

**REVIEW**  
**of the official reviewer for dissertation work**  
**Serikbolova Albina Askarovna on the theme « Branes and monopoles in modified gravities and Yang-Mills theories»**  
**presented for the degree of Doctor of Philosophy (PhD) in the specialty «8D05306-Physics».**

№	Criteria	Eligibility (one of the options must be checked)	Justification of the position of the official reviewer
1.	The topic of the thesis (as of the date of its approval) corresponds to the directions of development of science and/or state programs	<p>1.1 Compliance with priority areas of science development or government programs:</p> <p>1) The thesis was completed within the framework of a project or target program financed from the state budget (indicate the name and number of the project or program)</p> <p>2) The thesis was completed within the framework of another state program (indicate the name of the program)</p> <p>3) The dissertation corresponds to the priority direction of the development of science, approved by the Higher Scientific and Technical Commission under the Government of the Republic of Kazakhstan (indicate the direction)</p>	<p>Results of the study presented in the dissertation work of Serikbolova A.A. fully compliant with priority areas of science.</p> <p>Dissertation of Serikbolova A.A. corresponds to the priority direction of development of science "Scientific research in the field of natural sciences", according to the sub-priority «Fundamental and applied research in the field of physics and astronomy". This work was supported by Grant № BR05236730 in Fundamental Research in Natural Sciences by the Ministry of Education and Science of the Republic of Kazakhstan.</p>
2.	Importance for science	The work makes a significant contribution to science, and its importance is well disclosed	The results obtained in the dissertation work contain new, scientifically based theoretical results, which makes a significant contribution to the development of science in the field under study.
3.	The principle of independence	<p>Self-reliance level:</p> <p>1) <u>High</u>;</p> <p>2) Medium;</p> <p>3) Low;</p> <p>4) No independence</p>	It is worth noting the high level of independence of the author dissertation work that fully compliant requirements for dissertationist. The results of the research are confirmed by publications in journals of far abroad with high impact factors and in

			publications recommended by the Committee for Control in the Field of Education and Science of the Ministry of Education and Science of the Republic of Kazakhstan, and in the proceedings of international scientific conferences of near and far abroad.
4.	The principle of inner unity	4.1 Justification of the relevance of the thesis: 1) <u>Justified</u> ; 2) Partially justified; 3) Not justified.	An important direction in the study of the modern universe in recent years has been the consideration of the theory of the brane world. Within their framework, it is possible to describe the problem of the hierarchy of elementary particles, as well as to solve a number of other problems of the theory of elementary particles. The relevance of the dissertation work of Serikbolova A.A. is lies on the study of vacuum solutions in modified theories of gravity describing Branes. Author showed that regular vacuum brane solutions can exist in multidimensional modified theories of gravity. As far as we know, for getting all these solutions require the presence of matter. And this is physically understandable, since in GR, regular solutions almost always can be obtained in the presence of some sources. Such examples can be solutions with scalar, vector and spinor fields. Branes are hypothetical objects that can be discovered in the future in good perspective, so studying their properties is an important task in theoretical physics. Also, the relevance

		lies in the study of new monopole-like solutions in Yang-Mills' SU(2) theory are aimed at providing a comprehensive answer for understanding the nature and properties of the magnetic monopole.
	4.2 The content of the thesis reflects the topic of the thesis: 1) <u>Reflects</u> ; 2) Partially reflects; 3) Does not reflect	The content of the dissertation fully reflects the topic, goals and objectives. The dissertation consists of 4 chapters, an introduction, a conclusion and a list of references. All chapters of the dissertation are consistently interrelated and solve the tasks.
	4.3. The purpose and objectives correspond to the topic of the thesis: 1) <u>correspond</u> ; 2) partially correspond; 3) do not correspond	In the dissertation work, the author clearly formulated the purpose and objectives of the study, which fully correspond to the topic of the dissertation.
	4.4 All sections and provisions of the thesis are logically interconnected: 1) <u>completely interconnected</u> ; 2) the interconnection is partial; 3) there is no interconnection	All sections and the structure of the dissertation work are logically interconnected. The introduction substantiates the relevance of the dissertation. The purpose of the work, objects and subjects of study are formulated.
	4.5 The new solutions (principles, methods) proposed by the author are reasoned and evaluated in comparison with the known solutions: 1) <u>there is a critical analysis</u> ; 2) partial analysis; 3) the analysis does not represent one's own opinions, but quotes from other authors	The dissertation compares the obtained vacuum solutions describing branes in multidimensional space-time with similar solutions in the 5th and 6th dimensions within the framework of modified theories of gravity. The obtained regular monopole-like solutions within SU(2) Yang-Mills theory containing the doublet of nonlinear spinor fields were also compared with solutions in non-Abelian Proca-Dirac-Higgs theory and with Dirac monopoles and 't

			Hooft-Polyakov monopole.
5.	Scientific novelty principle	5.1 Are the scientific results and provisions new? 1) completely new; <u>2) partially new (25-75% are new);</u> 3) not new (less than 25% are new)	The scientific results and provisions to be defended in this paper are partly new, in particular: 1. Vacuum brane solutions in the modified theory of gravity are partially new and have not been explored by many authors in the field; 2. Monopole-like solutions in SU(2) Yang-Mills theory which interact with nonlinear spinor field and the presence of a minimum in the energy spectrum of these solutions are new.
		5.2 Are the dissertation findings new? 1) completely new; <u>2) partially new (25-75% are new);</u> 3) not new (less than 25% are new)	The dissertation findings are partially new, which lies in the fact that: 1. New flat-symmetric solutions in multidimensional modified theories of gravity for Branes are obtained; 2. New Yang-Mills monopole with the source of nonlinear spinor fields was investigated; 3. It was demonstrated that monopole-like solutions have a minimum in the energy spectrum, which can be considered as mass gap.
		5.3 Technical, technological, economic or management decisions are new and reasonable: 1) completely new; <u>2) partially new (25-75% are new);</u> 3) not new (less than 25% are new)	To achieve the goals and objectives of the dissertation work the modified theories of gravity and SU(2) Yang-Mills theory containing a doublet of nonlinear spinor fields were investigated. Moreover, proven mathematical methods of numerical solutions of ordinary differential equations

			in Wolfram Mathematica and Maple packages were used.
6.	The validity of the main findings	All main conclusions are based on scientifically significant evidence or well-grounded (for qualitative research and areas of training in the arts and humanities)	Based on the materials of the dissertation, 8 printed works were published: 2 - publication in Kazakh journals, which are recommended by the Committee for Control in the Field of Education and Science of the Ministry of Education and Science of the Republic of Kazakhstan (KKSON MON RK) and 3 articles in journals of foreign countries with high impact factors included in the international information resource Web of Knowledge (Thomson Reuters, USA) and Scopus (Elsevier, the Netherlands); 3 works in the collections of International Scientific Conferences. Moreover, research in the field of monopole solutions was awarded in the Republican competition of research among universities of the Republic of Kazakhstan. All of the above testifies to the validity of the conclusions.
7.	The main provisions for the defense	It is necessary to answer the following questions for each provision separately: 7.1 Is the provision proven? 1) proven; 2) rather proven; 3) rather not proven; 4) not proven 7.2 Is it trivial? 1) yes; 2) no 7.3 Is it new? 1) yes;	7.1 proven 7.2 No 7.3 yes 7.4 medium; 7.5 yes

		<p>2) no</p> <p>7.4 Application level:</p> <p>1) narrow;</p> <p>2) medium;</p> <p>3) wide</p> <p>7.5 Is it proven in the article?</p> <p>1) yes;</p> <p>2) no</p>	
8.	The principle of reliability Reliability of sources and information provided	<p>8.1 Choice of methodology - is justified or the methodology is described in sufficient detail</p> <p>1) <u>yes</u>;</p> <p>2) no</p>	All calculations and the choice of methodology specified in the dissertation work are described in detail.
<p>8.2 The results of the thesis were obtained using modern methods of scientific research and methods of processing and interpreting data using computer technologies:</p> <p>1) <u>yes</u>;</p> <p>2) no</p>		All calculations were made in Wolfram Mathematica software, which indicates the accuracy and application of modern technology. References to all observational data are also indicated, which proves the reliability of the information.	
<p>8.3 Theoretical conclusions, models, identified relationships and patterns have been proven and confirmed by experimental research (for areas of training in pedagogical sciences, the results have been proven on the basis of a pedagogical experiment):</p> <p>1) <u>yes</u>;</p> <p>2) no</p>		The research carried out in the dissertation is based on previous methods for obtaining regular solutions within the framework of modified theory gravity, as well as monopole solutions in non-Abelian Proca-Dirac-Higgs theory by other authors. Therefore, all theoretical results do not contradict the experimental study.	
<p>8.4 Important statements are confirmed by references to current and reliable scientific literature</p>		Important statements are supported by references to relevant and reliable scientific literature.	
<p>8.5 Used literature sources are sufficient for a literature review</p>		The list of literary sources in the dissertation includes 161 scientific and relevant sources. Author mentioned the usual Dirac string approach but there is also the two-photon	

			approach to monopoles pioneered in "Quantum electrodynamics with Dirac monopoles", N. Cabibbo and E. Ferrari, Nuovo Cim. 23 (1962) 1147-1154. And also some references to brane world models are missing like: Gogbeahvili, Arkni-Hamed-Dvali-Dimopulos, Randall-Sundrum, and more.
9	Practical value principle	9.1 The thesis has theoretical value: 1) <u>yes</u> ; 2) no	The dissertation is of theoretical importance, as it is devoted to one of them from the actual problems of modern theoretical physics.
		9.2 The thesis is of practical importance and there is a high probability of applying the results obtained in practice: 1) <u>yes</u> ; 2) no	There is a high probability of applying the results of hypothetical objects such as Branes and magnetic monopoles, which can be found in the future with the development of the latest tools and technology.
		9.3 Are the practice suggestions new? 1) completely new; 2) <u>partially new (25-75% are new)</u> ; 3) not new (less than 25% are new)	Ideas and developments for the practice of dissertation work are partially new.
10.	The quality of writing and design	Academic writing quality: 1) high; 2) <u>average</u> ; 3) below average; 4) low.	The dissertation is written in an accessible scientific language. Conclusions and conclusions are complete, are scientifically based.

Nevertheless, there are a number of comments to the dissertation work with a recommendatory character:

1. It would be good to understand the  $1/r^3$  behavior of the radial magnetic field. This kind of dependence usually is associated with a magnetic dipole, but as this work is in 5D maybe this is correct. Also the magnetic field has both  $\theta$  and  $\varphi$  dependence which is interesting. It would be good to have a physical explanation for this.
2. There are some references to the original brane-world models (Gogberahsvili, Randall-Sundrum, Arkani-Hamed, Dvali, and Dimpoulos, that would be good to include.

3. There is another type of monopole theory in addition to the Dirac model, where one introduces a second vector potential. This model was originally proposed by Cabibbo and Ferrari in 1962 and would be good to mention and to see if anything would change in the present analysis if one adopted this two-photon model.

**Conclusion on the possibility of awarding the degree of Doctor of Philosophy (PhD), Doctor in profile.**

On the whole, the dissertation work of Serikbolova Albina Askarovna on the theme «Branes and monopoles in modified gravities and Yang-Mills theories» performed at a high scientific level, is a completed independent research work, in content and design meets the requirements of the Committee for Control in the Field of Education and Science of the Ministry of Education and Science of the Republic of Kazakhstan to PhD dissertations, and its author Serikbolova Albina Askarovna, undoubtedly deserves to be awarded the degree of Doctor of Philosophy (PhD) in the specialty «8D05306-Physics».

**Official Reviewer:**

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