



Contribution ID: 1435

Type: **Talk**

Highlights from the GRAPES-3 Experiment on Galactic Cosmic Ray Measurements

Wednesday 23 July 2025 16:21 (15 minutes)

The GRAPES-3 experiment, located in Ooty, India (11.0°N , 76.7°E , 2200 m a.s.l.), uses a dense array of 400 plastic scintillator detectors and a 560 m^2 tracking muon detector to measure all charged particles and the muonic components of cosmic ray showers, respectively. The experiment has measured the cosmic ray proton spectrum in the energy range of 50 TeV to 1.3 PeV, and the relative composition of proton was determined using muon multiplicity distributions. A spectral hardening was observed beyond 166 TeV, challenging the simple power-law description extending to the knee energy. Machine learning techniques are being explored to extract composition for other elements using composition sensitive parameters such as multiplicity distributions, shower age and other less discriminating parameters. Various high energy hadronic interaction models existing in the framework of CORSIKA including QGSJET-II-04, SIBYLL 2.3d, EPOS-LHC were studied including muon multiplicity distributions and lateral distributions and compared with the observed data. Furthermore, two significant small-scale anisotropic structures in the cosmic ray arrival distribution were detected at a median energy of 16 TeV, consistent with results from the HAWC and ARGO-YBJ experiments. With the same data set, large-scale anisotropy has been observed including dipolar structures with an iterative maximum likelihood method with a statistical significance exceeding 10 standard deviations. A second muon detector of 560 m^2 area is in the advanced stage of its construction with 40% of modules are operational. The expanded muon detector will enhance the sensitivity for detection of gamma ray sources. This presentation will highlight these findings, along with updates on the status of the detector upgrades and future plans.

Collaboration(s)

GRAPES-3

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Session Classification: CRI

Track Classification: Cosmic-Ray Indirect