EP 16: Astrophysik I

Time: Thursday 10:30–12:30 Location: V55.21

EP 16.1 Thu 10:30 V55.21

A spatially resolved shock-in-jet model of blazars — •Stephan Richter and Felix Spanier — ITPA, Universität Würzburg, Germany

So called Synchrotron Self Compton (SSC) models have been quite successful in explaining the emissions of blazars. However, observational results of the last years, most importantly intra day variability and certain time lags between different bands, have led to the conclusion that the usual approach of modelling blobs in blazar jets as homogeneous regions employing SSC codes is not sufficient.

Here a linearly, spatially resolved, self-consistent SSC model with particle acceleration due to Fermi-I and -II processes is presented. The electron spectra are evolving from a low energetic delta distribution by means of these processes. In contrast to homogeneous models the Fermi-I process is modelled as actual scattering around shock fronts, while keeping causality when convecting particles through space, thus multiple-shock scenarios can be computed. The effects of adiabatic losses on the particles and hence on the spectral energy distribution (SED) can be investigated. The SED is calculated in each spatial slice using the full IC cross section employing highly parallelised graphic processing units. Hence the presented model is able to explain observed SEDs of leptonic sources as well as to verify high variability results from acausal simulations. High variability can be achieved not only via injection of particles but also due to the presence of multiple shocks. This is shown for data from the recent multi-frequency campaign on Mrk 501.

EP 16.2 Thu 10:45 V55.21

The blazar-sequence as blazar evolution? — •Matthias Weidinger and Felix Spanier — ITPA, Campus Hubland Nord, Universität Würzburg, Emil-Fischer-Str. 31, 97074 Würzburg

The dominating radiation processes leading to the second peak in the typical double humped blazar spectra as well as the differences in Flat Spectrum Radio Quasars and BL Lac objects have been puzzling for years now. An evolutionary scenario is presented giving rise to the features of the vast types of sources along the blazar-sequence as the gas-density in the subjacent galaxy decreases and hence the accretion rate declines. In the applied consistent, time dependent hybrid (i.e. leptonic and hadronic processes are considered) emission model this leads to a abating magnetic field of the considered emitting region allowing more and more protons to escape. The blazar-sequence is thus consistently explained as the hadronicness of the relativistic outflow. This naturally leads to a dichotomy in various manifestations of Active Galactic Nuclei often observed.

EP 16.3 Thu 11:00 V55.21

Modelling of blazar SEDs with the nonlinear SSC cooling process — •Michael Zacharias and Reinhard Schlickeiser — Theoretische Physik IV, Ruhr-Universität Bochum, Germany

Currently, inverse Compton dominated blazars (mostly FSRQ) are modelled assuming strong external photon fields that are scattered by highly relativistic electrons in the jet of AGN. This is justified by the observed strong emission of the accretion disk, the broad line region, and/or the dusty torus leading to rather simple cooling terms for the electrons. Thus, a steady-state approach for the electron distribution is normally adopted.

However, observations of fast variability invalidate the steady-state assumption requiring a time-dependent treatment. In fact, this is also demanded by the nature of the SSC process, which is normally regarded as being irrelevant for FSRQ modelling. However, if one takes into account the time-dependent nature of the SSC process for the electron cooling, the emerging photon SEDs are significantly altered.

We were able to show that even in a simple SSC scenario the nonlinear cooling process results in a dominating inverse Compton peak, contrary to what is usually obtained using SSC. We also found that the synchrotron peak exhibits a unique broken power-law, which does not need the usually assumed underlying broken power-law electron distribution.

We applied our model to strong flares of the blazars 3C 279 and 3C 454.3 and obtained very good fits with reasonable parameters.

EP 16.4 Thu 11:15 V55.21

Nuclear Lines as a Fingerprint of Hadronic Cosmic Rays — •Alexander Summa, Dominik Elsässer, and Karl Mannheim — Institut für Theoretische Physik und Astrophysik, Würzburg

Potential sources of cosmic rays can be observed through their gamma-ray emission. At high energies, the ambiguity between inverse-Compton emission and pion-decay gamma rays cannot easily be resolved. The experimental proof of nuclear de-excitation line spectra would therefore be of utmost diagnostic importance. Here, we focus on prospects for detecting nuclear de-excitation lines in the Wolf-Rayet supernova remnant Cassiopeia A. We calculate the spectrum of prominent gamma-ray lines using the proton spectrum inferred from high energy measurements by MAGIC and FERMI and the chemical abundances in the reverse shock region obtained from X-ray spectroscopy. It is shown that low-energy cosmic rays accelerated at the reverse shock are able to produce a flux of nuclear de-excitation lines which would be clearly detectable by a future telescope mission in the MeV range.

EP 16.5 Thu 11:30 V55.21

Identifikation leptonischer CR-Quellen mit einem numerischen Transportmodell — •Alex Ivascenko und Felix Spanier — ITPA, Universität Würzburg

Wir präsentieren unser CR-Transportmodell in Anwendung auf die hochenergetischen Elektronen im ISM. Das Modell ist eine numerische Erweiterung des in Hein und Spanier (2008) vorgestellten analytischen Modells und behandelt Orts- und Impulsdiffusion, Entweichverluste, Beschleunigung durch den Fermi I Prozess sowie kontinuierliche Energieverluste. Zum Lösen der Transportgleichung wurden quasilineare Theorie, Diffusionsnäherung und Separation in Orts- und Impulsproblem angewandt, um die Leaky-Box-Gleichung zu erhalten, die numerisch behandelt wurde. Das Ortsproblem wurde analytisch in zylindrischen und prolaten sphäroidalen Koordinaten gelöst. Das Transportmodell wurde angewandt um das Sekundärelektronenspektrum unserer Galaxie zu berechnen, wobei wir annehmen, dass Leptonen aus Pionenzerfällen den dominanten Beitrag liefern. Das Leptonenspektrum aus Kollisionen hochrelativistischer CR-Protonen mit thermischen Protonen des ISM wurde nach Kelner et al (2006) berechnet und als Injektionsfunktion verwendet. Bei realistischen Simulationsparametern liegt der resultierende Positronenfluß bemerkenswert nah am niederenergetischen Ende des PAMELA-Spektrums. Die Annahme eines Potenzspektrums für primäre Elektronen und einer zusätzlichen symmetrischen e+/e- Quelle erlaubt einen sehr guten Fit der Fermi, PAMELA und HESS Daten und damit Einschränkungen an mehrere Parameter des Transportmodells sowie die Eigenschaften des ISM.

EP 16.6 Thu 11:45 V55.21

The influence of Klein-Nishina steps on the spatial diffusion of galactic cosmic ray electrons — •Patrick Blies and Reinhard Schlickeiser — Institute for Theoretical Astro and Space Physics, Ruhr-University Bochum

The full Klein-Nishina cross section for the inverse Compton scattering interactions of electrons implies a significant reduction of the electron energy loss rate compared to the Thomson limit when the electron energy exceeds the critical Klein-Nishina energy $E_K = 0.27 m_e^2 c^4/(k_B T)$, where T denotes the temperature of the photon graybody distribution.

We investigate the influence of the Klein-Nishina reduction on the solution of the steady-state spatial diffusion transport equation for relativistic electrons. The modified electron spectrum for the case of only one relevant optical target photon field for the inverse Compton losses plus the unavoidable synchrotron losses in the energy range of interest are derived in terms of the Green's function solution for one-, two- and three-dimensional spatial diffusion. The modifications to the solutions of the one- and three-dimensional diffusion equation are calculated for a single point source of monoenergetic electrons. It is shown that orders of magnitude enhancements in the local electron intensity occur at electron energies greater than the critical Klein-Nishina energy E_K.

These drastic Klein-Nishina enhancements are potentially interesting for determining the contribution of point sources such as dark matter sources and/or electromagnetic particle accelerators to the local electron intensity and the local positron fraction.

EP 16.7 Thu 12:00 V55.21

Rossby waves and polar spots in rapidly rotating stars: Impli-

cations for stellar wind evolution — •Teimuraz Zaqarashvili[1], Ramon Oliver[2], Jose Luis Ballester[2], Marc Carbonell[2], Maxim Khodachenko[1], Helmut Lammer[1], Martin Leitzinger[3], and Petra Odert[3] — [1]Space Research Institute, Austria — [2]University of Balearic Islands, Spain — [3]University of Graz, Austria

We use shallow water magnetohydrodynamic equations to study the dynamics of large-scale waves at the rapidly rotating stellar tachoclines in the presence of toroidal magnetic field. Dispersion relations and latitudinal distribution of wave modes are derived. We found that low frequency magnetic Rossby waves tend to locate at poles. Unstable magnetic Rossby waves may lead to the local enhancement of magnetic flux at high latitudes of tachoclines in rapidly rotating stars. The enhanced magnetic flux may rise upwards due to the magnetic buoyancy in the form of tubes and appear as starspots at polar regions. The results may explain observed short period oscillations in magnetic activity and polar appearance of starspots in rapidly rotating stars. The polar spots may have important implications for the evolution of the stellar wind in young Sun-like stars.

EP 16.8 Thu 12:15 V55.21

Hintergrundsimulationen für den Wide Field Imager des ATHENA-Röntgenteleskops — •Steffen Hauf[1], Markus Kuster[2], Dieter H. H. Hoffmann[1], Philipp M. Lang[1], Stephan Neff[1], Maria Grazia Pia[3], Alexander Stefanescu[4,5] und Lothar Strüder[5,6] — [1]TU Darmstadt, Darmstadt, DE — [2]European XFEL GmbH, Hamburg, DE — [3]INFN Sezione de Genova, Genova, IT — [4]Johannes Gutenberg Universität, Mainz, DE — [5]Max Planck Halbleiter Labor - HLL, München, DE — [6]Max Planck Institut für Extraterrestrische Physik - MPE, Garching, DE

Das ATHENA Röntgenteleskop ist ein geplantes multinationales Weltraumobservatorium mit einer Fokallänge von 12m. ATHENA wird hochauflösende Röntgenspektroskopie im Energiebereich von 0.1 - 15 keV mit hoher Sensitivität ermöglichen. Der 640x640 pixel^2, DePFET-basierte Wide Field Imager ist hierbei der bevorzugte Fokal-Detektor, wenn eine hohe Orts- und Zeitauflösung mit einem Sichtfeld von bis zu 20 Bogenminuten benötigt wird. Basierend auf den aktuellen Detektorentwürfen, inklusive der Abschirmung und Kühlelementen, präsentieren wir eine detailierte Abschätzung des durch kosmische Strahlung verursachten Detektorhintergrundes, welche mit Hilfe von Geant4 Monte-Carlo Simulationen gewonnen wurde. Darauf aufbauend werden außerdem Möglichkeiten zur Reduktion dieses Hintergrundes vorgestellt.