T 37: Kosmische Strahlung 4

Zeit: Dienstag 11:00–12:45 Raum: H 4

T 37.1 Di 11:00 H 4

Cosmic ray radio detection: fast forward model and imaging — •David Butler[1], Tim Huege[1], Torsten Ensslin[2], and Olaf Scholten[3] — [1]Institut für Kernphysik, Karlsruher Institut für Technologie — [2]Max-Planck-Institut für Astrophysik, München — [3]Center for Advanced Radiation Technology, University of Groningen

The radio detection method for cosmic rays relies on coherent emission from electrons and positrons which is beamed in a narrow cone along the direction of the primary particle. Currently the only models to reproduce this emission with sufficient accuracy are Monte Carlo based simulations of the particle physics, which require large investments of computation time. Even then the final analysis relies on simple metrics and empirically determined correlations to retrieve quantities of interest.

The work presented here focuses on condensing the simulation results into a semi-analytical model, preserving the accuracy of the microscopic interactions while significantly reducing the computation time required for end-user analyses.

Going further one could use this knowledge to perform a tomographic reconstruction of the air shower, i.e. infer its development history only from ground-based measurements. This would open new avenues beyond the standard Xmax reconstruction, allowing more detailed analyses of individual air showers.

T 37.2 Di 11:15 H 4

Search for Cosmic Particles on the ZeV Scale with the Moon and LOFAR — •Tobias Winchen[1], A. Bonardi[2], S. Buitink[1], A. Corstanje[2], J. E. Enriquez[2], H. Falcke[2,3,5], J. R. Hörandel[2,3], P. Mitra[1], K. Mulrey[1], A. Nelles[2,3,7], J. P. Rachen[2], L. Rossetto[2], P. Schellart[2,8], O. Scholten[4,6], S. Thoudam[2], T.N.G. Trinh[4,6], and S. ter Veen[5] — [1]Vrije Universiteit Brussel (Belgium) — [2]Radboud University Nijmegen (The Netherlands) — [3]NIKHEF (The Netherlands) — [4]KVI-CART (The Netherlands) — [5]ASTRON (The Netherlands) — [6]University of Groningen (The Netherlands) — [7]Now at University of California Irvine (USA) — [8]Now at Princeton University (USA)

A significant challenge to answer the long standing question about the origin and nature of ultra-high energy cosmic rays (UHECR) is given by their extremely low flux. Even lower fluxes of neutrinos with energies beyond the ZeV (10^{21} eV) scale are predicted in certain Grand-Unifying-Theories (GUTs) and e.g. models for super-heavy dark matter (SHDM). The significant increase in detector volume required to detect these particles can be achieved by employing Earth's moon as detector and search for radio pulses that are emitted when a particle interacts in the lunar rock with a radio telescope. Here, we give an overview on the design and status of a corresponding search with the LOFAR radio telescope.

T 37.3 Di 11:30 H 4

Measuring the depth of shower maximum with SKA1-low: a first simulation study — •Anne Zilles[1], Stijn Buitink[2], and Tim Huege[3] — [1]Institut für Experimentelle Kernphysik, Karlsruher Institut für Technologie, Deutschland — [2]Astrophysical Institute, Vrije Universiteit Brussel, Belgien — [3]Institut für Kernphysik, Karlsruher Institut für Technologie, Deutschland

As LOFAR has already demonstrated, using a dense array of radio antennas for detecting extensive air showers initiated by cosmic rays in the Earth's atmosphere makes it possible to measure the depth of shower maximum for individual showers with a statistical uncertainty of less than $20\,\mathrm{g/cm^2}$. This allows detailed studies of the mass composition in the energy region around 10^{17} eV where the transition from a galactic to an extragalactic origin could occur.
As of 2023, the Square Kilometre Array will constitute the world's largest telescope in radio astronomy. Since SKA1-low, the low frequency part, ideally suited to detect extensive air showers initiated by cosmic ray via radio emission, will provide a much denser and very homogeneous antenna array with roughly 70.000 antenna on an area of about $0,5\,\mathrm{km^2}$ and a large bandwidth of $50-350$ MHz it is expected to reach an even smaller uncertainty on the shower-maximum reconstruction. We present results of a first simulation study with focus on the potential to reconstruct the depth of shower maximum for individual showers measured with SKA1-low, showing that a mean reconstruction uncertainty of less than $10\,\mathrm{g/cm^2}$ seems to be achievable.

T 37.4 Di 11:45 H 4

Radio emission from a particle cascade in a dense medium and in magnetic fields: Modelling and its experimental validation with the SLAC T-510 experiment — •Anne Zilles for the SLAC T-510-Collaboration — Institut für Experimentelle Kernphysik, Karlsruher Institut für Technologie, Deutschland

The SLAC T-510 experiment was designed to compare controlled laboratory measurements of radio emission of particle showers to particle-level simulations, which are relied upon in ultra-high-energy cosmic-ray air shower detection. Established formalisms for the simulation of radio emission physics, the "end-point" formalism and the "ZHS" formalism, lead to results which can be explained by a superposition of magnetically induced transverse current radiation and the Askaryan (charge-excess) effect. Here, we present the comparison of the results of Geant4 simulations, including the formalisms, and measured data of the SLAC T-510 experiment within the scope of e.g. linearity with magnetic field and angular distribution of the signal amplitude showing that microscopic simulations reproduce the measurements within uncertainties and give a very good description of the data.

T 37.5 Di 12:00 H 4

Systematische Unsicherheit der Energiebestimmung von Luftschauern mittels Radioemission* — •Marvin Gottowik und Julian Rautenberg für die Pierre Auger-Kollaboration — Bergische Universität Wuppertal

Mit dem Auger Engineering Radio Array (AERA) beim Pierre-Auger-Observatorium konnte kürzlich gezeigt werden, dass sich die absolute Energie von Primärteilchen der kosmischen Strahlung aus der Radioemission des Luftschauers präzise bestimmen lässt. Zur Abschätzung der systematischen Unsicherheit dieser Beziehung werden die zwei verschiedene Monte-Carlo-Simulationen CoREAS und ZHAireS verglichen. Die Simulationen werden bestmöglich mit gleichen Einstellungen durchge- führt. Insbesondere wird einheitlich SIBYLL 2.1 als Modell für die hadronischen Interaktionen sowie dieselbe Modellierung der Atmosphäre verwendet. Verbleibende Unterschiede können auf die Berechnung der Radioemission mit dem Endpunkt-Formalismus- bzw. dem ZHS-Algorithmus zurückgeführt werden. Aus dem Vergleich einer Vielzahl von Luftschauern mit unterschiedlicher Energien und Richtungen lässt sich die systematische Unsicherheit auf die Energie der elektromagnetischen Komponente bestimmen.

** Gefördert durch die BMBF Verbundforschung Astroteilchenphysik (Vorhaben 05A14PX1).*

T 37.6 Di 12:15 H 4

Non-thermal radiation from cloud-disk collisions in active galactic nuclei — •Ana Laura Müller[1,2] and Gustavo Esteban Romero[1,3] — [1]Instituto Argentino de Radioastronomía (CCT-La Plata, CONICET; CICPBA), Villa Elisa, Argentina — [2]Karlsruher Institut für Technologie, Karlsruhe, Germany — [3]Facultad de Ciencias Astronómicas y Geofísicas (Universidad Nacional de La Plata), La Plata, Argentina

The ultraviolet and optical spectra of active galactic nuclei (AGN) have prominent broad emission lines, produced close to the central black hole. The emitting gas is contained in the so-called broad line region (BLR). Clouds with velocities in the range from ~ 1000 km $\mathrm{s^{-1}}$ to ~ 5000 km $\mathrm{s^{-1}}$ exist within this region. Because of the random velocity distribution of the clouds, direct collisions with the accretion disk feeding the AGN should occur. Assuming the typical parameters for clouds and an accretion disk, we estimate that $\sim 10^{43}$ erg can be released per impact. The collision produces two shock waves, one propagating through the disk and the other moving through the cloud. This scenario might be in principle favorable to the acceleration of particles by first order Fermi mechanism. We present estimates of the cosmic ray production inside the shocked cloud and model the non-thermal emission. We also offer a brief discussion of the contribution of this process to the total variability of AGNs.

T 37.7 Di 12:30 H 4

A test of the existence of primary protons in cosmic rays — •Philipp Heimann[1], Kevin Lopata[1], Markus Risse[1], and Alexey

Yushkov[2] for the Pierre Auger-Collaboration — [1]Universität Siegen, Department Physik — [2]Instituto de Tecnologías en Detección y Astropartículas, Buenos Aires, Argentinien

We present a method to test whether at a certain primary energy, protons exist in the cosmic-ray beam. We introduce a probability measure for air shower events in a sample to be produced by helium, which includes all uncertainties of a detector. If this probability is small one can exclude helium or heavier nuclei as the primary candidates, leading thus to a conservative conclusion that the shower was produced by a primary proton. We show that even a single deep event might be enough to conclude that protons exist in the primary beam up to the event's energy.

Gefördert durch die BMBF-Verbundforschung Astroteilchenphysik sowie der Helmholtz-Allianz für Astroteilchenphysik.