ANNOTATION

of the Thesis for the PhD Degree Specialty 6D060400 – Physics
Altaibayeva Aziza Bibolovna

Investigation geometrodynamics of some topological objects and holographic model of the wormhole

Topic actuality of the research.

Necessity of studying of the geometrothermodynamics of some topological objects, particularly black holes and holographic models of wormholes due to the fact that they really are thermodynamic systems. A few decades ago, scientists S. Hawking and others, as well as Y. Zel'dovich first investigated the thermodynamic properties of the black hole. It has been established that the black hole, emits energy in the form of radiation. Such radiation is focused on the event horizon of black hole. Irradiation of its entropy decreases. But the problem of the statistical nature of the entropy of black hole today is still one of the most fascinating and controversial issues. The research of the thermodynamic properties of black holes is also an urgent task, especially the problem of the heat capacity of black hole. Negative heat capacity usually gives the thermodynamics of an unstable system, and assumes a positive local stable system. The divergence points of the specific heat, generally in accordance with the phase Davis points second-order transition. The properties and phase transitions of the black hole as a thermodynamic system can also be studied from the point of view of geometry.

During the last century, differential geometry has become an essential element of theoretical physics. One of the most interesting examples of this fact is the application of Riemannian geometry in general relativity as a theory of the gravitational field. Indeed, today we understand gravity as a manifestation of the Riemann curvature of spacetime so that measuring the curvature is equivalent to measuring the gravitational interaction. This is a consequence of the astonishing principle “field strength = curvature”, proposed originally by Einstein. Since the field strength can be considered as a measure of the gravitational interaction, it follows that that the entire idea of general relativity can be summarized in the principle “interaction = curvature”. The same principle is valid in the case of gauge theories. For instance, Maxwell’s theory of electromagnetism can be described geometrically in terms of the elements of a principal fiber where the base manifold is the Minkowski spacetime, the standard fiber is the gauge group U(1), which represents the internal symmetry of the electromagnetic interaction, and the connection across the fibers is a local cross-section which takes values in the algebra of U(1). If we replace the gauge group and the connection U(1) by SU(2) or SU(3), we obtain the geometric description of the weak or the strong interaction, respectively. Although in the case of gauge theories the Riemannian curvature of the base space vanishes, it is the gauge curvature of the principal fiber bundle which is equivalent to the interaction. Another important branch of theoretical physics is thermodynamics, and one may wonder whether it is possible to represent it in the context of differential geometry. The first attempts in this direction were

made in the pioneering works by Gibbs and Caratheodory in which the language of differential forms were introduced in thermodynamics. Riemannian geometry was first introduced in statistical physics and thermodynamics by Rao, by means of a metric whose components in local coordinates coincide with Fisher's information matrix. Hessian metrics have been used intensively to study the geometry of the thermodynamics of ordinary systems and black holes. An additional aspect of classical thermodynamics is that it is invariant with respect to Legendre transformations, i.e., the properties of a given thermodynamic system are independent of the choice of thermodynamic potential.

Over the past 30 years, the study of the theory of black holes in general relativity showed good prerequisites to finding the fundamental relationship between gravity, thermodynamics and quantum theory. The basis of the correlation of thermodynamics of black holes, where there are some laws of mechanics is in fact a normal law of thermodynamics as applied to a system containing a black hole. Indeed, the discovery of the thermodynamic behavior of black holes is achieved, first of all, in the classical and semi-classical analysis, which gives rise to most of our present views on the physical nature of quantum phenomena occurring in strong gravitational fields.

Present thesis is devoted to research geometrodynamics topology black holes of various configurations dark matter, such as a black ring, strange quark matter and wormholes, as well as a generalization of general relativity.

The aim of the research and scientific outcomes.

Research geometrodynamics some topological objects with different configurations and holographic wormhole modified simulating gravity, as well as their use in the generalized theory of general relativity.

The scientific results obtained in the thesis

- The phase transitions of the second kind for different configurations of multi-dimensional black holes Reissner-Nordström, Kerr, , and Mayer-Perry.
- Obtain topology of black holes in four dimensions changed to a non-trivial ring topology.
- The behavior and interaction of the photon gas was examined and proved that the considered space is flat.
- Basic thermodynamic properties of strange quark matter investigated and proved that the results are valid in the zero temperature and finite limits.
- Accretion of three holographic dark energy: the holographic dark energy, holographic dark energy Ricci modified holographic dark energy in the wormhole Ricci Morris-Thorne investigated and revealing that in all cases the weight increases.
- Get the three different classes of solutions for gravity-Lifshitz Khorava and accurate solutions in the study of the singularities of these classes.
- Revealed two independent equations of motion to mimic the modified gravity and investigated some partial solutions such as mimetic gravity to cosmology. It was suggested that the cosmological solution in a heterogeneous form of the scalar field.

The object of the research is Localized objects of the universe such as black holes, black rings and wormholes consisting of different types of matter.

The subject of the research is searching phase transitions of the wormhole and black holes with different configurations.

The scientific novelty:

- Obtain a second-order phase transitions in the space-time dimensions of various multi-dimensional black holes.
- Investigated the topology of black holes in four dimensions changed to a non-trivial ring topology.
- Considered the behavior of the interaction of the photon gas.
- Investigated basic thermodynamic properties of quark matter, and proved that the results are valid in the zero temperature and finite limits.
- Investigated accretion of three holographic dark energy: the holographic dark energy, holographic dark energy Ricci and modified holographic dark energy in the wormhole Ricci Morris-Thorne.
- Obtained three different classes of solutions for gravity-Khorava Lifshitz.
- Revealed two independent equations of motion to mimic the modified gravity and investigated some partial solutions such as mimetic gravity to cosmology.

Research objectives. The main tasks of the thesis are as follows**:**

- obtain the geometry of space-time thermodynamics topological objects such as a black hole, wormhole and strange quark symmetry;
- gain mass accretion of wormhole three holographic dark energy: the holographic dark energy, holographic dark energy Ricci and modified holographic dark energy in the universe Ricci characterizes the degree view of the scale factor;
- obtain the equations of motion to mimic gravity.

Statements for the defense:

1. Conditions under which phase transitions occur in the second-order space-time dimensions of multi-dimensional black holes were determined.
2. Researched the geometrodynamics of black geometric objects: large and small black rings and a photon gas. The possibility of restoration of the geometrical method of phase transitions from black hole to black rings. Considered photon gas as a particular case of black objects.
3. Using the analytical expressions of free and internal energies considered geometrodynamics of strange quark matter.
4. In view of the holographic dark energy, holographic dark energy and modified Ricci holographic dark energy Ricci refurbished Hubble parameter and get a mass of wormholes, with the appearance of the accretion of dark energy on them.

Practical significance of the research outcomes.

This dissertation work is theoretical. Its results can be used for further study of black holes and wormholes, and explanations of modern observational data to confirm the existence of the effect of the accelerated expansion of the Universe. The results and solutions obtained in the thesis can be use for further research in modern cosmology.

Therefore the results of the thesis can be applied in the educational process for teaching masters and doctoral students of the specialty "Physics" of elective courses.

PhD student. In progress of dissertation research under the guidance of supervisors candidate for a degree was directly involved in all stages of work: held all calculations, built graphics found solutions, personally prepared a publication.

Approbation of the outcomes.

The results obtained in the thesis, reported and discussed at:

- Astrophysics, Gravity and Cosmology. 1-st Eurasian International Conference. Astana, 2012;
- IX Международная научная конференция студентов, магистрантов и молодых ученых «Ломоносов – 2013», Astana-2013;
- VIII International Scientific Conference for students and young scholars "SCIENCE AND EDUCATION-2013" Astana-2013;
- Международная конференция “Актуальные проблемы современной физики”, посвященной 75-летию академика НАН РК Абдильдина М.М., Almaty-2013;
- Международная конференция «Современные проблемы физики и новых технологий», в честь 70-летия академика НАН РК Такибаева Н.Ж., Алматы-2014;
- Astrophysics, Gravity and Cosmology. 2-nd Eurasian International Conference. Astana, 2014;
- International scientific conference “International Conference of Physics”. WASET, Istanbul, Turkey, February, 16-17, 2015;
- X International Scientific Conference for students and young scholars "SCIENCE AND EDUCATION-2015" Astana-2015.

In addition, the results were presented and discussed at scientific seminars of the department of general and theoretical physics L.N. Gumilyov ENU and seminars of Eurasian International Centre for Theoretical Physics and seminars of department of Physics, California State University, Fresno.

Publications.

Main provisions of the work presented in 17 scientific publications author of dissertation, of which 5 papers in international journals with high impact factor, 5 articles in periodicals of the Republic of Kazakhstan, recommended by the Committee for Control of Education and Science of the MES; 1 monograph, 3 articles and 2 theses in materials of the international conference of the CIS countries, 1 article in international conferences.

The impact factor of journals. In general, a doctoral student has published 5 articles in international journals with high impact factor.

H-index and cited works. Doctoral candidate has the following scientometric indicators on Google Scholar databases and Thomson Reuters, which are listed in the table.

Table – Scientometric indicators

Database	h-index	Citation
Google Scholar	4	53
Thomson Reuters	2	25

Volume and structure of the thesis. The thesis consists of an introduction, 3 chapters, conclusion and list of references of 169 titles, contains 127 pages of basic computer text, including 29 figures and 2 tables.