T 78: Kosmische Strahlung IV

Zeit: Donnerstag 16:30–19:00 Raum: Philo-HS6

T 78.1 Do 16:30 Philo-HS6

Correlation analysis between arrival directions of ultra-high energy cosmic rays and positions of starburst galaxies — •Marcus Wirtz, Tersa Bister, Martin Erdmann, and Martin Urban — III. Physikalisches Institut A, RWTH Aachen University, Deutschland

A strong correlation between the arrival directions of ultra-high energy cosmic rays above 39 EeV and the positions and fluxes of nearby starburst galaxies has been discovered recently. By performing a likelihood analysis with symmetric search radius around the galaxy positions, an isotropic arrival hypothesis can be excluded at the 4.0σ confidence level. We extend this model by introducing an individual charge-sensitive cosmic ray weight in the likelihood, and therefore account for our current understanding of cosmic ray deflection in the galactic magnetic field.

T 78.2 Do 16:45 Philo-HS6

The Cosmic-Ray Shadow of the Moon and Sun: Seven Years of Data from the IceCube Neutrino Observatory and Particle Propagation within the Solar Magnetic Field — •Frederik Tenholt, Julia Tjus, and Fabian Bos for the IceCube-Collaboration — Ruhr-Universität Bochum

The shadowing effect of the Moon and Sun in high-energy cosmic rays has been measured with high statistical significance by several experiments. Unlike particles from the direction of the Moon, charged particles passing the Sun are deflected due to the solar magnetic field. Because of this deflection, a change in the shape and depth of the cosmic-ray Sun shadow measured at Earth is expected.

While the Moon shadow is used to estimate the angular resolution and to verify the stability of the IceCube detector, we use the Sun shadow in order to investigate a possible correlation between solar shadowing and solar activity, which is, in turn, a measure for the strength of the near magnetic field of the Sun. Ultimately, we aim to simulate both the Moon and Sun shadow in order to verify the data results and to quantitatively investigate particle deflection due to the solar magnetic field.

In this talk, we present results from seven years of data from the IceCube Neutrino Observatory and first conclusions about the temporal variation of the cosmic-ray shadow of the Sun.

T 78.3 Do 17:00 Philo-HS6

Untersuchung der Abschattung kosmischer Strahlung durch die Sonne mithilfe von Teilchenpropagation im sonnennahen Magnetfeld — •Niklas Döpper[1], Mike Kroll[1], Julia Becker Tjus[1], Horst Fichtner[1], Frederik Tenholt[1] und Paolo Desiati[2] — [1]Ruhr-Universität Bochum — [2]Wisconsin IceCube Particle Astrophysics Center, Madison, USA

Kosmische Strahlung ist eine hochenergetische Teilchenstrahlung, deren Quellen in der Milchstraße sowie in anderen Galaxien liegen, und die zum größten Teil aus Protonen besteht. Da elektrisch geladene Teilchen wie Protonen von dem Magnetfeld der Sonne abgelenkt werden, lassen sich über ihre Ablenkung Rückschlüsse auf die Stärke und Struktur des Sonnenmagnetfeldes ziehen. In diesem Vortrag geht es um die Simulation der Trajektorien von Protonen im sonnennahen Magnetfeld. Von Interesse ist dabei die Form des sogenannten Sonnenschattens, der durch die Abschirmung der kosmischen Strahlung durch die Sonne auf der Erde entsteht und von Experimenten wie Tibet, HAWC und IceCube im GeV - PeV Bereich gemessen werden kann. Die Ergebnisse der Simulation werden bezüglich zweier Verfahren zur Lösung der Bewegungsgleichungen verglichen: Dem klassischen Runge-Kutta-Verfahren sowie dem sogenannten Boris-Push, einem von J.P. Boris entwickelten Verfahren. Perspektivisch ermöglicht ein Vergleich des simulierten Sonnenschattens mit experimentellen Daten eine Untersuchung verschiedener Modelle zur Beschreibung des sonnennahen Magnetfeldes.

T 78.4 Do 17:15 Philo-HS6

Investigation of cosmic ray deflections in cosmic magnetic fields for the source hypothesis of starburst galaxies — •Paula Bigalke, Teresa Bister, Martin Erdmann, Martin Urban, and Marcus Wirtz — III. Physikalisches Institut A, RWTH Aachen University, Deutschland

Magnetic field deflections of cosmic rays provide rigidity dependent patterns which can be exploited in anisotropy studies on small and intermediate scales. The galactic magnetic field leads to coherent displacements in the arrival directions and small scale turbulent components in extragalactic and galactic regions induce a symmetric scatter around the source directions.

Recently, an indication for anisotropy in the arrival directions of UHECRs correlating with the flux patterns of the Starburst Galaxy source catalogue was found. In order to further study this Starburst Galaxy scenario we investigate several observables sensitive to patterns originating from deflections in cosmic magnetic fields.

T 78.5 Do 17:30 Philo-HS6

Cosmic ray production in superwinds generated by starbursts — •Ana Laura Müller[1,2,4], Gustavo Esteban Romero[1,3], and Markus Roth[2] — [1]Instituto Argentino de Radioastronomía (CCT-La Plata, CONICET; CICPBA), Villa Elisa, Argentina — [2]Institut für Kernphysik (Karlsruher Institut für Technologie), Karlsruhe, Deutschland — [3]Facultad de Ciencias Astronómicas y Geofísicas (Universidad Nacional de La Plata), La Plata, Argentina — [4]Instituto de Tecnologías en Detección y Astropartículas (CNEA, CONICET, UNSAM), Buenos Aires, Argentina

Starburst galaxies have an exceptionally high rate of star formation. Stellar winds of massive stars and supernova explosions produce a high-temperature cavity in the nuclear region of these objects. This very hot gas expands adiabatically and escapes from the galaxy creating a superwind which sweeps matter from the galactic disk. The collision of the superwind with the halo and swept-up material generates shock waves and turbulent conditions where cosmic rays might be accelerated up to high energies. We present our results for the acceleration rate, particle distributions, and non-thermal emission resulting from this astrophysical scenario in the case of nearby galaxy NGC 253. We conclude that NGC 253 and galaxies with similar starbursts can only accelerate heavy nuclei up to $\sim 10^{18}$ eV unless some very special conditions occur. Further research is necessary to assess quantitatively this latter possibility.

T 78.6 Do 17:45 Philo-HS6

Tidally disrupted stars as a possible origin of both cosmic rays and neutrinos at the highest energies — •Daniel Biehl[1], Denise Boncioli[1], Cecilia Lunardini[2], and Walter Winter[1] — [1]Deutsches Elektronen-Synchrotron (DESY), Platanenallee 6, D-15738 Zeuthen, Germany — [2]Department of Physics, Arizona State University, 450 E. Tyler Mall, Tempe, AZ 85287-1504 USA

Tidal Disruption Events (TDEs) are processes where stars are torn apart by the strong gravitational force near to a massive or supermassive black hole. If a jet is launched in such a process, particle acceleration may take place in internal shocks. We demonstrate that jetted TDEs can simultaneously describe the observed neutrino and cosmic ray fluxes at the highest energies if stars with heavier compositions, such as carbon-oxygen white dwarfs, are tidally disrupted and these events are sufficiently abundant. We simulate the photo-hadronic interactions both in the TDE jet and in the propagation through the extragalactic space and we show that the simultaneous description of Ultra-High Energy Cosmic Ray (UHECR) and PeV neutrino data implies that a nuclear cascade in the jet develops by photo-hadronic interactions.

T 78.7 Do 18:00 Philo-HS6

Influence of the source evolution on the energy spectrum, chemical composition and anisotropy of ultra-high-energy cosmic rays* — •David Wittkowski and Karl-Heinz Kampert — Bergische Universität Wuppertal, Gaußstr. 20, 42119 Wuppertal

In the context of ultra-high-energy cosmic rays (UHECR, cosmic charged particles with energies $E > 1$ EeV), most of the main questions are still unanswered. This includes the important question about the sources of UHECR. A reason for this lack of knowledge is that on the way from their sources to Earth UHECR interact with the photon background and are deflected in cosmic magnetic fields, which obscures the origin of UHECR measued at Earth. To examine these questions, we carried out realistic simulations of the UHECR' propagation to Earth, taking into account all relevant effects on the propagation, and compared the results with experimental data measured at Earth. In this talk, we present a novel astrophysical scenario that – in contrast to previous approaches – correctly reproduces the measured energy spectrum, chemical composition and anisotropy of UHECR. Furthermore, we address how these observables depend on the cosmological evolution of the UHECR' sources and discuss conclusions that can be drawn about the sources.

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T 78.8 Do 18:15 Philo-HS6

Die Leistung der ultrahochenergetischen kosmischen Strahlung von Radiogalaxien im Vergleich — •Karolin Hymon, Julia Tjus und Björn Eichmann — Ruhr Astroparticle and Plasmaphysics Center, Ruhr-Universität Bochum, Theoretische Physik IV, Bochum, Germany

Der Ursprung der ultrahochenergetischen kosmischen Strahlung (UHECR) ist noch immer eines der großen Rätsel der Astrophysik. Eine der meistdiskutierten möglichen Quellen dieser höchst-energetischen Teilchen (mit $E > 5$EeV) sind Aktive Galaktische Kerne (AGN). AGN bilden ein- bzw. zweiseitige Plasma-Jets,die Strahlung im Radiowellen- bis Gammabereich emittieren. Dazu muss kosmische Strahlung in diesen Objekten beschleunigt werden, vermutlich sogar bis zu Energien von einigen EeV. Die Jetleistung kann über die Radioleuchtkraft oder die Masse des zentralen super-massiven schwarzen Lochs abgeschätzt werden.

In dem Vortrag sollen die verschiedenen Korrelationen, welche sich hieraus für die Jetleistung ergeben, verglichen und diskutiert werden. Darüber hinaus wird der Anteil der kosmischen Strahlung an der gesamten Leistung des Jets abgeschätzt und die maximale Energie der individuellen radiolauten AGN bestimmt. Solche physikalischen Charakterisierungen der möglichen Quelle der UHECR stellen eine notwendige Grundvoraussetzung für weitere Analysen dar.

T 78.9 Do 18:30 Philo-HS6

Cosmic rays from the Galactic termination shock — •Lukas Merten[1,2], Chad Bustard[3], Ellen Zweibel[3,4], and Julia Becker Tjus[1,2] — [1]Ruhr-Universität Bochum, Theoretische Physik IV, Bochum, Germany — [2]Ruhr Astroparticle and Plasmaphysics Center — [3]Physics Department, University of Wisconsin-Madison, Madison, WI 53706 — [4]Department of Astronomy, University of Wisconsin-Madison, Madison, WI 53706

Although several theories for the origin of cosmic rays in the region between the spectral "knee" and "ankle" exist, this problem is still unsolved. A variety of observations suggest that the transition from Galactic to extragalactic sources occurs in this energy range.

In this work we examine if a Galactic wind outflow which eventually forms a termination shock far outside the Galactic plane can contribute as a possible source to the observed flux in the region of interest. In previous work by Bustard et al. was shown that particles can be accelerated up to energies above the "knee" up to $R_{\max} = 10^{16}$ V. The remaining questions is if the accelerated cosmic rays can propagate back into the Galaxy.

To answer this crucial question, we simulated the propagation of the cosmic rays using the CRPropa framework. The setup included all relevant processes, like three-dimensional anisotropic spatial diffusion, advection and corresponding adiabatic cooling. We find that, assuming realistic parameters for the shock evolution, a possible Galactic termination shock can contribute significantly to the energy budget in the knee region and above.

T 78.10 Do 18:45 Philo-HS6

An empirical modification of the force field approach to describe the modulation of galactic cosmic rays close to Earth in a broad range of rigidities — Jan Gieseler, •Bernd Heber, and Konstantin Herbst — IEAP, University of Kiel, Germany

On their way through the heliosphere, Galactic Cosmic Rays (GCRs) are modulated by various effects before they can be detected at Earth. This process can be described by the Parker equation, which calculates the phase space distribution of GCRs depending on the main modulation processes: convection, drifts, diffusion and adiabatic energy changes. A first order approximation of this equation is the force field approach, reducing it to a one-parameter dependency, the solar modulation potential ϕ. Utilizing this approach, it is possible to reconstruct ϕ from ground based and spacecraft measurements. However, it has been shown previously that ϕ depends not only on the Local Interstellar Spectra (LIS) but also on the energy range of interest. We have investigated this energy dependence further, using published proton intensity spectra obtained by PAMELA as well as heavier nuclei measurements from IMP-8 and ACE/CRIS. Our results show severe limitations at lower energies including a strong dependence on the solar magnetic epoch. Based on these findings, we will outline a new tool to describe GCR proton spectra in the energy range from a few hundred MeV to tens of GeV over the last solar cycles.