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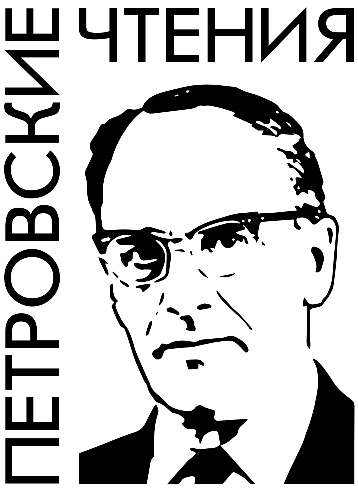

4-я Международная зимняя школа-семинар по гравитации, космологии и астрофизике «Петровские чтения-2018»

Программа и тезисы докладов

4th International Winter School-Seminar on gravity, cosmology, and astrophysics «Petrov School-2018»

Program and Abstracts

Казань, 2018

УДК 530.12+521

4-я Международная зимняя школа-семинар по гравитации, космологии и астрофизике «Петровские чтения-2018». Программа и тезисы докладов международной научной школы-семинара. — Казань: Изд-во КФУ, 2018. – 64 с.

Сборник содержит программу и тезисы докладов участников 4-ей Международной зимней школы-семинара по гравитации, космологии и астрофизике «Петровские чтения-2018». В материалах представлены работы ведущих специалистов и начинающих исследователей из научных центров России, ближнего и дальнего зарубежья, посвящённые исследованиям в ОТО и модифицированных теориях гравитации, теоретической и наблюдательной космологии, релятивистской астрофизике. Международная зимняя школа-семинар проходила в Казанском университете с 26 ноября по 1 декабря 2018 года.

Сборник адресован научным работникам, аспирантам и молодым ученым, специализирующихся в области теории гравитации, космологии и астрофизики, а также для студентов старших курсов естественнонаучных направлений.

Школа-семинар «Петровские чтения-2018» проводится за счет средств субсидии, выделенной в рамках государственной поддержки Казанского (Приволжского) федерального университета в целях повышения его конкурентоспособности среди ведущих мировых научно-образовательных центров. Проведение «Петровских чтений-2018» нацелено на реализацию научно-образовательных задач в рамках стратегической академической единицы «Астровызов».

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СОДЕРЖАНИЕ

medium version of the Pound-Rebka experiment in gravity. This parallel lends validity to the "effective medium" approach. The probability of stability of a certain object is redefined in terms of reflection (R) and transmission (T) coefficients of the perturbations hitting the throat or horizon. Our conclusion is that there is a non-zero probability that EB and phantom wormholes could appear stable or unstable depending on the *location of observers*, leading to the possibility of *ghost wormholes* (similar to ghost stars). Schwarzschild horizon, however, would always appear stable ($R = 1$, $T = 0$) to observers independently of their locations. Phantom wormholes of bounded mass in the extreme limit $a \to -1$ are also shown to be stable just as the Schwarzschild black hole is. We shall propose a thought experiment showing that our non-deterministic results could be numerically translated into observable deterministic signatures of ghost wormholes.

References

1. H.G. Ellis, J. Math. Phys.**14**, 104 (1973); **15**, 520(E) (1974).
2. K.A. Bronnikov, Acta Phys. Polon. B **4**, 251 (1973).
3. J.A. González, F.S. Guzmán and O. Sarbach, Class. Quant. Grav. **26**, 015010 (2009).
4. J.A. González, F.S. Guzmán and O. Sarbach, Class. Quant. Grav. **26**, 015011 (2009).
5. F.S. N. Lobo, F. Parsaei and N. Riazi, Phys. Rev. D **87**, 084030 (2013).
6. S.V. Sushkov, Phys. Rev. D **71**, 043520 (2005).
7. K. K. Nandi, A. A. Potapov, R. N. Izmailov, A. Tamang, and J. C. Evans, Phys. Rev. D 93, 104044 (2016).

VACUUM POLARIZATION OF A QUANTIZED SCALAR FIELD IN THE THERMAL STATE IN A LONG THROAT

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The study of vacuum polarization effects in strong gravitational fields is a pertinent issue since such effects may play a role in the cosmological scenario and the construction of a self-consistent model of black hole evaporation. These effects may be taken into account by solving the semiclassical backreaction equations,

$$G^\mu_\nu = 8\pi \langle T^\mu_\nu \rangle, \tag{1}$$

where $\langle T^\mu_\nu \rangle$ is the expectation value of the stress-energy tensor operator for the quantized fields.

The main difficulty in the theory of semiclassical gravity is that the effects of the quantized gravitational field are ignored. The popular solution for this problem is to justify ignoring the gravitational contribution by working in the limit of a large number of fields, in which the gravitational contribution is negligible. Another problem is that the vacuum polarization effects are determined by the topological and geometrical properties of spacetime as a whole or by the choice of quantum state in which the expectation values are taken. It means that the calculation of the functional dependence of $\langle T^{\mu}_{\nu}\rangle_{ren}$ on the metric tensor in an arbitrary spacetime presents formidable difficulty. Only in some spacetimes with high degrees of symmetry for the conformally invariant fields $\langle T_{\mu\nu}\rangle_{ren}$ can be computed and equations (1) can be solved exactly [1–5]. Let us stress that the single parameter of length dimensionality in such a problem is the Planck length l_{Pl}. This implies that the characteristic scale l of the spacetime curvature (which correspond to the solution of equations (1)) can differ from l_{Pl} only if there is a large dimensionless parameter. As an example of such a parameter one can consider a number of fields, the polarization of which is a source of spacetime curvature [1]. For the quantized scalar field such a parameter can be the coupling constant ξ of scalar field to the curvature of spacetime. In the case of $|\xi| \gg 1, \xi < 0$ the vacuum fluctuations of a quantized scalar field can determine the curvature of spacetime so-called *a long throat* [6].

In this work we have shown that in a long throat the effect of vacuum polarization of a quantized scalar field in the thermal state does not depend on temperature and conditions at infinity. This implies that in considered situation $\langle\varphi^2\rangle$ is a local quantity for any finite mass m of the quantized field, including $m = 0$.

References

1. Starobinsky A. A. *A new type of isotropic cosmological models without singularity* // Phys. Lett. B – 1980. – Vol. 91. – Is. 1. – p. 99-102.

2. Mamaev S. G., Mostepanenko V. M. *Isotropic cosmological models determined by vacuum quantum effects* // Sov. Phys.–JETP 1980. – Vol. 51 (1). – p. 9-13.

3. L. A. Kofman, V. Sakhni, and A. A. Starobinskii *Anisotropic cosmological model created by quantum polarization of vacuum* // Sov. Phys.–JETP 1980. – Vol. 58 (6). – p. 1090.

4. Kofman L. A., Sahni V. *Hew self-consistent solution of the Einstein equations with one-loop quantum gravitational corrections* // Phys. Lett. B – 1983. – Vol. 127. – p. 197-200.

5. Kofman L. A., Sahni V. *Some self-consistent solutions of the Einstein equations with one-loop quantum gravitational corrections:* $G_{ik} = 8\Pi G < T_{ik} >_{vac}$ // Phys. Lett. A – 1986. – Vol. 117. – p. 275-278.

6. Popov A. A. *Long throat of a wormhole created from vacuum fluctuations* // Classical and Quantum Gravity – 2005. – Vol. 22. – № 24. – p. 5223-5230.

1 Here and below it is assumed, of course, that the characteristic scale of change of the background gravitational field is sufficiently greater than l_{Pl} so that the very notion of a classical spacetime still has some meaning.