

THEME: HOW TO DISTINGUISH DIFFERENT ACCELERATION MECHANISMS

THEME: HOW TO DISTINGUISH HADRONIC VS LEPTONIC

THEME: EXTRA FLAVORS: ANISOTROPY, BEAMING, HEAVY ION ACCELERATION

THEME: SIMULATION ISSUES

THEME: HOW TO DISTINGUISH DIFFERENT ACCELERATION MECHANISMS

Can different accelerators be distinguished by (1) predictions on slope? (2) predictions on acceleration rate?

How to discriminate among different acceleration mechanisms?

How the knowledge of particle acceleration mechanism can contribute to our understanding of the large-scale plasma physical conditions?

What is latest on hadron vs lepton acceleration efficiency? [ϵ_e vs ϵ_p , vs. ϵ_b]? Can PWNe accelerate hadrons too/how much (discussed yesterday already)

How does the shock angle affect ion and electron acceleration, respectively?

What other observational evidence is needed? Can theory show us definitively how to make proton PeVatrons?

What observable signatures (spectral/temporal/polarization) can distinguish different particle acceleration mechanisms?

How to confirm the magnetic amplification mechanism? Bell is supported but any proof?

In real life, can shock acceleration still work at relativistic $\sim$ perpendicular shocks? (e.g., due to realistic, corrugated? shock geometry or turbulence)

2. In case of the Crab nebula, cooling time is too short in the field of 100 μ G. In case of PSR J1849-0001, the size of the accelerator is too small to hold those high energy electron in.

Acceleration efficiency

Ultra-relativistic shocks: $>10\%$ for both species, but thermal contribution may eventually be masked.

Non-rel shocks: in quasi-parallel shocks 10% for ions, $\ll 10\%$ for electrons. In quasi-perp shocks, ask Luca Orusa (quasi-perp shocks can inject electrons easier than ions).

Relativistic reconnection: 100%

Relativistic turbulence: ask Luca Comisso

Acceleration rate

Ultra-relativistic shocks: sub-Bohm, for shocks that can accelerate particles (superluminal constraint, as mentioned by Giacinti). Max energy grows as $\sqrt{t}$ [small-angle scattering]

Non-rel shocks: Bohm, so max energy grows linear in t .

Relativistic reconnection: $\dot{\gamma} = 0.1 \text{ eB/mc}$

Relativistic turbulence: acceleration time is $L/(\sigma c)$, where L is driving scale.

Accelerated slope

Ultra-relativistic shocks: ~ 2

Non-rel shocks: ~ 2

Relativistic reconnection: ~ -1 below break, ~ -2 or steeper above break [with some caveats, e.g., guide field]

Relativistic turbulence: ask Luca Comisso

Caveats:

Trans-relativistic shocks can be subluminal and accelerate fast.

Reconnection with guide field has slower acceleration rate, and steeper high-energy slope.

Not enough work done on characterizing the cutoff shape [ask Luca Comisso]

THEME: HOW TO DISTINGUISH HADRONIC VS LEPTONIC

The highest energy photons we see from LHAASO are $\sim 5 \text{ PeV}$. We know PeVatrons exist just from the CR spectrum (measured). These are observational evidence. Yet we don't know for sure if the sources associated with the gamma-ray emission are electron PeVatrons or proton PeVatrons.

1. Extreme Accelerators: how an electron is accelerated to 2 PeV ? Different problems are there for various cases.

What would be the most convincing proof of hadronic emission?

How to consistently simulate electron and proton acceleration to their maximal energy indicated by observations? What correlated leptonic and hadronic observable signatures may be identified?

What have we learned from X-ray polarization measurements, e.g., of SNR, Crab? [very high polarization $\Rightarrow$ ordered field, but we need turbulence - disordered field?]

- Proton synchrotron signature at the burnoff limit (tens of GeV)
- Polarization: reconnection vs turbulence [Haocheng]
- It appears that few/no relativistic accelerators have very different efficiencies in electrons vs ions. Do we all agree? This would make life harder...

- Polarization: synchrotron from secondary pairs from hadronic cascade
- Time variability: a number of PeV sources are extended, but compact PeV sources may further constraint acceleration rate.
- Spectral shape? Either slope, or some info hiding in the cutoff?

THEME: EXTRA FLAVORS: ANISOTROPY, BEAMING, HEAVY ION ACCELERATION

What is the role of pitch angle in particle acceleration?

What observable signatures can identify anisotropy in particle distribution?

How does particle acceleration differ for heavy ions? Does this answer change if their mass fraction is large?

THEME: SIMULATION ISSUES

Are the spectral cut-offs we see in simulations really cut-offs or perhaps transitions to softer spectra that extend much higher in energy?

How can we best bridge gap between MHD and PIC?

How much of current numerical “knowledge” limited by box size constraints? E.g., can have inverse cascade, and important large scales structure will grow in real life, but that’s not allowed to happen with small box.

How to “paint” particles on MHD simulations to compare with observations?

Does the story still hold that DSA doesn’t work in SNR because Chandra resolves some of the acceleration sites and they are too small? (its relevant Larmor radius)?

SS433 peaks at 100 TeV. Is it a proton PeVatron? Can it explain the observed CR flux up to a PeV?

