Oscillatory solutions in cosmological models and in a centrally symmetric space in a modified theory of gravity

Farkhat Zaripov*
N. Lobachevsky Institute of Mathematics and Mechanics, Kazan Federal University, 35 Kremlievskaia st., Kazan, 420008, Russia

PACS numbers:

Abstracts for the report

This work is related to research in the field of the theory of gravity and cosmology in connection with existing problems given below.

1.There is a problem of "accuracy of measurement of the gravitational constant" G. For example, in the International System of Units (SI), for 2008: $G = 6,67428 \times 10^{-11} m^3 c^{-2} kg^{-1}$; the value of the gravitational constant was obtained in 2000 (Cavendish Experiment): $G = 6,67390 \times 10^{-11}$; in 2010, the value of G was corrected: $G = 6,67384 \times 10^{-11}$; in 2013 a group of scientists from the International Bureau of Weights and Measures: $G = 6,67545 \times 10^{-11}$; in 2014, the value of the gravitational constant recommended by CODATA became: $G = 6,67408 \times 10^{-11}$. In fact, G is not determined even with an accuracy of the fourth decimal place.

2.The Λ Cold Dark Matter model ΛCDM represents the current standard model in cosmology. Within this, there is a tension between the value of the Hubble constant, H0, inferred from local distance indicators (the predicted value given in article [1] is $H_{local} = 73.48 \pm 1.66\ km \cdot s^{-1} Mpc^{-1}$) and the angular scale of fluctuations in the Cosmic Microwave Background (CMB) (as follows from [2] $H_{CMB} = 67.0 \pm 1.2\ km \cdot s^{-1} Mpc^{-1}$). These two independent measurements give a discrepancy of approximately 9% and tension with Planck+ΛCDM increases to 3.7 sigma ([1], [2]. It also follows from the above that the measurement accuracy of H_{local} is about 4.5%.

This work is the extension of author's research [3] - [5], where the modified theory of induced gravity (MTIG) is proposed. The equations with quadratic potential that are symmetric with respect to scale transformations are considered. The solutions of the equations obtained for the case of centrally symmetric space, as well as the cosmological model, determined by the Friedman-Robertson-Walker metric, are investigated.

Our theory is a phenomenological model used for comparison with observational data dark matter and dark energy. The aim of the work is to solve equations MTIG for the case of a quadratic potential and compare them with observational cosmology and astrophysics data.

The solutions of the equations of geodesic curves for a centrally symmetric metric are qualitatively different from the solutions of the Schwarzschild-de Sitter. The found gravitational potential contains many extremum. which become significant away from the center. For a galaxy model, with a central mass of the order of four million solar masses, these distances are more than 0.1 kpc. Due to quasi-oscillatory solutions, bands (spherical shells) are formed corresponding to the bands of gravity and antigravity. Accordingly, where the acceleration of the test body is directed toward the center, these are the bands of gravity, and where from the center are the bands of antigravity. For simplicity, we model galaxies as centrally symmetric objects with masses of about - $(10^6 \div 10^{11}) \cdot M_{\odot}$, in which the entire mass is concentrated in the center. This is justified by the fact that we are interested in the behavior of the characteristics of the gravitational field at sufficiently large distances $r > r_{cr}$, where Kepler's laws are violated. The presented model satisfactorily describes the rotation curve of galaxies and opens up new possibilities for further predictions. A classification is given (incomplete) of the types of geodetic lines.

---

[1] Riess, A. G., et al., 2018, arXiv:1801.01120 [astro-ph.SR], 15p.; Riess, A. G., Macri, L. M., Hoffmann, S. L., et al.2016, ApJ, 826, 56.

[2] Planck Collaboration, Aghanim, N., Ashdown, M.,et al. 2016, A and A, 596, A107.

[3] F.Zaripov. Astr. and Space Sci. : Volume 352, Issue 1 (2014), Page 289-305. DOI:10.1007/s 10509-014-1909-8. https://link.springer.com/article/10.1007

[4] F.Zaripov. Symmetry. 2019, 11, 81; https://doi.org/10.3390/sym11010081

[5] F.Zaripov. Advances in Astronomy. Volume 2019, Article ID 1502453, 15 pages, //doi.org/10.1155/2019/1502453

*Electronic address: farhat.zaripov@kpfu.ru