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April 07, 2023

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Report on the dissertation thesis "Lense-Thirring effect and modified gravity" submitted by Mr. Shant Khlghatyan for the academic degree of a Candidate of Science in specialty 01.04.02 – Theoretical Physics

By the 1980s, the increasing accuracy of experimental tests had all confirmed general relativity; no competitors were left except for those that included general relativity as a special case. Further, shortly after that, theorists switched to string theory, which was starting to look promising, but has since lost popularity. In the mid-1980s a few experiments were suggesting that gravity was being modified by the addition of a fifth force acting in the range of a few meters. Subsequent experiments eliminated these ideas.

Motivations for the more recent alternative theories are almost all cosmological, associated with or replacing such constructs as "inflation", "dark matter" and "dark energy". Investigation of the Pioneer anomaly, gravitomagnetic effects in the orbital motion of geodetic satellites like LAGEOS and LARES, and in binary pulsars have caused renewed public interest in more careful and intensive studies of various alternatives to general relativity. The strategic idea is to develop more general forms of the theories that survived the experimental tests, so that a modified gravity theory would be ready to either explain a disagreement with general relativity or to propose a new experimental test(s) of general relativity probing the range of the parameters having been previously technologically unavailable. This dissertation thesis represents a comprehensive

theoretical study of currently important and vibrant area of astrophysics and theoretical physics called gravito-electromagnetism. Especially important and unorthodox new development in the dissertation is the scrutiny examination of contribution of the cosmological constant to several astrophysical phenomena, the gravitomagnetic frame dragging in the strong field regime, a black hole shadow, etc. In each case the dissertator presents a meticulous derivation of relevant theoretical formulae and experimental constraints. The dissertation of Mr. Khlghatyan gives us an excellent example of a truly painstaking work of high quality in advanced theoretical physics.

The thesis consists of Introduction, three chapters, conclusion, bibliographic references, and includes 11 figures and 11 tables. The first chapter analyzes the Lense-Thirring precession in the Kerr metric and the evolution of the angular momentum of a test particle for both bounded and unbounded orbits. Here, a new relativistic effect has been discovered, namely, nutation of the angular momentum. The analytic results are confirmed by numerical integration. The chapter also considers a contribution of the cosmological constant to the Lense-Thirring effect in a strong field regime of the Kerr metric. The Lense-Thirring precession is also examined in the modified gravity theory and the LLR data from the LAGEOS-1, LAGEOS-2 and LARES satellites are used to obtain experimental constraints on the parameters of the modified gravity theory.

The second chapter investigates the astrophysical processes leading to the formation of a shadow of a supermassive black hole lying at the center of galaxies. The parametrized post-Newtonian (PPN) formalism is used to derive correction to the shadow's formula and a new constraint on the value of the PPN parameter ζ is obtained that narrows down the range of various alternative modified theories of gravity. The chapter gives a generalization of the nodal and apsidal precession formulae of the accretion disk around the black hole in the modified gravity theory.

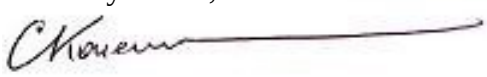
The third chapter is making use of the action variable technique and finds out new adiabatic invariant quantities for the Schwarzschild-de Sitter metric in the modified gravity. Formulae for orbital parameters, like eccentricity, focal parameter, etc., are given in the case of the relativistic Kepler problem. The chapter studies the effect of tidal disruption of stars near the massive black holes in modified gravity case and several interesting predictions for future astrophysical observations are made.

The presentation and English grammar of the thesis are excellent, the results of the dissertation

are well articulated and rigorously proven. The publication list of the author contains 7 papers completely covering the results of the dissertation. The papers have been published in respectable, peer-review journals indicating to the high quality research and competitiveness of the dissertation work. The author demonstrates his strong standing and competence in the field of mathematical and theoretical physics. The results of the dissertation can be used both by research scientific centers working on the problems of fundamental physics and by astronomical observatories doing observational work. The synopsis exactly corresponds to the content of the dissertation thesis.

I conclude that the dissertation thesis fully satisfies all requirements prescribed to the thesis submitted for the degree of the Candidate in Physical and Mathematical Physics in specialty 01.04.02 − theoretical physics. I am confident that the author of the dissertation thesis, Mr. Shant Khlghatyan honorably deserves the award of this scientific degree.

Sincerely Yours,



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