Brief information about the project

Name of the project	AP19174979 «Investigation of Quasi-Periodic Oscillations of X-ray Emission from Neutron Stars and Black Holes»
Relevance	Today, one of the key tasks of the general theory of relativity (GR) is to verify the predictions of GR for strong gravitational fields. Thanks to relativistic objects with strong gravitational fields, such as neutron stars and black holes, many effects can be observed. It is possible to check the reliability of GR in the strong field regime and obtain information about the parameters of neutron stars and black holes using quasi-periodic oscillations (QPO) emitted by accretion disks. QPO is a phenomenon associated with the X-ray emission of an astronomical object. One can study with QPO, many processes occurring in the inner regions of accretion disks around neutron stars and black holes. It is also possible to infer the masses, radii and periods of rotation of compact objects. Observations that began at the Rossi X-ray Timing Explorer (RXTE) observatory in 1996 detected rapid variability and found that compact objects (neutron stars and black holes) emit X-rays that have QPOs with frequencies up to 1000 Hz and above. Such types of QPO have been established in which there are two peaks of similar power. This, in turn, shows that high-frequency QPOs can be combined with low-frequency QPOs. Throughout the world, the latest space X-ray telescopes are used for QPO studies. QPOs identified in systems with neutron stars belonged to the Z and Atoll source class
Purpose	The aim of the project is to obtain the parameters of compact objects using QPO data, which can allow testing the effects of GR in the regime of a strong gravitational field.
Objectives	To explain QPO, the proposed project will use the relativistic precession model, since this is one of the simplest models, including a minimum set of free parameters. Information on the mass, quadrupole momentum, and radius of compact objects in low-mass X-ray binaries can be provided by QPO data. The approach that will be used in this project can be considered as an alternative, since it is difficult to obtain accurate mass values in low-mass X-ray binaries from observations. To further confirm the nature of a compact object as a neutron star or a black hole, one should consider a more general solution of the Einstein field equations, considering the mass M, the angular momentum j, and the quadrupole momentum q. Thus, the following key tasks can be formulated: 1. Derivation of fundamental frequencies of test particles in q-metric, Kerr metric and Quevedo-Mashhoon metric;

	2. Analysis of QPO observational data for low-mass X-ray binaries. 3. Obtaining the main parameters of neutron stars and black holes from QPO.
Expected and achieved results	1. Exact solutions of the Einstein equations such as the q-metric and the Quevedo-Mashhoon metric will be investigated. 2. Observable quasi-periodic oscillations from low-mass X-ray binaries will be investigated. 3. Fundamental frequencies will be obtained, such as radial, azimuthal, and polar frequencies of test particles in the field of a rotating deformed body using the q-metric and the Quevedo-Mashhoon metric. 4. The main parameters of neutron stars and black holes such as mass, angular momentum, quadrupole moment, etc. will be inferred. 5. Publication of articles in foreign peer-reviewed scientific journals. - or at least 2 (two) articles and (or) reviews in peer-reviewed scientific publications indexed in the Science Citation Index Expanded of the Web of Science database and (or) having a CiteScore percentile in the Scopus database of at least 35 (thirty-five) and at least 1 (one) patent included in the Derwent Innovations Index database (Web of Science, Clarivate Analytics);
Research team members with their identifiers (Scopus Author ID, Researcher ID, ORCID, if available) and links to relevant profiles	1. Konysbayev Talgar, Senior Researcher, Project Manager. Researcher ID: FEJ-3989-2022; ORCID: 0000-0001-9476-3700; Scopus Author ID: 57219800003. 2. Boshkayev Kuantay, Chief Researcher, Scientific consultant. Researcher ID: AAZ-3346-2020; ORCID: 0000-0002-1385-270X; Scopus Author ID: 54883880400.
List of publications with links to them	-
Patents	-