DESCRIPTION FOR THE GENERAL PUBLIC

Optical light of astronomical sources has been studied for centuries now using classical telescopes. Nevertheless, particles of light (photons) of higher energies do not reach the ground instruments. X-rays and gamma rays with energies millions to billions times higher than visible light are absorbed in the Earth's atmosphere. Such absorption in the atmosphere gives us an unique possibility to study the highest energy gamma rays: above 30 billion times more energetic than visible light. A gamma-ray photon entering the atmosphere interacts with the atmospheric nuclei producing thousands of secondary electrons and positrons in the so-called extensive air shower. Those particles propagating faster than light in the atmosphere causing emission of faint, nanosecond-long flashes of bluish Cherenkov light. Ground-based telescopes can detect this light and obtain images of individual showers on their cameras. In the last 20 years the current generation of Cherenkov telescopes proven to be successful and allowed us to detect and study the emission of such energetic gamma rays from hundreds of objects.

As our knowledge of processes occurring in astrophysical objects increase, we start to use them as extraterrestrial laboratories for studies of fundamental physics. One such possibility is the search for the so-called Lorentz Invariance Violation (LIV) that could manifest as dependence of the speed of light on its energy. While the constancy of this speed is one of the pillars of the Einstein’s General Relativity, modern theories trying to reconcile General Relativity with Quantum Physics (and obtain a unified Quantum Gravity theory), often require to give up this requirement of the constancy of the speed of light. Such effects can become large only at extreme energies, 28 orders of magnitude higher than the visible light, not reachable neither in human-build or known natural accelerators of particles. However even at much smaller energies, accessible to the Cherenkov telescopes, it is possible to study such effects. The key point is that even tiny deviations are amplified by the cosmological distances to cosmic sources. The radiations emitted at different energies can develop measurable delays of seconds or minutes over their billions of years long travel to Earth.

In this project we propose a novel approach for searching such effects. We plan to use next-generation Cherenkov telescopes, Large-Sized Telescopes (LSTs), part of the future Cherenkov Telescope Array Observatory. We will employ state-of-art analysis methods and newly developed data calibration methods to improve the sensitivity of LSTs to such effects. We will develop theoretical models allowing us to predict and take into account the expected energy-dependent evolution of the emission from cosmic sources. Combining such three-fold approach we expect to detect or significantly improve the limits on the LIV effects.