

復旦大學

FUDAN UNIVERSITY

REVIEW

of the reviewer of the dissertation work (series of articles) of

Suliyeva Gulnara Badyrkhanovna on the topic "Application of field theories to astrophysical problems" submitted for the degree of Doctor of Philosophy (PhD) in the educational program 8D05306 – Physics

№	Criteria	Compliance with the criteria (underline one of the answer options)	Justification of the official reviewer's position (comments should be highlighted in italics))
1.	The topic of the dissertation (as of the date of its approval) corresponds to the directions of scientific development and/or state programs	1.1 Compliance with priority areas of scientific development or state programs: 1) the dissertation 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); 2) the dissertation was completed within the framework of another state program (indicate the name of the program); 3) the dissertation corresponds to the priority direction of scientific development approved by the Higher Scientific and Technical Commission under the Government of the Republic of Kazakhstan (indicate the direction).	The dissertation work corresponds to the priority areas of scientific development and state programs of the Republic of Kazakhstan in the field of fundamental research in Physics. The research work was performed within the framework of project AP19680128 «Motions of test particles and photons in the gravitational field of dilatonic black holes».

2.	Importance for Science	The work makes/does not make a significant contribution to science, and its importance is/is not well explained.	The dissertation work presents a detailed analysis of the motion of test particles around black hole models in which gravity is coupled to nonlinear electromagnetic and dilaton fields. G. Suliyeva's work makes a significant contribution to national and international science, specifically to understanding gravitational phenomena occurring around black holes. Its importance is clearly demonstrated by its aim to advance our understanding of black hole physics.
3.	The principle of independence	Level of independence: 1) high; 2) average; 3) short; 4) there is no independence.	The level of independence is high, as evidenced by the work done by the author, which includes a comprehensive study, the use of various methods, and justification of the conclusions reflected in the work.
4.	The principle of internal unity	4.1 Justification of the relevance of the dissertation: 1) justified; 2) partially justified; 3) not substantiated.	The relevance of the scientific work is substantiated. The relevance of the research, related to the use of alternative black hole models to describe gravitational phenomena, is described in detail.
		4.2 The content of the dissertation reflects the topic of the dissertation: 1) reflects; 2) partially reflects; 3) does not reflect.	The content of this work is fully consistent with the topic of the dissertation. The first part is devoted to a literature review and the selection of research objects; the second part describes the research methods and their application to specific problems; the main part presents the results and their analysis.
		4.3. The goal and objective correspondence is the topic of the dissertation: 1) correspond; 2) partially match; 3) do not correspond.	The author provided a clear and concise statement of the research goals and objectives, which are fully consistent with the dissertation topic.

			The author defined the direction of her research and highlighted key aspects for achieving this goal.
		4.4 All sections and provisions of the dissertation are logically interconnected: 1) completely interconnected; 2) partial relationship; 3) there is no connection.	All sections and provisions of the work are logically interconnected.
		4.5 The new solutions (principles, methods) proposed by the author are substantiated and evaluated in comparison with known solutions: 1) there is a critical analysis; 2) partial analysis; 3) The analysis does not represent personal opinions, but quotes from other authors; 4) analysis missing.	In the research work, the author demonstrated a detailed analysis and comparison with previous works of other authors, supported by references.
5.	The principle of scientific novelty	5.1 Are the scientific results and provisions new? 1) completely new; 2) partially new (25-75% are new); 3) not new (less than 25% are new).	The scientific results and provisions for the defense are completely new. The author provides qualitative and quantitative estimates of the gravitational effects around black hole models in which gravity is coupled to nonlinear electromagnetic and dilaton fields. The relevant studies have not been previously conducted for the models under consideration – Fan-Wang, Dymnikova regular black holes and double-charged dilatonic black hole.

		5.2 Are the findings of the dissertation new? 1) completely new; 2) partially new (25-75% are new); 3) not new (less than 25% are new).	The dissertation's findings are entirely new. The scientific novelty lies in the fact that for the first time: 1. Analytical expressions for the perihelion shift and the deflection of massless particles and photons in the gravitational field of a Fan-Wang black hole were derived; 2. The properties of accretion disks around the Fan-Wang and Dymnikova black hole models were studied; 3. Circular orbits in the field of double-charge dilatonic black hole were analyzed.
		5.3 Technical, technological, economic or managerial decisions are new and justified: 1) completely new; 2) partially new (25-75% are new); 3) not new (less than 25% are new).	The results obtained by the doctoral student are completely new. It is confirmed by recent articles in peer-reviewed journals.
6.	Validity of the main conclusions	All key findings are based/not based on sound scientific evidence or are reasonably well supported (for qualitative research and arts and humanities majors).	The main conclusions are confirmed and proven, since the author relies on previously analyzed models and observational data.
7.	The main provisions submitted for defense	The following questions must be answered for each provision separately: 7.1 Has the position been proven? 1) proven; 2) rather proven; 3) rather not proven; 4) not proven; 5) In the current formulation, it is impossible to verify the proof of the position.	The dissertation work presents three provisions for defense: 1. In the Fan-Wang regular black hole model, the effects of nonlinear electrodynamics lead to a weakening of gravitational phenomena, including perihelion shift, photon and massless particle deflection, as the magnetic charge increases. A direct application to observational data for the perihelion shift of the S2 star orbiting Sagittarius A* allows us to constrain the magnetic charge to the value l≈4.34*10^(-11) Wb. 7.1 proven 7.2 no
		7.2 Is it trivial? 1) yes; 2) no; 3) in the current formulation it is impossible to verify the triviality of the position.	
		7.3 Is it new? 1) yes; 2) no; 3) In the current formulation it is impossible to verify the novelty of the provision.	

		7.4 Level to use: 1) narrow; 2) average; 3) wide; 4) In its current formulation, it is not possible to verify the level of application of the provision.	7.3 yes 7.4 average 7.5 yes 2. Accretion disks around the Fan-Wang and Dymnikova regular black holes are characterized by higher differential luminosity than those around the Schwarzschild black hole. The efficiency of converting mass into radiation reaches 11.43% (Fan–Wang) and 8.7% (Dymnikova) exceeding the Schwarzschild value by 2 and 1.5 times, respectively. In the binary system Cygnus-X1, the maximal possible temperature of a disk surface is: 6.70*10^6 K (Fan-Wang) and 5.45*10^6 K (Dymnikova), exceeding value for the Schwarzschild black hole by 1.75 and 1.43 times, correspondingly. 7.1 proven 7.2 no 7.3 yes 7.4 average 7.5 yes 3. For the dilatonic black holes, the innermost stable circular orbit radius, and efficiency of conversion mass into radiation increase monotonically with increasing dilaton coupling parameter a, with the Schwarzschild ($a = a_{min} = 0$), Sen ($a = 1$) and Reissner-Nordström ($a = a_{max} = 2$) solutions emerging naturally as limiting cases of the theory. 7.1 proven 7.2 no 7.3 yes 7.4 average 7.5 yes
		7.5 Is it proven in the article? 1) yes; 2) no; 3) in the current wording it is impossible to verify the proof of the position in the article	

8.	The principle of reliability. Reliability of sources and information provided.	8.1 The choice of methodology is justified or the methodology is described in sufficient detail: 1) yes; 2) no;	The published articles provide a detailed description of the research methodology, allowing readers to fully understand the research process. Each stage is described in detail, ensuring the clarity and reliability of the results.
		8.2 The results of the dissertation work were obtained using modern methods of scientific research and methods of processing and interpreting data using computer technologies: 1) yes; 2) no;	The results of the research work were obtained through the modern computing program – Wolfram Mathematica.
		8.3 Theoretical conclusions, models, identified relationships and patterns are proven and confirmed by experimental research (for areas of training in pedagogical sciences, the results are proven on the basis of a pedagogical experiment): 1) yes; 2) no;	The theoretical justifications, created models, discovered relationships and patterns are confirmed by precise mathematical proofs. Comparison to observational data have been conducted that confirm the validity of theoretical conclusions.
		8.4 Important claims are supported/partially supported/not supported by references to relevant and reliable scientific literature.	All important statements are supported by references to relevant and reliable scientific literature. A thorough analysis of modern research has been conducted, and the main findings have been compared with the results of other scientists.
		8.5 The literature sources used are sufficient/not sufficient for a literature review.	The sources used are sufficient for a literature review.
9.	The principle of practical value	9.1 The dissertation has theoretical significance: 1) yes; 2) no.	The theoretical significance of the dissertation work lies in the quantitative and qualitative estimation of gravitational effects around black holes.
		9.2 The dissertation has practical significance and there is a high probability of applying the obtained results in practice: 1) yes; 2) no.	The practical significance is shown in relation to different black hole models.

		9.3 The suggestions for practice are new: 1) completely new; 2) partially new (25-75% are new); 3) not new (less than 25% are new).	All suggestions in the research work are completely new. The applied methods of analysis are necessary for understanding the physics of compact objects.
10.	Quality of writing and design	Quality of academic writing: 1) high; 2) average; 3) below average; 4) low.	The publications are characterized by good quality academic writing, which is reflected in the clarity and logicality of presentation.
11.	Comments on the dissertation	There are no comments regarding the dissertation work.	
12.	The scientific level of the doctoral student's articles on the research topic (in the case of defending a dissertation in the form of a series of articles, reviewers comment on the scientific level of each article of the doctoral student on the research topic)	1) Publication "Geometric properties versus particle motion in the Fan-Wang spacetime" is of a high scientific level. It is devoted to the study of classical effects of general relativity in the field of Fan-Wang regular black hole. The corrections due to nonlinear electrodynamics are derived for the phenomena, such as gravitational capture, perihelion shift and deflection of massless particles and photons. The article corresponds to the topic of the dissertation work. 2) Publication "Accretion disks properties around regular black hole solutions obtained from non-linear electrodynamics" is of a high scientific level. It is devoted to the analysis of radiative properties of accretion disks around Fan-Wang and Dymnikova regular black holes. The results are compared to those for a Schwarzschild black hole to analyze the deviations from general relativity arising due to nonlinear electromagnetic fields. The article corresponds to the topic of the dissertation work. 3) Publication "Circular geodesics in the field of double-charged dilatonic black holes" is of a high scientific level. It is devoted to the study of circular orbits around dilatonic black holes with two scalar and two Abelian vector fields. It is proven that given solution contains naturally the Schwarzschild, Sen and Reissner-Nordstrom geometries. The article corresponds to the topic of the dissertation work.	
13.	Decision of the reviewer	The research work by Suliyeva G.B., titled "Application of field theories to astrophysical problems" meets all the standards established by the Committee for Quality Assurance in Science and Higher Education of the Republic of Kazakhstan for awarding the degree of Doctor of Philosophy. Suliyeva Gulnara is deserving of being awarded the academic degree of Doctor of Philosophy (PhD) in the educational program "8D05306 – Physics".	

Reviewer:
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Aldabergenov Ye.S.