Future Plans for Cosmic Ray Activities in Saudi Arabia

Maghrabi A. H., Alharbi H.H., Alghamdi A.S.
National Centre For Mathematics and Physics, King Abdulaziz City For Science and Technology, Riyadh, Saudi Arabia.
amaghrabi@kacst.edu.sa

Abstract: Optical astronomy, solar and lunar studies are the most interesting fields of studies among astronomy researchers in Saudi Arabia, while detecting and studying the cosmic ray are considered to be a new field of research in the country. This paper presents brief discussion of the main objectives of establishing cosmic ray detecting and monitoring systems in Saudi Arabia. These include the future plans for constructing different types of cosmic ray detectors for various research activities, such as cosmic ray variations studies. Also, our vision of joining the international experiments, such as the AUGER project, are discussed. Our proposal for establishing the cosmic ray outreach program for pre degree level students in schools and underground level university students are outlined too.

Keywords: Detectors, GEM, cosmic rays, muon, Saudi Arabia, Outreach.

1 Beginning of Cosmic Rays in Saudi Arabia

The large fraction of professional observational astrophysics deals either with photons in other energy ranges (such as x-rays and gamma-rays) for which the emission processes are often related to cosmic rays or with particle astrophysics directly [1]. So, as part from high-energy astrophysics branch, the cosmic ray field of study has opened new windows to the physical worlds and gave a birth to many new scientific disciplines. The modulation of cosmic ray by solar activity results in changing the global electrical properties of the atmosphere, which is in turn believed to affect weather and climate which attracts interest scientists from different field of research [2, 7]. Ground-based cosmic ray monitors considered as the most effective tools to study cosmic ray variations and its link to different applications [8]. Therefore, monitoring cosmic ray variations on different time scales is of a great importance. Here in Saudi Arabia, optical astromony is the main field of research. Particle physicists involved in high energy experiments, with no real activity on cosmic ray research.

In 2000 studies of cosmic rays were announced as one of the new research area at institute of Astronomical and Geophysical Research, of King Abdulaziz city for science and technology (KACST). This research was by designing and constructing muon detector. This was done through the joint efforts between KACST and the high energy astrophysics group at the University of Adelaide, Australia. The construction of the detector was completed in July 2002 and has been in operation since that time [9]. Between 2003 and 2008, KACST researchers have been involved in various technological space borne studies and little work was done in cosmic rays.

2 KACST Detector Laboratory (KDL)

In early 2009, the National Centre for Mathematics and Physics (NCMP) at KACST has launched a project aiming to establish a radiation detector laboratory at KACST. This project aims to transfer technology from international institutions to Saudi scientists, which will result in the participation of Saudi scientists in international experiments and collaborations in modern detector technology. Between May 2009 and December 2011, we have been involved in construction and building the lab and equip it with all the necessary materials. Early 2012 we have started our research activities at the lab by two projects. These are constructing a small gas electron multiplier (GEM) detector and muon detector. In the following, we will briefly discuss these two projects.

2.1 Gas electron multiplier (GEM) detector

The first research activity conducted at our lab was to build a prototype simple radiation gas detector, with collaboration and advices from GSI labs in Germany, and from the available resources at our lab. We have succeeded in designing and constructing a small 10x10 cm2 GEM detector as shown in figure (1). More details of this project can be found in [10]. The next plans will be to modify the prototype GEM detector for both medical and cosmic ray detection applications. Since it is the first time that such kind of detectors used for cosmic ray measurements, we are in the phase of doing a complete simulation of detection setup to study its feasibility.
2.2 Small Muon Detector
The second research activity at our lab was to develop different types of cosmic ray detectors. From the available resources, we have designed and installed a small scintillator detector (250x250 mm) to detect the cosmic ray muons. The detailed descriptions of the design concepts, constructions, and calibration procedures for this detector are given in [11]. Results from this detector are given in [12]. A new design with diminution of 100x100 cm scintillator for continues monitoring of the vertical incident muons, and a rotatable system to detect muons at different zenith angles was built, figure (2). A more ambitious program to build and operate two different types of cosmic ray detectors, Cerenkov water detectors and neutron monitors, is currently in progress.

2.3 Outreach Program
Astrophysics teaching at schools is often supplemented with the use of optical or radio telescopes to demonstrate observational techniques, but many schools find cost an inhibiting factor in demonstrating high-energy particle physics. The purpose of this part of the KDLs project is to explore the possibility of designing and constructing cosmic ray detectors, which could be used to assist in teaching pre degree level students in schools. In this regard, an outreach project was discussed with ministry of education to install and operate school-based muon detectors in coordination with KACST researchers. A required fund was allocated for this project. At this stage, muon detectors are deployed in some schools in Riyadh. Later a national network of cosmic detectors will be installed all over the kingdom.

3 Future plans and research activities in Cosmic Ray in Saudi Arabia
There are several future studies in cosmic ray variations of great interest for the community of cosmic rays, and data from our location is of a great importance. These include:

- The impact of cosmic rays on cloud formation and its effect on climate changes will be one of the expected future studies.

Future plans for cosmic ray program in Saudi Arabia include:

- Train and qualify national staff in designing and developing radiation detectors.
- Research group members need to get experience in theoretical investigations of different aspects of cosmic rays, such as transport and modulation of galactic cosmic rays in the heliosphere, acceleration and propagation of solar energetic particles, and terrestrial effects caused by energetic cosmic rays.
- Train our staff in handling and analyzing cosmic rays data and conduct the theoretical simulations using the appropriate softwares.
- Establishing scientific and technical collaboration with international institutions.
- Joining the international cosmic ray program such as the AUGER project and QuarkNet program at Fermi National Accelerator Lab is one of the aims for establishing cosmic ray field of research. Joining such international project will help in raising the ability of the researchers in Saudi Arabia by experts exchange program.
- Conducting cosmic ray educational workshops for teachers and students. We are planning to increase the number of the detectors that will allow having an array, which will enable us for advance cosmic ray experiments such as air shower and directional studies of arrival cosmic rays. This will serve as a starter for a future activity dedicated to the study of UHECR (Ultra High Energy Cosmic Rays).

4 Conclusion
Due to its importance to many fields of researches, cosmic ray studies become crucial field, hence Saudi scientist should involve in such topics. KACST started the efforts in establishing cosmic ray activates by constructed and equipped the first physics detectors laboratory in the country for designing different type of radiation detectors for various applications. The outreach program was started with collaboration of ministry of education at Riyadh schools. Several communications with similar international programs were done to be a part of the international muon detection network. More scientific collaborations with international institutes and organizations are ongoing for more technology transfer and training purposes.

Acknowledgment: The authors would like to thank the King Abdulaziz City for Science and Technology (KACST) for supporting this work.

References