

Brief information about the project

Name of the project	Investigation of observable signatures of dilatonic black holes
Relevance	This project is aimed at identifying unique properties and investigating parameters of dilatonic black holes for their observational identification. This will be achieved by calculating the characteristics of accretion disks, analyzing quasi-periodic oscillation frequencies, and computer modeling of the shadows of dilatonic black holes. These studies will allow for more accurate determination of parameters, such as photon sphere radii and shadow intensity, by comparing the results of computer modeling with observational data obtained from the Event Horizon Telescope network. Solving this problem will help constrain parameters of alternative theories of gravity and further expand the understanding of black hole properties.
Purpose	The goal of the project is the analytical and numerical investigation of the characteristics of accretion disks, quasi-periodic oscillations, and black hole shadows in the spacetime of dilatonic black holes.
Objectives	1. Calculate the characteristics of accretion disks, such as the radius of the innermost stable circular orbit, radiation flux, differential, and spectral luminosity using the Novikov-Thorne-Page model. 2. Investigate the fundamental frequencies of particles in accretion disks around dilatonic black holes. Using the relativistic precession model by Stella and Vietri, determine black hole parameters from observed quasi-periodic oscillations. 3. Solve the geodesic equations for light particles and calculate the photon sphere radii and the specific intensity of the shadows of dilatonic black holes under conditions of spherical accretion.
Expected and achieved results	Expected results: 1. The orbital parameters of particles in the accretion disk, such as angular velocity, angular momentum, energy, and effective potential, will be calculated. Based on these parameters, the stability of circular orbits, the radius of the innermost stable orbit, radiation flux, and luminosity will be analyzed using the Novikov-Thorne-Page model. 2. Fundamental epicyclic frequencies in the metric of dilatonic black holes will be determined, and theoretical modeling will be compared with observed quasi-periodic oscillation data based on the relativistic precession model. Black hole parameters are expected to be derived for sources such as GRO J1655-40, XTE J1550-564, and GRS 1915+105. 3. The radii of photon orbit and impact parameters will be

	calculated. The observed shadow intensity, as well as the luminosity of the shadow and photon ring of dilatonic black holes under spherical accretion conditions, will be investigated. Observations of Sgr A* and M87* by the Event Horizon Telescope will be used to constrain the parameters of dilatonic black holes. Achieved results: The orbital parameters of particles in the accretion disk, such as angular velocity, angular momentum, energy, and effective potential, were calculated. Based on these parameters, the stability of circular orbits, the innermost stable circular orbit (ISCO) radius, radiant flux, and luminosity were obtained and analyzed using the Novikov–Thorne–Page model. As part of the promotion of the project's scientific results, a paper has been published in a high-ranking international journal indexed in the Web of Science (Q1) and Scopus (91st percentile) databases: “Boshkayev K., Muccino M. Constraints on the Sen black hole mass and charge from quasi-periodic oscillations // The European Physical Journal C. – 2025. – Vol. 85. – No. 12. – Art. 1477.” As part of the promotion of the project's scientific results, participation in the following international conference was carried out: 11th APSS 2025 (The 11th International Conference on Astrophysics and Space Science), Sanya, China. As part of the promotion of the project's scientific results, participation in the following international workshop was carried out: Astrophysical Implications of Compact Objects (Plenary talk by Prof. K. Boshkayev), Marrakesh, Morocco.
Research team members with their identifiers (Scopus Author ID, Researcher ID, ORCID, if available) and links to relevant profiles	1. Manas Khassanov, PhD; ResearcherID (WoS): ABA-7250-2020; ScopusID : 57204019721; ORCID: 0000-0001-9857-0658. 2. Kuantay Boshkayev, PhD; ResearcherID (WoS):AAZ-3346-2020; ScopusID: 54883880400; ORCID: 0000-0002-1385-270X. 3. Saken Toktarbay , PhD; ResearcherID (WoS): B-3614-2012; ScopusID: 56336189300; ORCID: 0000-0002-5699-4476. 4. Urazalina Ainur, PhD; ScopusID: 57076979300; ORCID: 0000-0002-4633-9558.

	5. Aimuratov Yerlan, PhD; ResearcherID: J-3040-2019; Scopus ID: 56743315700; ORCID: 0000-0001-5717-6523. 6. Zhuldyz Beisenbekova , Докторант; ResearcherID (WoS): LKL-3038-2024; ORCID: 0009-0005-6048-3221. 7. Aidana Kurmanbek, Докторант; Orcid ID: 0009000185427390. 8. Adel Umirbayeva, Докторант; ORCID: 0000-0001-9339-4990; Scopus AuthorID: 57776936900
Usage	Domestic and foreign research teams, master's and doctoral students working in the fields of theoretical astrophysics and high-energy astrophysics. The results will be useful in the fields of general relativity and theoretical astrophysics.
Priority compared to real-world alternatives	The key distinction of this project from previous studies lies in its comprehensive approach to investigating accretion disks, quasi-periodic oscillations (QPOs), and black hole shadows within the spacetime of dilaton black holes. It is expected to yield new data regarding the orbital parameters of particles in accretion disks and their impact on radiative characteristics. Furthermore, an analysis of dilaton black hole shadows, incorporating EHT observations for objects such as Sgr A* and M87*, will be conducted for the first time.
List of publications with links to them	Boshkayev K., Muccino M. Constraints on the Sen black hole mass and charge from quasi-periodic oscillations //The European Physical Journal C. – 2025. – T. 85. – №. 12. – C. 1477. https://doi.org/10.1140/epjc/s10052-025-15167-w
Patents	No patents are planned under the project, since the research is fundamental and theoretical in nature.