CREDO-edu programme for schools – our way to introduce kids to modern physics and enage in scientific research.

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Abstract. Cosmic Ray research is a new branch of physics and astrophysics, which was not known until their discovery in 1912 by Victor Francis Hess [1]. Its deeper understanding has been possible through the development of electronics and detectors. Therefore it was rarely introduced to school curricula. Our CREDO-edu program will reverse the trend of avoiding 20th-century discoveries in physics lessons. We created an application dedicated to conducting cosmic rays measurements [2] in schools and home environments. Moreover, we prepare a programme of year-round school lessons that fully engage teachers on how to familiarise students with cosmic ray phenomena.

Introduction

While standard way in Cosmic Ray (CR) research is concerned on detection and analysis of CR particles by individual sophisticated observatories, we propose the correlated observations on global scale within the Cosmic-Ray Extremely Distributed Observatory (CREDO) [2]. Our concept of research assumes the need to involve the community into data collection. We construct cheap, compact and easy to operate detectors which could be installed everywhere and CREDO app to use smartphones as detectors. The new task inside CREDO collaboration – CREDO-edu – is the way to engage students into scientific research. Working with schools can give benefits to both sides – researchers who will collect an amount of data taken as planned and in desired schedule. Students will have an unique chance to be involved in a research programme, be a part of a scientific work, look into raw scientific data and propose their own conclusions.

Scientific basis of our work

The correlated observations on a global scale is the new way of measuring CRs. Scientific goal is to observe and understand large scale CR phenomena. Dubbed the Cosmic Ray Ensembles (CRE) are yet not observed groups of primary cosmic rays with a common primary interaction vertex or the same parent particle. Some incidental, unexplained observations of CR signal excess significantly extended in time [3], or seen by very distant detectors [4] might point to the existence of CRE, provided sufficient statistics of similar events can be collected. It is an interesting hypothesis to check with a wider community of participants, possibly also within a citizen science formula [5]. If the CRE will be visible in our data it will give us a new insight to primary CR at the highest energies known, with a possible impact on the foundations of our understanding of the Universe. Observing and analysing correlations between secondary CRs will help us to find traces of physics that happened billions of years ago at the unexplored parts of the Universe.

Additionally there are some very rare observations of high energetic CR particles that were registered only a few times during the history of cosmic ray research. The Oh-My-God (OMG) particle, the CR of the highest energy ever, detected by the Fly's Eye Observatory [6] is a great example of an unexplained rare phenomenon called Ultra High Energy Cosmic Rays (UHECR). Every event of registration of an UHECR at the high-end of the CR energy spectrum is a huge thing in the scientific world, such as the detection of OMG or the Amaterasu particle in Utah [7], the second

highest energy CR. For the UHECR of energies of 10^{20} eV probability of registration is one particle per 1 km^2 in 1000 years. A globally coordinated CR detection and analysis effort as proposed and implemented within CREDO could increase the chance of registration of UHECR at the high-end of the CR energy spectrum, and of those CRE which consist of at least one UHECR.

Educational values of CREDO-edu

To achieve an optimum performance of a global network of CR detectors one needs a proper balance between the quality of detectors and their density. While universities and research centres can afford and operate professional detectors or even detector arrays of high quality and precision, the maximum density of such locations might not be sufficient to successfully implement a global research strategy dedicated to CRE and to UHECR. On the other hand there exists another network of numerous locations where there is interest in both science and education: schools. Provided low- cost CR sensors, such as smartphones [2] or pocket size devices [8], and basic analysis know- how are made available for the students and their teachers, a school network might be an excellent environment to locate the detector. According to Digital Care researches we have more than 30 millions of unused smartphones in Poland so we assumed that every school participating in the programme could allocate at least one smartphone for measurement purposes.

CREDO-edu programme is a package of around 20 lesson scenarios – exact duration depends on teachers' decision on taking a part in additional activities and number of students in a group. First meeting we plan online – during the short course we are going to familiarise students and teachers with the CREDO app. Then most of the time schools will work at their own pace. First part of scenarios concerns reasons why CR is in our interest. Topics focus on the possible applications of the phenomena, in particular on the connections between CR fluxes and earthquakes [2]. This part also serves to equalise the level of knowledge in the group. The second part revolves around better knowledge of CR phenomena. The last, most advanced part is an introduction to data analysis techniques.We hope that before this part student teams will participate in collecting fresh data.which lets us work with the latest data. During this part we also plan a couple of online meetings during which we will discuss with students about collected data and further experimental plans. All of the scenarios are based on simple and low cost experiments available for schools without a fully equipped laboratory. This program is our voice in the ongoing curriculum discussion. We present a way to introduce contemporary physics issues to schools without relying on advanced mathematical techniques.

Conclusion

We present a new idea of cooperation between schools and research centres. In our CREDO-edu programme all of the participants are beneficial – the researchers as they get a great amount of raw data and the schools because of being a part of innovative schools workshops. The CREDO-edu will bring closer the scientific methods and understanding of modern physics phenomena.

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