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1 Curriculum vitae

MSc. Pavel Klepáč, Ph.D.

Personal data:	born 13 August 1976 in Brno, Czech Republic
Education:	1994 School–leaving exam
	1994–1999 student at Masaryk University Brno
	1999 Master degree in physics diploma thesis: "Closed timelike curves in charged Gödel universes" (supervisor prof. J. Horský)
	1999–2002 PhD student at Institute of Theoretical Physics, Faculty of Science, Masaryk University
	2002 PhD degree in Theoretical Physics and Astrophysics PhD thesis: "Chronology violation, charged perfect fluid and exact solutions of Einstein's equations" (supervisor prof. J. Horský)
Student staying:	University of Aberdeen, Scotland, January–February 2002
Jobs:	2003 research worker at Inst. Theoret. Phys. & Astrophys.
	Holder of grant No. 202/03/P113 of Grant Agency of Czech Republic "Higher–dimensional spacetimes in string cosmology"
Research interests:	General relativity, its overlap with string theory, relativistic and string cosmology, quantum theory, differential geometry and topology
Conferences and schools:	Contribution on "4. Mathematical physicists meeting", Krnov 1999
	Contribution on "8–th International Conference on Differential Geometry and its Applications", Opava 2001
	Poster presented on "EURESCO Conference on Particle Physics and Gravitation", Bad Herrenalb 2002
	"Summer school Mathematical structure of general relativity", Levoča 2000
	"Triangle graduate school in particle physics", Prague 2000

"Summer school 50 years of Cauchy problem in general relativity", Cargese 2002
Poster presented on "Hyperbolic Models in Astrophysics and Cosmology", Cambridge 2003

Contribution on "7–th Hungarian Relativity Workshop", Sarospatak 2003

Contribution on "Mathematics of Gravitation II", Warszaw 2003

Poster presented on "17–th Conference on General Relativity and Gravitation", Dublin 2004

Seminars: Relativistic seminar at Charles University, Prague

Relativistic seminars at Masaryk University

Educational experience: 1999–2000 "Tutorials from Mathematical analysis I"

2000–2001 "Problems from Theoretical Physics"

2003 Tutorials from "Advanced quantum mechanics"

2003 Tutorials from "Electrodynamics and Relativity Theory"

2003–2005 "Tutorials from Mathematical Analysis I and II"

2003 "Relativistic seminar" – semester lecture at Brno University of Technology

2004 Tutorials from "Quantum Electrodynamics"

Awards: Physical Section of the Faculty of Science Award 1999

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2 List of publications

[1] P. Klepáč and J. Horský, "Closed timelike curves in charged universes of the Gödel–type", *Class. Quant. Grav.* **17**, 2547 (2000)

[2] P. Klepáč and J. Horský, "Charged perfect fluid and scalar field coupled to gravity", *Czech. J. Phys.* **51**, 1177 (2001)

[3] P. Klepáč, "On spacetimes with 3–parameter isometry group in string–inspired theory of gravity", *Proc. 8-th Conf. Dif. Geom. Appl.*

[4] P. Klepáč and J. Horský, "A cylindrically symmetric solution in Einstein–Maxwell–dilaton gravity", *Gen. Rel. Grav.* **34**, 1979 (2002)

[5] P. Klepáč, "On a solution in Einstein–Maxwell–dilaton gravity", in *Proceedings of the 8–th Hungarian Relativity Workshop* (Akadémiai Kiadó, Budapest 2004)

[6] P. Klepáč, "On a solution in Einstein–Maxwell–dilaton cosmology", in *Proc. of Conf. Mathematics of Gravitation II*, Warszaw 2003

[7] J. Geršl, P. Klepáč and J. Horský, "A charged rotating cylindrical shell", *Gen. Rel. Grav.* **46** 1399 (2004)

[8] P. Klepáč, J. Horský, "Relativity Theory and the Global Position System", (in czech) *Czech. J. Phys.* **53**, 320 (2003)

[9] "Models of string cosmology", (in czech), a chapter in J. Horský, J. Novotný and M. Štefaník, *Introduction to Physical Cosmology* (Academia, Prague 2004)

3 Research Experience statement

Rotating stationary cylindrically symmetric spacetimes (at least of unegligible part of them) are characteristic by violation of some of the chronology conditions, i.e. there appear closed timelike curves. Therefore it is natural to address a question whether the chronology could be protected in the framework of modern unified theories. In a series of publications [1-7] the results rotating cylindrically symmetric spacetime filled with a charged perfect were summarized.

In [1] in the fluid rest frame the electromagnetic field was a superposition of radial electric and longitudinal magnetic fields, so the Lorentz force generally did not vanish. The solutions that have been found were divided into two classes.

Since in my PhD thesis I investigated these solutions in the string theory framework, my further effort concerned with a generalization to the case when additional massless scalar field were present in the spacetime. Some partial results were discussed in [2].

Further progress continued in two directions. First, it was an incorporation of a modified action following from string theory. From more recent results it can be mentioned that the second class solution in [1] is essentially also stringy solution [4]. Secondly, one can attempt to involve more scalar fields (dilaton, axion and possibly additional fields) [3, 4]. This subject has been extended in further contributions [5-6].

From later activities, together with J. Geršl we examined behavior of a rigidly rotating cylindrical shell. The shell has been obtained by matching Bonnor–Melvin solution (interior) to Datta–Raychaudhuri spacetime (exterior) [7]. Furthermore, two last publications are in czech. The first one has to do with string theory, and it is actually a chapter in a book devoted to (relativistic) cosmology and braneworlds [9]. The second one, a reviewing paper on GPS just reflects my interests in a wide context of general relativity [8].

References

See the part List of publications

4 Research Proposition

My current attempts are related to an important question of the gravitational entropy and generally the entropy of a physical system in a curved background. This is because my main interest is an application of the covariant entropy bound (phenomenological point of view) and the holographic principle to solutions of field equations (in particular Einstein equations, e.g. Gödel solution), that admit cosmological interpretation.

It is promissible direction, since a deeper understanding of these conjectures would certainly affect an understanding of string theory and QFT as well. The holographic principle could have a number of consequences in general relativity and its overlap with string theory. For instance, returning to Gödel solution, which is well known for the time travel possibility, one way how to resolve the causality in Gödel spacetime without an artificial cutting etc., is to find an holographic screen and show that it shields an observer from closed timelike curves. This was carried out in paper [1], in which the authors studied an inertial observer moving along the time axis. But a question arises whether the shielding by the preferred screens have to occur also for a non–inertial observer, in particular, an observer moving along a closed timelike curve.

To answer the question constitutes one of my most interesting current goals. From my computations which I have performed up to date, it seems that it need not be necessary the case. In connection with holographic screens I have also conjectured in [2] a relationship which should hold in this particular class of metrics, namely between a critical radius for closed timelike curves and a radial location of a holographic screen (a ratio of these radii is saturated e. g. for Gödel spacetime). But these two works are still in progress.

My further interest relies in solutions of supergravity field equations. Recently, in [3], a solution has been found within framework of minimal supergravity, which exhibits maximal supersymmetry. Searching for solutions within SUGRA is an attractive task for many researchers, since it is interesting in itself, and moreover, it is important also from string point of view.

Contemporary I also collaborate with J. Geršl as it was already mentioned. It concerns the junction conditions and matching of spacetimes. So far we have analysed a classical general relativistic stationary system, but we would like to push our attempts further, to brane–world cosmology, where the junction conditions are naturally employed.

Finally, let me mention that I collaborate with another colleague on behavior of null geodesic congruences in solutions in Einstein–Maxwell–dilaton gravity [4]. This work should continue and extend former contribution [5].

There are several further subjects which would, according to my opinion, deserve attention. Let me recall just one point. In connection with recent speculations concerning the fate of black strings and branes which are extended in a compact dimension [7, 6] it would be interesting to study solutions to Einsteins equations in higher dimensions which are periodic in one of the coordinates. This could answer the questions about which is the final state for an instable black string wrapped on a compact dimension.

References

[1] E. Boyda, S. Ganguli, P. Horava, U. Varadarajan *Phys. Rev.* **D67** (2003) 106003

[2] P. Klepáč contribution to *17–th Int. Conf. on Gen. Rel. Grav.*

[3] J. P. Gauntlett, J. B. Gutowski *Phys. Rev.* **D68** (2003) 105009

[4] P. Klepáč and J. Horský *Gen. Rel. Grav.* **34** 1979 (2002)

[5] P. Klepáč in *Proc. 7–th Hungarian Relativity Workshop* (Akadémiai Kiadó, Budapest 2004)

[6] G. Horowitz and K. Maeda *Phys. Rev. Lett.* **87** 131301 (2001)

[7] R. Gregory and R. La *Phys. Rev. Lett.* **70** 2837 (1993)