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 was prepared in alignment with the plans for fundamental scientific research projects. 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 presented as a series of articles offers a clear study of gravitational phenomena in black hole models that incorporate nonlinear electromagnetic and dilaton fields. The analysis is carried out thoroughly and with attention to the physical meaning of the obtained results. The work of G. Suliyeva represents a solid contribution to national and international research on black hole physics. It shows how additional fields can modify gravitational behavior near compact objects, thereby enriching our

			overall 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 dissertation demonstrates a strong level of independent work. This is reflected in the depth of the research, the application of multiple analytical approaches, and the well-reasoned conclusions presented by the author.
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 convincingly substantiated. The author explains in detail why studying alternative black hole models is important for understanding gravitational phenomena.
		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 the dissertation work (publications) fully corresponds to the stated topic. The publications, firstly present a review of the relevant literature and the research objects; secondly, outline the chosen methods and demonstrate their application; and contain the obtained results together with their detailed analysis.
		4.3. The goal and objective correspond to the topic of the dissertation: 1) correspond; 2) partially match; 3) do not correspond.	The author presents the research goals and objectives in a clear and well-structured manner, and they fully align with the subject of the dissertation. She has accurately identified the scope of her study and emphasized the essential elements required to achieve the stated aims.
		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 dissertation work, the author provides a thorough analysis of the subject and offers meaningful comparisons with earlier studies, all supported by appropriate references to the literature.
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 the provisions submitted for defense are entirely original. The author presents both qualitative and quantitative evaluations of gravitational effects in black hole models where gravity interacts with nonlinear electromagnetic and dilaton fields. Such analyses have not previously been carried out for the specific spacetimes considered — the Fan–Wang and Dymnikova regular black holes, as well as the 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 results of the dissertation are new. The scientific novelty is demonstrated by the fact that, for the first time: 1. Analytical formulas were obtained for the perihelion shift and for the deflection of massless particles and photons in the gravitational field of the Fan–Wang black hole; 2. The accretion disk characteristics of the Fan–Wang and Dymnikova black hole models were examined in detail; 3. The behavior of circular orbits in the spacetime of a double-charged dilatonic black hole was investigated.
		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 achieved by the doctoral student are new, which is supported by their publication in recent peer-reviewed scientific 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 well justified, as the author bases them on established theoretical models and relevant observational data that were carefully analyzed in advance.
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 $l \approx 4.34 \times 10^{-11}$ Wb. 7.1 proven 7.2 no 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 5.45×10^6K (Dymnikova), exceeding value for the Schwarzschild black hole by 1.75 and 1.43 times, correspondingly.
		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.	
		7.5 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	

			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
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 present the research methodology in a detailed and transparent manner, enabling readers to clearly follow the progression of the study. Each stage is thoroughly described, which ensures both the clarity and the credibility of the obtained 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 using a 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 foundations, constructed models, and identified relationships are supported by rigorous mathematical derivations. In addition, comparisons with observational data were performed, providing further confirmation of the

			reliability and validity of the conclusions.
		8.4 Important claims are supported/partially supported/not supported by references to relevant and reliable scientific literature.	All key points are supported by references to authoritative scientific sources. The dissertation includes a comprehensive review of current research, and its main findings are carefully compared with the findings of other authors.
		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 is expressed in the detailed qualitative and quantitative evaluation of gravitational effects in the vicinity of 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 of the work is demonstrated through its applications 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 presented in the dissertation work are new. The analytical methods employed in the study are essential for our understanding of the physical processes occurring around compact astrophysical objects.

10.	Quality of writing and design	Quality of academic writing: 1) high; 2) average; 3) below average; 4) low.	The publications demonstrate a high standard of academic writing, evident in the clear structure and logical coherence of the material presented.
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" meets a high scientific standard. It examines classical general relativistic effects in the spacetime of the Fan–Wang regular black hole. The study derives corrections arising from nonlinear electrodynamics for phenomena such as perihelion shift and the deflection of massless particles and photons. The article is fully aligned with the subject of the dissertation. 2) Publication "Accretion disks properties around regular black hole solutions obtained from non-linear electrodynamics" is prepared at a high scientific level. It investigates the radiative characteristics of accretion disks in the spacetimes of the Fan–Wang and Dymnikova regular black holes. The obtained results are compared with the classical Schwarzschild case in order to assess deviations from general relativity caused by nonlinear electromagnetic fields. This article is fully consistent with the thematic scope of the dissertation. 3) Publication "Circular geodesics in the field of double-charged dilatonic black holes" is prepared at a high scientific level. It analyzes the properties of circular orbits in the spacetime of dilatonic black holes supported by two scalar and two Abelian vector fields. The study demonstrates that this solution naturally includes the Schwarzschild, Sen, and Reissner–Nordström geometries as special cases. The article is fully aligned with the subject 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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