

Pasquale Blasi (GSSI, L'Aquila, Italy): *Acceleration mechanisms*

Lecture 1: Introduction to Astroparticle Physics

- Ancient history
- The discovery of cosmic rays and the birth of modern physics
- Modern measurements
- The non thermal universe or how to look at the same thing with different lights and different messengers
- Perspectives for the future

Lecture 2: basics of plasma physics

- What is a plasma and why should you care?
- Vlasov equation and its perturbations
 - *Alfven waves*
 - *Magneto-sonic waves*
- Basics of magneto-hydrodynamics
- Collisionless shocks waves in a plasma

Lecture 3: Transport equation

- From Vlasov equation to the transport equation (see also Prof. Serpico)
- Interaction of non-thermal particles with a bunch of Alfven waves: second order acceleration
- Non-thermal particles in the vicinity of a shock front: statistical approach (test-particle theory)

Lecture 4: Diffusive Shock Acceleration

- Non-thermal particles in the vicinity of a shock: approach based on transport equation
 - *spectrum of accelerated particles*
 - *maximum energy*
 - *effect of waves on the spectrum*
- Limitations of the test-particle theory (dynamics, maximum energy, ...)
- Conservation equations at a shock in the presence of non-thermal particles (primer on non-linear theory)
- Primer on theory of unstable modes excited by accelerated particles
- Unstable Alfven waves versus non-resonant (Bell) modes and their role in acceleration

Lecture 5: Applications of DSA

- Acceleration of cosmic rays at supernova remnant shocks
- Reacceleration vs acceleration
- Connection between acceleration and transport: what do we see at Earth?
 - escape from sources
 - escape from the Galaxy
- Primer of DSA at relativistic shocks (if time is enough)