

NEW PARTICLE OR DARK MATTER DECAY DISCOVERY STUDYING COSMIC RAY SHOWERS

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Introduction. In the field of High Energy Physics today there are several open topics that are left. The Higgs boson has been recently discovered, neutrino oscillations are being studied, and some hints of the dark matter have been detected as well. The large remaining mystery is the origin and the nature of the Ultra-high energy Cosmic Rays (UCR).

Materials and methods. The UCRs of ultra-high energy up to 10^{20} eV have been previously detected by other observatories; however, they suffer from low time resolution and/or location. The functioning prototype system is called HorizonT and has both the optimal high-altitude location at the shower development maximum (~ 3400 m above sea level in Tyan-Shan mountains, Kazakhstan), and the ~ 25 ns range to resolve detail of the UCR and the coordinates of the origin (Figure 1).

Results and discussion. The two new effects have been observed by the prototype. First one is the advanced or retarded arrival of the Cerenkov light w.r.t the muons from the Extensive Atmospheric Shower (EAS). The discovery of the phenomenon was reported in [1,2]. It can be used to determine the type of the EAS primary particle to differentiate between the protons and nuclei. Second one is a completely **new** discovery that was not expected beforehand. The preliminary results have been published in [3]. The prototype has confirmed the existence of so-called multimodal EAS originating from 2-3 UCRs arriving almost simultaneously with the transverse distance of \sim hundreds of meters. Plausible explanations of this discovery currently include a decay of the very heavy parent from an unknown source, or from some exotic source like dark matter decay/ejection or other.



Figure 1. H_or_iz_on T_sy_st_em

Conclusions. To expand the results, next step is to construct the HT-KZ (HorizonT-Kazakhstan) detector system in order to study the ground-breaking phenomena of the multi-modal signals that possibly indicate the new particle discovery and to measure the directions to the origins of the UCRs that are being currently studied.

References.

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