suggest that this situation is not nearly as clear-cut as it might appear at first sight. Indeed, we shall argue that relativity is virtually as viable and self-consistent as a physical theory in the presence of superluminal signals as it is with such signals excluded.

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12. **Late time tails in the Kerr spacetime**
Authors (speaker): Reinaldo Gleiser*, Jorge Pullin & Richard Price*

Outside a black hole perturbation fields die off in time as $1/t^n$. For spherical holes $n = 2\ell + 3$ where ℓ is the multipole index. In the nonspherical Kerr spacetime there is no coordinate-independent meaning of "multipole", and a common sense viewpoint has set ℓ to the lowest radiatiable index, although theoretical studies have led to very different claims. Numerical results, to date, have been controversial. Here we show that expansion for small Kerr spin parameter a leads to very definite numerical results confirming previous theoretical analyses.

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13. **Some exact solutions with torsion in 5-D Einstein-Gauss-Bonnet gravity**
Authors (speaker):F. Canfora, A. Giacomini* & Steven Willison*

Exact solutions with torsion in Einstein-Gauss-Bonnet gravity are derived. These solutions have a cross product structure of two constant curvature manifolds. The equations of motion give a relation for the coupling constants of the theory in order to have solutions with nontrivial torsion. This relation is not the Chern-Simons combination. One of the solutions has a $AdS_2 \times S^3$ structure and is so the purely gravitational analogue of the Bertotti-Robinson space-time where the torsion can be seen as the dual of the covariantly constant electromagnetic field.

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14. **Extraction of gravitational radiation and global physical quantities at finite distances in numerical generated spacetimes**
Authors (speaker): Emanuel Gallo*, Luis Lehner & Osvaldo M. Moreschi*

We study the difficulties found in numerical representations of spacetimes, where the gravitational radiation and total momentum is estimated at finite distances.

We point out several possible problems arising from gauge and tetrad ambiguities. We indicate how to remove these freedom.

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15. **Wormholes with a Chaplygin gas**
Authors (speaker): Ernesto F. Eiroa * y Claudio Simeone*

Wormholes are solutions of gravitational theory which consist of two regions joined by a throat, usually giving a multiple connected topology. In general relativity theory, these kind of solutions have the characteristic that they require the presence of exotic matter, which violates the usual energy conditions. In this talk, spherical thin shell wormholes with exotic matter in the form of a Chaplygin gas will be considered, with an analysis of their stability under perturbations preserving the symmetry. It will be shown that there are geometries for which exist stable solutions for some values of the parameters.

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16. **Static black hole solutions with a self interacting conformally coupled scalar field**
Authors (speaker): Gustavo Dotti*, Reinaldo J. Gleiser, Cristian Martinez*

We study the space of static, spherically symmetric black hole solutions of the Einstein equations with a positive cosmological constant and a conformally coupled self interacting scalar field. Exact solutions for this model found by Martínez, Troncoso, and Zanelli, (MTZ), were subsequently shown to be unstable under linear perturbations. We characterize the space of static, spherically symmetric solutions with a regular horizon that satisfy the weak and dominant energy conditions outside the horizon. The results obtained provide an explanation for the instability of the MTZ spacetimes.

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17. **Lorentz Violation in Quantum Gravity theories**
Héctor Vucetich

We show through simple examples that if there exists Lorentz symmetry violations at the Planck scale, such as those that may originate in Quantum Gravity Theories, radiative corrections would produce unsupressed Lorentz violations at the usual scale of QED.

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18. **Static wormholes in vacuum and charged without charge**
Authors (speaker): Julio Oliva, José David Tempo, Ricardo Troncoso* & Roberto Troncoso*

A static spherically symmetric wormhole solution for conformal gravity in vacuum is found, whose neck connects two static homogeneous universes of constant spatial curvature. Time runs at different rates on each side of the neck. The extension with radial electric or magnetic fields is also found, and it turns out to have "charge without charge". The solutions can be further generalized to the case of necks with genus greater than one. It is shown that the wormholes in vacuum correspond to the matching of different Einstein spacetimes by means of improper conformal transformations.

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19. **Numerical investigations of cosmological solutions of Einstein's field equations**
Florian Beyer

To a large extent, the global properties of solutions of Einstein's field equations are not understood. Recently, the fruitful interplay between rigorous analytical analysis and numerical simulations has

helped to shed some light on outstanding fundamental conjectures about general relativity in the cosmological setting, including strong cosmic censorship and the BKL-picture. However, most of these results are restricted to special classes of spacetimes. In particular, the

Gowdy case with spatial 3-sphere topology and the Gowdy class with a non-vanishing cosmological constant are, apart from a limited number of results, still open. In my talk I present results of new numerical

investigations of some outstanding cases, after having discussed necessary background material.

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20. **Some exact solutions with torsion in 5-D Einstein-Gauss-Bonnet gravity**
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Exact solutions with torsion in Einstein-Gauss-Bonnet gravity are derived. These solutions have a cross product structure of two constant curvature manifolds. The equations of motion give a relation for the coupling constants of the theory in order to have solutions with nontrivial torsion. This relation is not the Chern-Simons combination. One of the solutions has a $AdS_2 \times S^3$ structure and is so the purely gravitational analogue of the Bertotti-Robinson space-time where the torsion can be seen as the dual of the covariantly constant electromagnetic field

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21. **Wormhole Solutions in Einstein Theory Coupled to a Gauss-Bonnet Term**
Authors (speaker): C.Garraffo (*), G.Giribet, E.Gravanis and S.Willison.*

We study junction conditions in five-dimensional Einstein theory coupled to a Gauss-Bonnet term. We show that this theory admits solutions that represent spherically symmetric vacuum shells that connect two spaces with different curvature. In particular, we show that vacuum wormhole-like solutions arise in this theory. For certain region of the space of parameters these solutions turn out to be unstable and this enables us to prove the existence of a new kind of classical instability that appears in Lovelock theory of gravity. The issues of uniqueness, staticity and determinism in the dynamical evolution will be also mentioned.

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22. **Brane-world cosmology and varying G.**
Authors (speaker): Leonardo Amarilla (*), Héctor Vucetich, Gastón E. Giribet*

We study a cosmological model in which a 3+1-dimensional hypersurface is embedded in a 5-dimensional space-time with negative curvature (bulk), and is coupled to a scalar field.The set-up is Randall-Sundrum like, with one of the two branes placed at infinity, and a non compact extra dimension. In this scenario, the brane tension is not constant and depends on the scalar field. Our Universe could be a 3-brane, where the Standard Model gauge fields are confined, while the scalar and gravity are free to explore the bulk. In this context, the brane potential is proportional to G, and depends on the scalar field. Time variation of G is predicted, and model parameters are constrained with observational data.
