those associated with supernovae blast waves, will also be discussed.

Masahiro Hoshino
University of Tokyo
Particle acceleration and injection problem in relativistic and nonrelativistic shocks

Acceleration of charged particles at the collisionless shock is believed to be responsible for production of cosmic rays in a variety of astrophysical objects such as supernova, AGN jet, and GRB etc., and the diffusive shock acceleration model is widely accepted as a key process for generating cosmic rays with non-thermal, power-law energy spectrum. Yet it is not well understood how the collisionless shock can produce such high energy particles. Among several unresolved issues, two major problems are the so-called "injection" problem of the supra-thermal particles and the generation of plasma waves and turbulence in and around the shock front. With recent advance of computer simulations, however, it is now possible to discuss those issues together with dynamical evolution of the kinetic shock structure. A wealth of modern astrophysical observations also inspires the dynamical shock structure and acceleration processes along with the theoretical and computational studies on shock. In this presentation, we focus on the plasma wave generation and the associated particle energization that directly links to the injection problem by taking into account the kinetic plasma processes of both non-relativistic and relativistic shocks by using a particle-in-cell simulation. We will also discuss some new particle acceleration mechanisms such as stochastic surfing acceleration and wakefield acceleration by the action of nonlinear electrostatic fields.

Ocker Cornelis (Okkie) de Jager for the HESS collaboration
Unit for Space Physics, NWU, South Africa
Pulsar Wind Nebulae in TeV gamma-ray emission

In this presentation we review the observational properties of pulsar wind nebulae (PWN) detected at VHE gamma-ray energies. Whereas we have evidence for dynamic plerions in binary systems, we will focus on those which resulted from supernova explosions, leaving an expanding pulsar driven bubble and a supernova shell. For these we see two types: (1) The younger Crab-like PWN, which are mostly unresolved and composite and (2) the evolved Vela-like PWN which show resolved, but offset morphologies. A shell is seldom seen. We also notice an evolution in the ratio of X-ray to VHE fluxes from PWN. A general theoretical framework will also be presented within which these observations can be understood.

Claus H. Jaroschek
University of Tokyo
PRadiation dominated relativistic current sheets

Relativistic Current Sheets (RCS) feature plasma instabilities considered as potential key to magnetic energy dissipation and non-thermal particle generation in Poynting flux dominated plasma flows. We show in a series of kinetic plasma simulations that the physical nature of non-linear RCS evolution changes in the presence of incoherent radiation losses: In the ultra-relativistic regime (i.e. magnetization parameter sigma = 104 defined as the ratio of magnetic to plasma rest frame energy density) the combination of non-linear RCS dynamics and synchrotron emission introduces a temperature anisotropy triggering the growth of the Relativistic Tearing Mode (RTM). As direct consequence the RTM prevails over the Relativistic Drift Kink (RDK) Mode as competitive RCS instability. This is in contrast to the previously studied situation of weakly relativistic RCS (sigma ~ 1) where the RDK is dominant and most of the plasma is thermalized. The simulations witness the typical life cycle of ultra-relativistic RCS evolving from a violent radiation induced collapse towards a radiation quiescent state in rather classical Sweet-Parker topology. Such a transition towards Sweet-Parker configuration in the late non-linear evolution has immediate consequences for the efficiency of magnetic energy dissipation and non-thermal particle generation. Ceasing dissipation rates directly affect our present understanding of non-linear RCS evolution in conventional striped wind scenarios.

Jack R. (Randy) Jokipii
University of Arizona

Pre-existing turbulence, magnetic fields and particle acceleration at a supernova blast wave

We consider effects of pre-existing, large-scale turbulence, upstream of a shock, on the magnetic field and the acceleration of charged particles. Turbulent density fluctuations upstream of the shock have a large effect on the magnetic field downstream (Giacalone & Jokipii, ApJ 633, L41, 2007). For high Alfven Mach number shocks, the downstream magnetic field is amplified considerably above the value obtained from the shock jump conditions. These effects may provide a robust and natural understanding of recent observations at supernova shocks.
The magnetic field amplification implied by our simulations should exceed factors of 100, consistent with observed X-rays from supernova remnants, which require magnetic fields of 100 \muG. These are much larger than expected from the shock jump conditions. The upstream field is not amplified, so cosmic-rays with energies approaching the "knee" in the spectrum require rapid acceleration, which can occur at the quasi-perpendicular part of the supernova blast wave, where the turbulent field-line mixing plays a large role.
We have carried out a simple global test-particle simulation of acceleration at a spherical blast wave propagating into a uniform magnetic field. We find that although most of rapid particle acceleration occurs in the "equatorial" band, where the upstream magnetic field is quasi-perpendicular, the ongoing temporal evolution of the shock brings most of the particles to the quasi-parallel "polar" part of the shock. This is in agreement with the observational constraints reported by Rothenflug et al. (A&A 4225, 121, 2004), and allows the rapid acceleration at the quasi-perpendicular shock.
We conclude that a model in which the magnetic-field amplification occurs because of the upstream turbulence and rapid acceleration to the knee occurs at the quasi-perpendicular part of the shock is consistent with the observations. Amplification of the upstream magnetic field is not necessary in this model.

Alexander Lazarian
University of Wisconsin-Madison

Numerical simulations of astrophysical turbulence

Turbulence is a crucial component of dynamics of astrophysical fluids dynamics, including those of ISM, clusters of galaxies and circumstellar regions. The knowledge of turbulence properties is essential for understanding star formation, molecular chemistry, cosmic ray transport and acceleration, transport of heat and angular momentum etc. I shall show that a substantial progress in understanding major astrophysical processes is possible if we know very basic properties of the magnetized turbulent flow, e.g., its spectrum. I shall show that more subtle properties can be obtained if we also know turbulent intermittency. I shall discuss theoretical models, their numerical testing and the practically important astrophysical