Kinetic Modeling of Astrophysical Plasmas

5-9 października 2008, Kraków

The motivation for this conference is the growing interest of the astrophysical community in the application of kinetic plasma methods to the problems of modern astrophysics. The intent of the meeting is therefore to review the recent progress in this field in wide range of astrophysical applications and to confront the results with observations. The main emphasis of the meeting will be on kinetic plasma methods - numerical (Particle-In-Cell and hybrid simulations) as well as analytical. However, the progress in the MHD modeling of astrophysical plasmas will also be reviewed to enable comparison with kinetic methods and stimulate discussion on what approach is the most appropriate tool to study astrophysical sources. All main topics will also be reviewed from observational perspective.

INVITED TALKS:

Takanobu Amano

NagoyaUniversity, STEL

Surfing and drift acceleration at high mach number quasi-perpendicular shocks

Electron acceleration in high Mach number collisionless shocks relevant to supernova remnant is discussed. By performing one- and two-dimensional particle-in-cell simulations of quasi-perpendicular shocks, we find that energetic electrons are quickly generated in the shock transition region through shock surfing and drift acceleration. The electron energization is strong enough to account for the observed injection at supernova remnant shocks.

Elena Amato

Osservatorio Astrofisico di Arcetri

PIC simulations of relativistic transverse magnetosonic shocks

I will present the results of one-dimensional PIC simulations of magnetized ultrarelativistic shock waves in proton-electron-positron plasmas. Relativistic cyclotron instability, as the incoming particles encounter the increasing magnetic field within the shock front, provides the basic plasma heating mechanism. When the protons provide a sufficiently large fraction of the upstream flow energy density (including particle kinetic energy and Poynting flux), a substantial fraction of the shock heating goes into the formation of suprathermal power-law spectra of electrons and positrons. Cyclotron absorption by the pairs of the high harmonic ion cyclotron waves provides the nonthermal acceleration mechanism. The major new results come from simulations with mass ratio of 100 between ions and pairs, which show that electrons can be accelerated as efficiently as positrons when the proton fraction is small enough (pair plasma almost charge-symmetric). Both the acceleration efficiency and the non-thermal particles' spectra depend on the fraction of flow energy carried by the ions, suggesting that the varying power-law spectra observed in synchrotron sources powered by magnetized winds and jets might reflect the correlation of the proton-to-pair content enforced by the underlying electrodynamics of these sources' outflows.