CURRICULUM VITAE
Teófilo Vargas Auccalla

Contact Information:

- Permanent Address: Facultad de Ciencias Físicas
  Universidad Nacional Mayor de San Marcos
  Lima–Peru.
- e-mail: teofilo.vargas@gmail.com

Personal Information:

- Date of Birth: March 1th, 1966.
- Nationality: Peruvian.
- Marital Status: Married.

Research Interests:

- Traversable wormholes in Anti de Sitter space-time
- Cosmology: Cyclic cosmology and cosmological hysteresis.
- Quantum Cosmology: Quantum creation of a cosmology with nontrivial topology in both the Hartle-Hawking boundary condition and Vilenkin's tunneling prescription.

Professional Experience:

- 10/2015-Present, responsible of the Theoretical Physics Group "Grupo de Física Teorica" (GFT).
- 10/2015-Present, responsible of the astronomy group "Seminario Permanente de Astronomía y Ciencias Espaciales" (SPACE).
- 05/2019-Present, Full professor, Facultad de Ciencias Físicas, Universidad Nacional Mayor de San Marcos, Lima-Peru.
- 10/2018-05/2019, Associate professor, Facultad de Ciencias Físicas, Universidad Nacional Mayor de San Marcos, Lima-Peru.
- 10/2014-10/2018, Adjunct professor, Facultad de Ciencias Físicas, Universidad Nacional Mayor de San Marcos, Lima-Peru.

- 04/2010-10/2014, Temporary full time professor, Facultad de Ciencias Físicas, Universidad Nacional Mayor de San Marcos, Lima-Peru.
- 11/2006-07/2008, PostDoctoral Fellow, Department of Physics, National Central University, Department of Physics, Chungli - Taiwan.
- 12/2005-10/2006, PostDoctoral Fellow, Instituto de Ciências Exactas, Universidade Federal de Itajubá MG-Brasil.
- 09/2002-08/2005, PostDoctoral Fellow, Instituto de Física Teórica IFT-UNESP, SP-Brazil.

Education:

- 1998-2002, Instituto de Física Teórica, IFT-UNESP-Brazil, Ph. D. in Physics.
- 1995-1998, Moscow State University "M. V. Lomonosov" Moscow-Russia, M. Sc. in Physics and Mathematics.
- 1990-1995, Moscow State University "M. V. Lomonosov" Moscow-Russia, B. S. in Physics and Mathematics.

Languages:

- Spanish: Native Language.
- English: Speaker, Reader and Writer.
- Russian: Speaker, Reader and Writer.
- Portuguese: Speaker, Reader and Writer.
- Chinese: Basic Level.

Research Award:

- 2006-2008, Recipient of a PostDoctoral Fellowship, TNSF, Chungli-Taiwan.
- 2005-2006, Recipient of a PostDoctoral Fellowship, FAPEMG, MG-Brazil.
- 2005-2006, Recipient of a PostDoctoral Fellowship, FAPESP, SP-Brazil.
- 1998-2002, Recipient of a Doctoral Fellowship, CAPES, SP-Brazil.

Scientific Publications:

1. T. Vargas, *Quantum cosmology with nontrivial topology*, *AIP Conference Proceedings* **1059**, 48, (2008).

2. J. M. Nester, L. L. So & T. Vargas, *Quasi-local energy-momentum of homogeneous cosmological models*, *Phys.Rev.D* **78**, 044035, (2008).

3. L. L. So & T. Vargas, *The energy of the Bianchi type I and II universes in teleparallel gravity*, *Chin. J. Phys.*, **43**,901-908, (2005).

4. Yu. N. Obukhov & T. Vargas, *Gödel type solution in teleparallel gravity*, *Phys. Lett. A*, **327**, 365–373 (2004).

5. T. Vargas, *The energy of the universe in teleparallel gravity*, *Gen. Rel. Grav.*, **36**, 1255–1260 (2004).

6. J.G. Pereira & T. Vargas, *Regge calculus in teleparallel gravity*, *Class. Quantum Grav.*, **19**, 4807–4816 (2002).

7. J.G. Pereira, T. Vargas & C.M. Zhang, *Axial-vector torsion and teleparallel Kerr spacetime*, *Class. Quantum Grav.*, **18**, 833–841 (2001).

Work in Progress:

1. T. Vargas and C. Rivera, *Charged traversable wormhole in AdS*

2. A. Toporensky and T. Vargas, *Cyclic cosmology with non-minimal coupling scalar field.*

Other Publications:

1. Helio V. Fagundes & T. Vargas, *Quantum cosmology with nontrivial topology*, WSPC-Proceedings *11th Marcel Grossmann Meeting on General Relativity*, 1933-1935, (2006) Berlin-Germany.

Academic References:

- Professor José G. Pereira (thesis advisor)
  Instituto de Física Teórica, IFT-UNESP-Brazil.

- Professor James M. Nester
  Department of Physics, National Central University
  Chungli 320 Taiwan.

- Professor Yuri N. Obukhov
  Department of Theoritical Physics, Moscow State University
  Moscow 117234 Russia.

Short description of research accomplishments and publication list

Teófilo Vargas Auccalla

During the study of my doctorate and the first post doctorate ($1998 - 2006$) I studied and developed the applications of teleparallel gravity to different astrophysical and cosmological models, whose results were the first five publications. During my second and third postdoctoral studies I worked on the problems related to the non-trivial topology of the universe in quantum cosmology and the two results were published. During the third post doctorate at National Central University in Taiwan in the group of Professor James M Nester, I continued with problems of topology in quantum cosmology and the calculation of energy for different cosmological models of the Bianchi type, and the result was also published.

In 2010 I started working at the department of physics of the National University of San Marcos and adapting took time. Since 2011 I have been responsible for the astronomy group and had the opportunity to prepare the talks for students and general public every Friday on different topics of astrophysics and cosmology, which we now exchange with different recently incorporated colleagues. Parallel to these activities, I had the opportunity to implement and teach the courses of General Relativity, Classical Field Theory and Quantum Field Theory for undergraduate students interested in theoretical physics and now are mandatory courses for all students interested in theoretical physics and high energies physics. In 2014, the theoretical physics group was formed and since 2017 it has been a research group of the university and receives funding by competition to develop undergraduate theses and other activities.

With the incorporation of new professors both to the astronomy group and to the theoretical physics group, since last year I have resumed my research work essentially in two problems, namely in the cyclic model of the universe and traversable wormholes in AdS. The Asia-Pacific Economic Cooperation Young Scientist Training (APEC YST) program offered by your prestigious institution, not only will enhance and reshape my research activity far form administrative and other bureaucratic activities, but especially allow me to interact with researches of the center and it will be beneficial for future academic and cultural collaborations and exchanges between our institutions and countries.

1. T. Vargas, *Quantum cosmology with nontrivial topology*, *AIP Conference Proceedings* **1059**, 48, (2008).

2. J. M. Nester, L. L. So & T. Vargas, *Quasi-local energy-momentum of homogeneous cosmological models*, *Phys.Rev.D* **78**, 044035, (2008).

3. L. L. So & T. Vargas, *The energy of the Bianchi type I and II universes in teleparallel gravity*, *Chin. J. Phys.*, **43**,901-908, (2005).

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Other Publications:

1. Helio V. Fagundes & T. Vargas, *Quantum cosmology with nontrivial topology*, WSPC-Proceedings *11th Marcel Grossmann Meeting on General Relativity*, 1933-1935, (2006) Berlin-Germany.

Work in Progress:

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2. A. Toporensky and T. Vargas, *Cyclic cosmology with non-minimal coupling scalar field.*

Research Program

T. Vargas

Facultad de Ciencias, Universidad Nacional de Ingenieria, Lima-Peru.

Charged Traversable Wormhole in AdS and Cyclic Cosmology

The entanglement is one of the most basic features of quantum mechanics, with no classical equivalent, as it is a characterization of the spatial correlations between parts of a quantum system, where the measurement of one part of the entangled system affects the measurement of the other parts [1]. For finite dimensional systems, the quantitative measure of the amount of entanglement in a system, or more exactly between two subsystems, is the entanglement entropy (EE) or geometric entropy (von Neumann entropy) that quantifies the difference of the entropy of a system with respect to a pure state. In recent years, the notion of EE has been widely used to investigate the general characteristics of quantum phases in the physics of condensed matter [2] and in quantum field theory (QFT) [3]. In addition, in the context of the correspondence or duality of Anti-Sitter / Conforming Field Theory (AdS / CFT) [4], a geometric interpretation for the EE of the CFT has been proposed, with its respective dual gravitational interpretation [5].

The area theorem proposed by Bekenstein and Hawking showed that the area of a black hole never decreases, giving a result similar to that obtained with the second law of thermodynamics, in which entropy never decreases. It was shown that not only does a black hole have an entropy, which is proportional to the area of its horizon, but that the entropy of the black hole is a quarter of the area of its horizon measured in units of Planck. This analogy led to the conclusion that gravity produces fundamental limitations on how information can be densely packed: if we try to squeeze too much entropy into a region too small, the entire system will collapse into a black hole. Thus, here a new concept emerges: if the entropy of any object is limited by its area, then the correct fundamental theory must be one whose number of degrees of physical freedom are proportional to your area and not your volume. This conclusion is not intuitive, since the world we observe is local, and the degrees of freedom at different points in space-time are independent. This motivated the holographic principle conjecture: the world is a hologram and generally all information that is contained in a volume of space can be represented by information that resides on the border of that region [6]. Maldacena extended the Holographic Principle within the string theory for asymptotically anti-Sitter spacetime, called Maldacena's conjecture or AdS / CFT correspondence (Anti-De Sitter / Conforming Field Theory) which states: The complete string theory in the AdS space is exactly dual to a conformal field theory living at the boundary of AdS.

It is well known that wormhole solutions to Einsteins equations connecting two asymptotically different regions of spacetime cannot be used to travel form one of the regions to the other since traversable wormholes are forbidden in classical general relativity [7]. Their existence would require an violation of the Average Null Energy Condition (ANEC) usually achieved by including exotic matter [8]. Recently the authors [9] considered the scenario of an eternal black hole with two asymptotically AdS boundaries and proposed a mechanism that evades the assumptions of the theorems forbidding ANEC violation. They showed that, semi-classically, including a deformation that couples both boundaries modifies the causal structure rendering the geodesics chronal and ANEC can be violated without contradicting any known theorem, which means that if ANEC is violated the wormhole becomes traversable. In this context, the previous result was extended to rotating eternal black hole in three dimensions case [10]. Recently, it was proposed the possibility of experimental realization of a traversable wormhole [11].

In the present project it is proposed to carry out a systematic study of traversable wormhole in the space-time of charged BTZ. The importance of the charge has already been addressed previously in the case of black holes in AdS by [12]. The main objective of the present work is to analyze the ANEC roll and the correlation function in the passable condition of the charged wormholes, specifically, how the size of the wormhole and the amount of information transferred depends from the charge.

Another problem we would like to address in this project is to investigate, following the works [12], the arrow of time without any relation to the evolution of entropy in cyclic cosmology. The effects of vector fields are analyzed, during the processes of expansion or contraction of the Universe instead of scalar fields (inflaton). It will be demonstrated that these vector fields, respecting the conditions of homogeneity and isotropy, can dominate the kinematics of the Universe in a similar way as the scalar fields do. In particular, it will be shown that the presence of the fields Vector during a Big Bounce can naturally produce an inflationary period during which the Universe expands rapidly, as has been proposed in modern cosmological models [14]. As a complement to this, the importance of understanding anisotropic cosmological models for the study of the early universe serves as a basis for the continuation of vector field case. The influence of this spatial anisotropy on cyclic cosmological models emerges as an open problem. Our specific work will be to calculate its influence on the production of cosmological hysteresis. To develop this work, we will rely on the study of the metrics of Bianchi and Kantowski-Sachs [15] in the presence of a scalar field and then compare it with the results already obtained in case of a homogenous and isotropic cosmological model.

References

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[14] Vargas T. Carbajal S. (2019). Vector inflation in oscillating universe. (In preparation)

[15] Bali, R., Jain, V. C. (2002). Pramana, 59(1), 1-7; Adhav, K. S., Bansod, A. S., Wankhade, R. P., Ajmire, H. G. (2011). Central European Journal of Physics, 9(4), 919-925.