Contribution ID: **33** Type: **Overview**

The orbital telescope system ERA: Extreme Relativistic Astrophysics

Wednesday, 25 June 2025 17:40 (20 minutes)

One of the most challenging tasks in modern astrophysics is determining the nature and origin of cosmic rays with energies exceeding the Greisen-Zatsepin-Kuzmin (GZK) cutoff (˜50 EeV), known as ultra-high-energy cosmic rays (UHECRs). The primary difficulty lies in their extremely low flux, necessitating experiments with vast exposure areas. The two largest ground-based observatories–the Pierre Auger Observatory (Auger) in Argentina and the Telescope Array (TA) in the USA – cover areas of approximately 3000 km² and 1800 km², respectively. However, neither Auger nor TA can achieve uniform exposure across the entire celestial sphere, a crucial requirement for identifying UHECR sources. Moreover, discrepancies exist between their results concerning the energy spectrum and composition of UHECRs.

An alternative approach to measuring UHECRs from low-Earth orbit (LEO) via extensive air shower (EAS) fluorescence emission was first proposed by J. Linsley in the early 1980s and later developed through projects such as TUS, JEM-EUSO, OWL, and POEMMA. This method offers the advantages of a large observational area and uniform exposure over the celestial sphere. However, designing instruments that combine large aperture, wide field of view, and high temporal resolution presents significant technological challenges.

The ERA (Extreme Relativistic Astrophysics) project proposes a novel solution: deploying a constellation of small spacecraft in LEO, each equipped with identical compact telescopes. Each telescope has a relatively narrow field of view (˜10°) but is capable of detecting at least 10 particles with energies above the GZK limit. The telescopes are launched in pairs to enable stereoscopic observation of EAS tracks, substantially improving the reconstruction accuracy of primary particle parameters, particularly the depth of the shower maximum.

The initial phase involves launching two spacecraft to validate the technique and achieve the first reliable detection of about a dozen UHECR events from space within one year of operation. Ultimately, a fleet of 5 pairs of satellites will provide sufficient statistics to measure the UHECR spectrum across the entire celestial sphere, helping to resolve discrepancies between ground-based experiments. This advancement will mark a critical step toward identifying the sources and acceleration mechanisms of UHECRs and testing hypotheses about the existence of a nearby source (within ˜10 Mpc), potentially enabling its identification.

This report presents the current status of detector development, including the optical system design, photodetectors, spacecraft subsystems, and organizational aspects of preparing and conducting the space-based experiment.

Primary authors: Dr KLIMOV, Pavel (Skobeltsyn Institute of Nuclear Research, Lomonosov Moscow State University); Dr ZOTOV, Mikhail (Skobeltsyn Institute of Nuclear Research, Lomonosov Moscow State University); Dr SHARAKIN, Sergei (Skobeltsyn Institute of Nuclear Research, Lomonosov Moscow State University); Dr BORODIN, Artur (Joint Institute of Nuclear Research); CHUMAK, Sergei (Orbital Systems); Dr KUZNETSOV, Mikhail (Institute for Nuclear Research of the Russian Academy of Sciences); Dr LIVSHITS, Irina (University ITMO); PERETYATKO, Oleg (Skobeltsyn Institute of Nuclear Research, Lomonosov Moscow State University); Dr RUBTSOV, Grigory (Institute for Nuclear Research of the Russian Academy of Sciences); Dr SAPRYKIN, Oleg (Space Regatta Consortium)

Presenter: Dr KLIMOV, Pavel (Skobeltsyn Institute of Nuclear Research, Lomonosov Moscow State University)

Session Classification: Overview Talks

Track Classification: Cosmic rays (nuclei, gammas, neutrinos) of very high energies (> 100 TeV)