Current Issues in the Acceleration and Transport of Solar Energetic Particles

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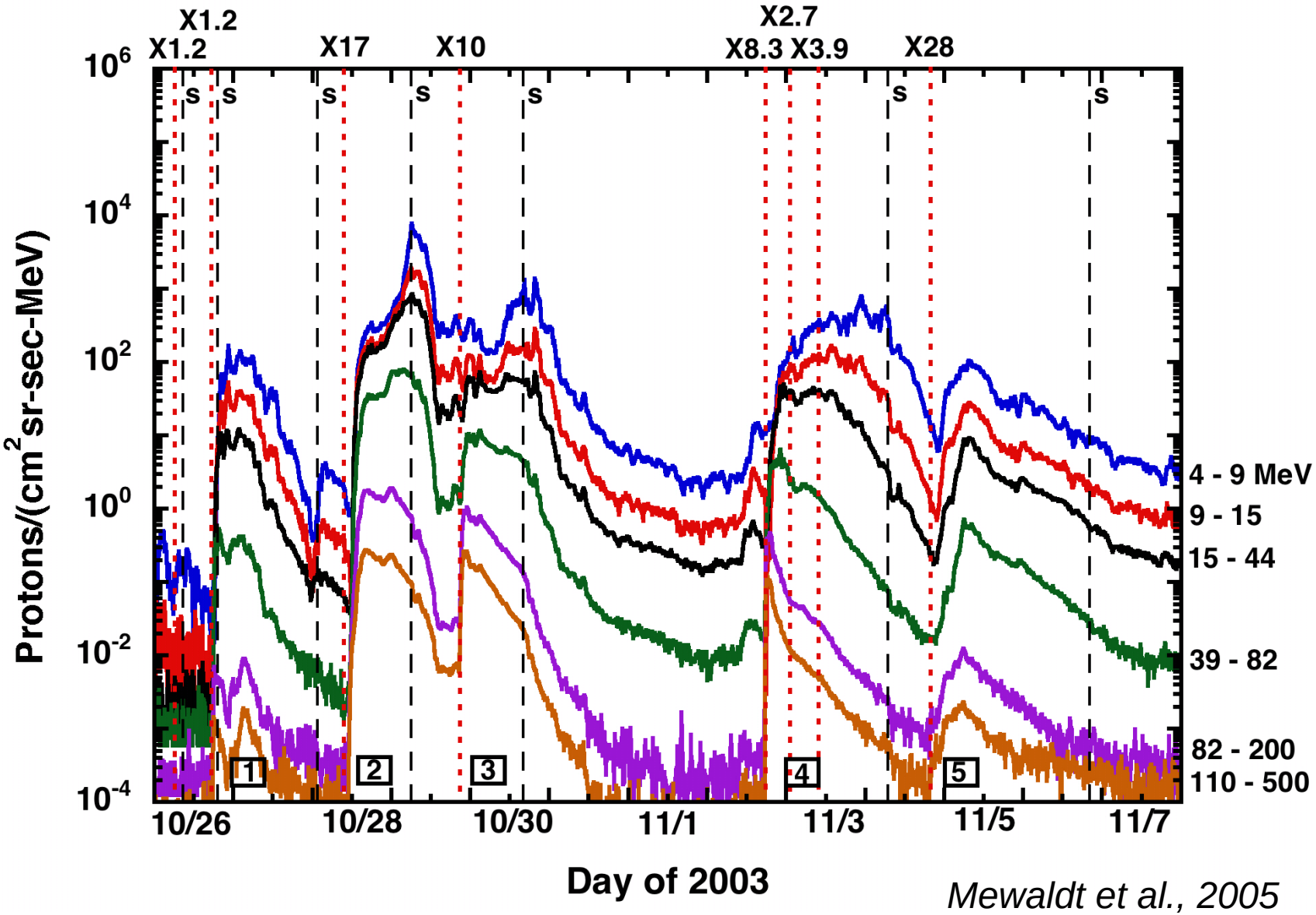
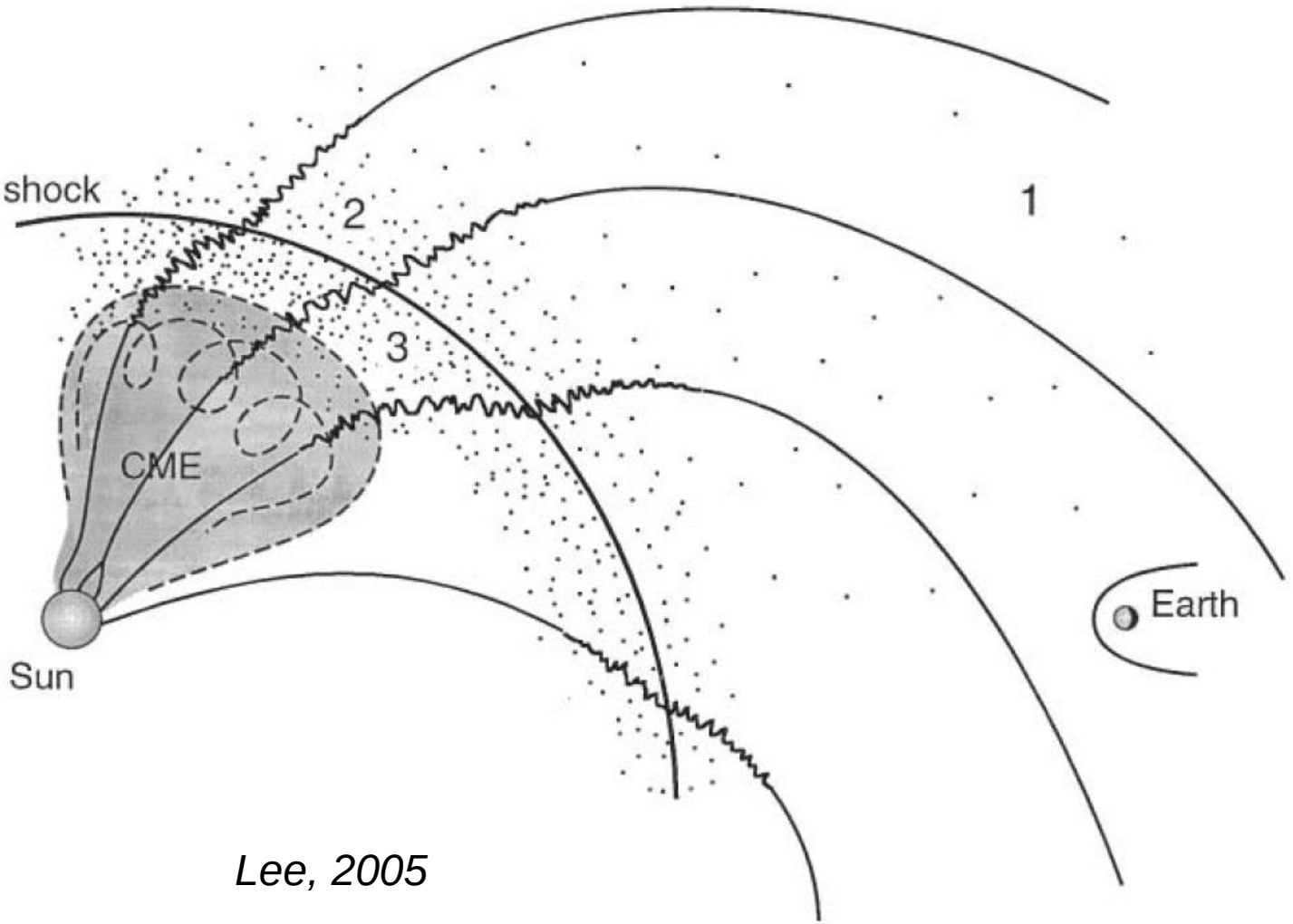
2003 Haloween Events



Mewaldt et al., 2005

Acceleration at a CME-Driven Shock



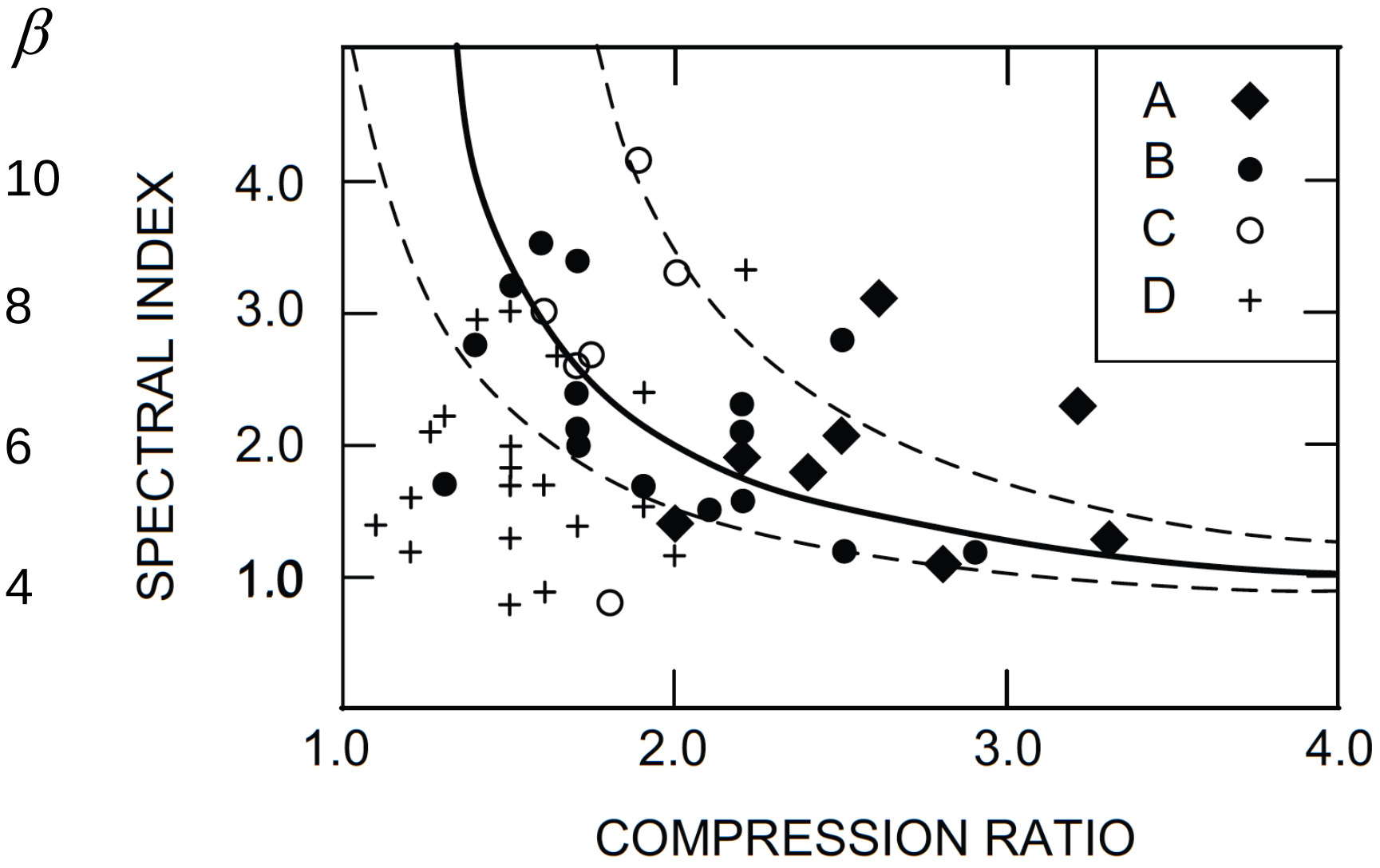
Lee, 2005

Gradual Event Challenges

- Diffusive shock acceleration is established but the “devil is in the details.”
- Injection and seed particles
- Excitation of upstream turbulence
- Quasi-perpendicular versus quasi-parallel
- Curvature, gradient and deHoffman-Teller drift
- Geometry, time-dependence and interplanetary transport
- Reacceleration by downstream turbulence

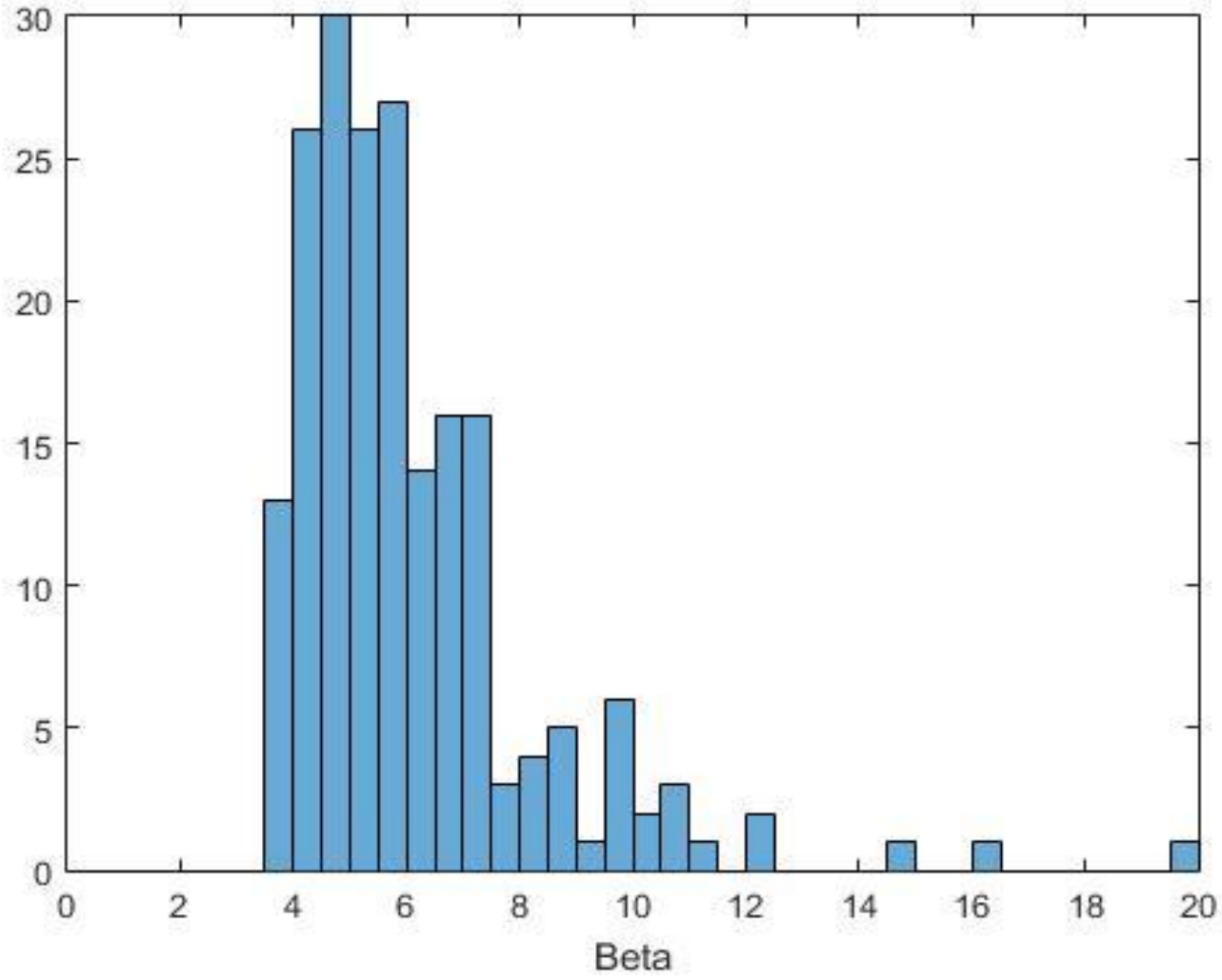
Compression Ratios & Power Laws

$$\beta = 3X/(X-1)?$$

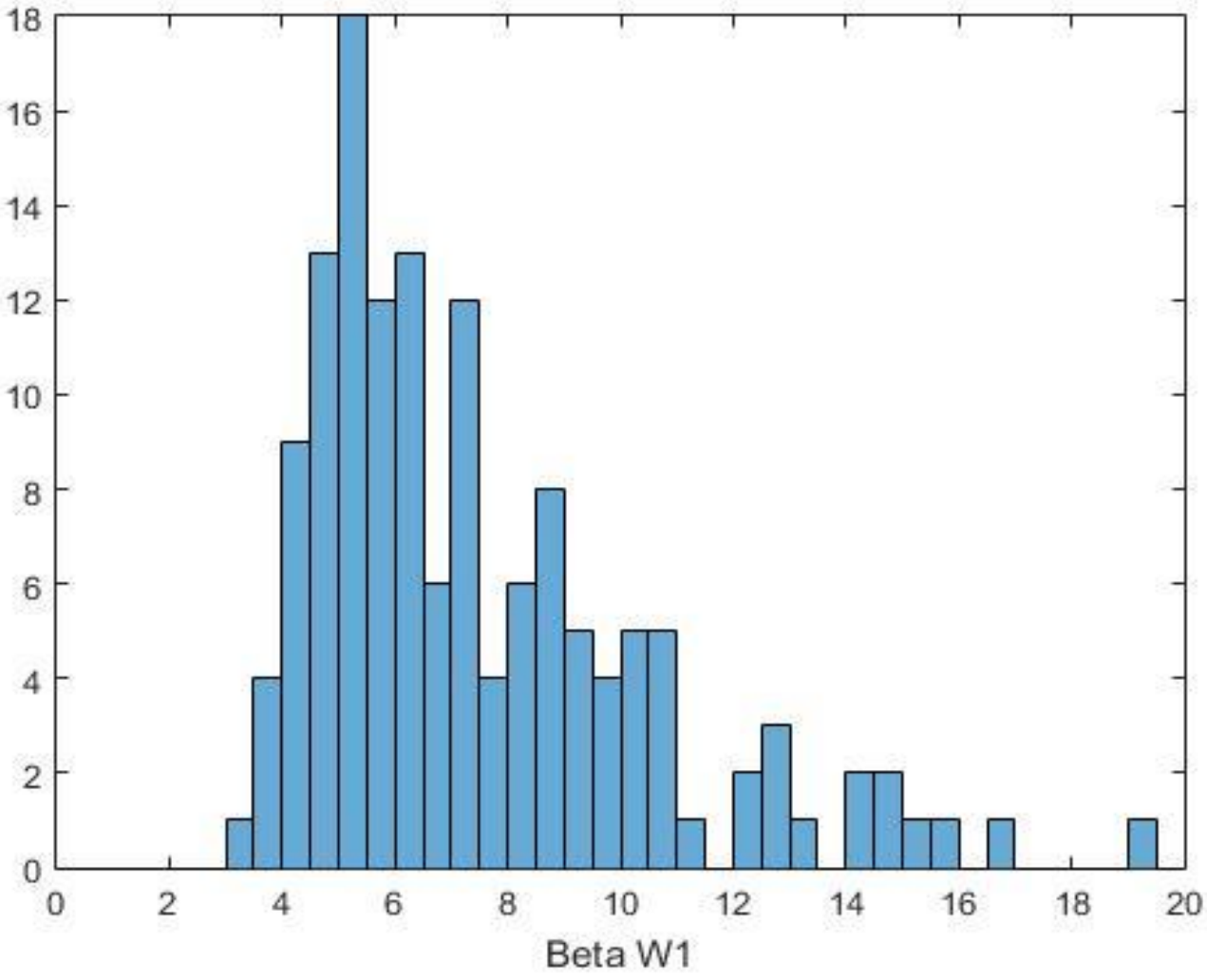


Van Nes et al., 1984

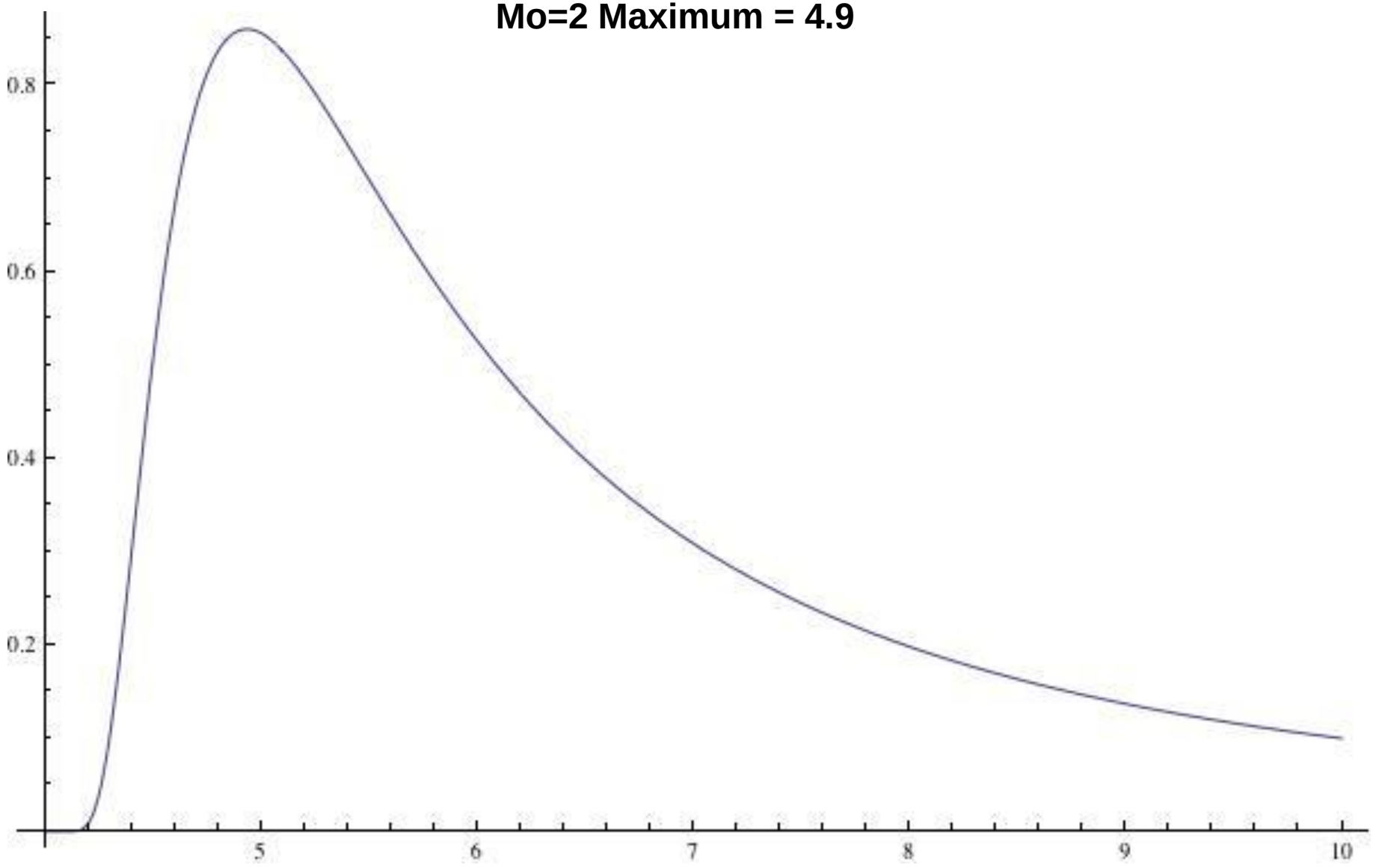
Beta(X) for X>1

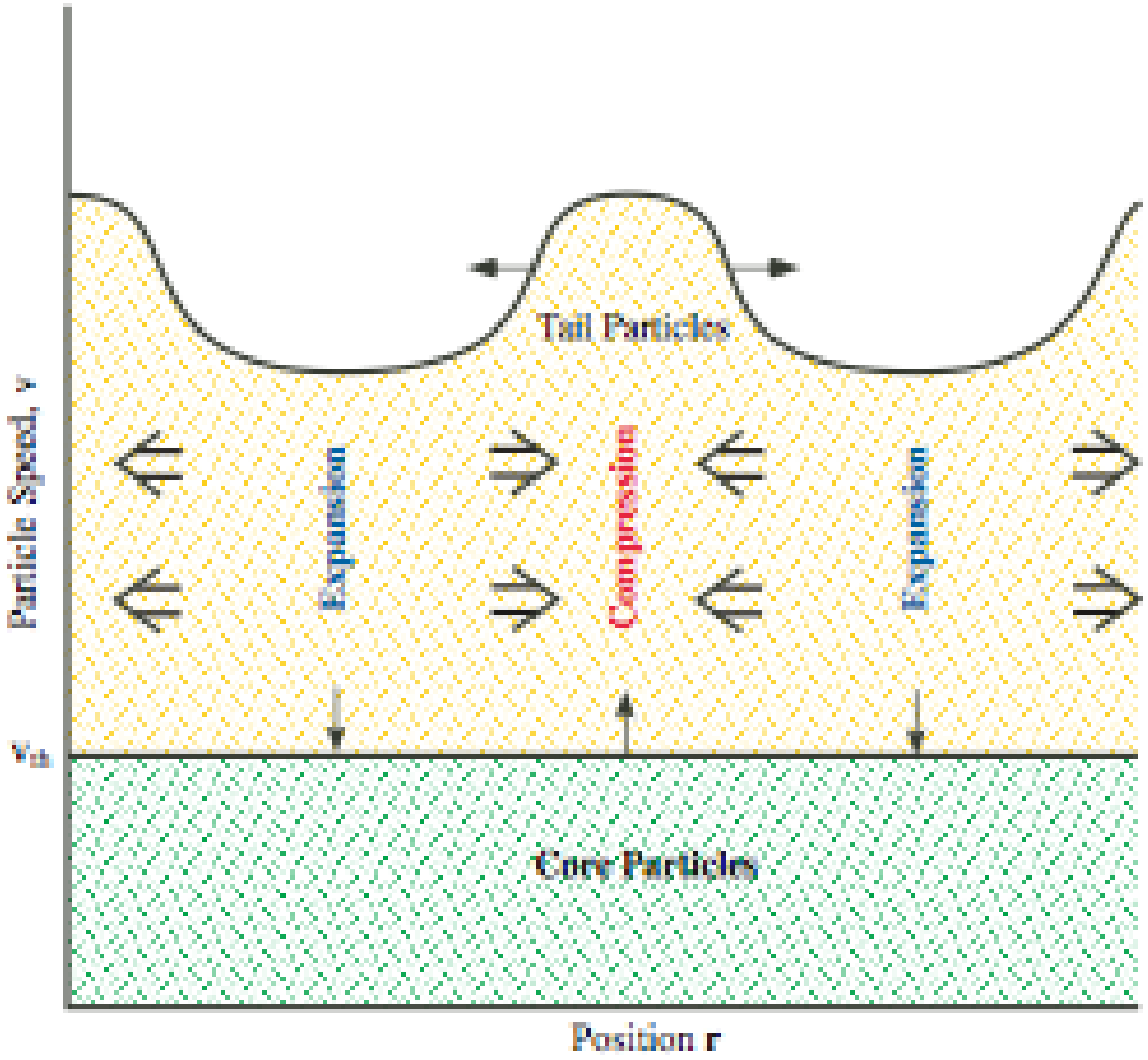


Beta(X) for upstream Alfven waves only



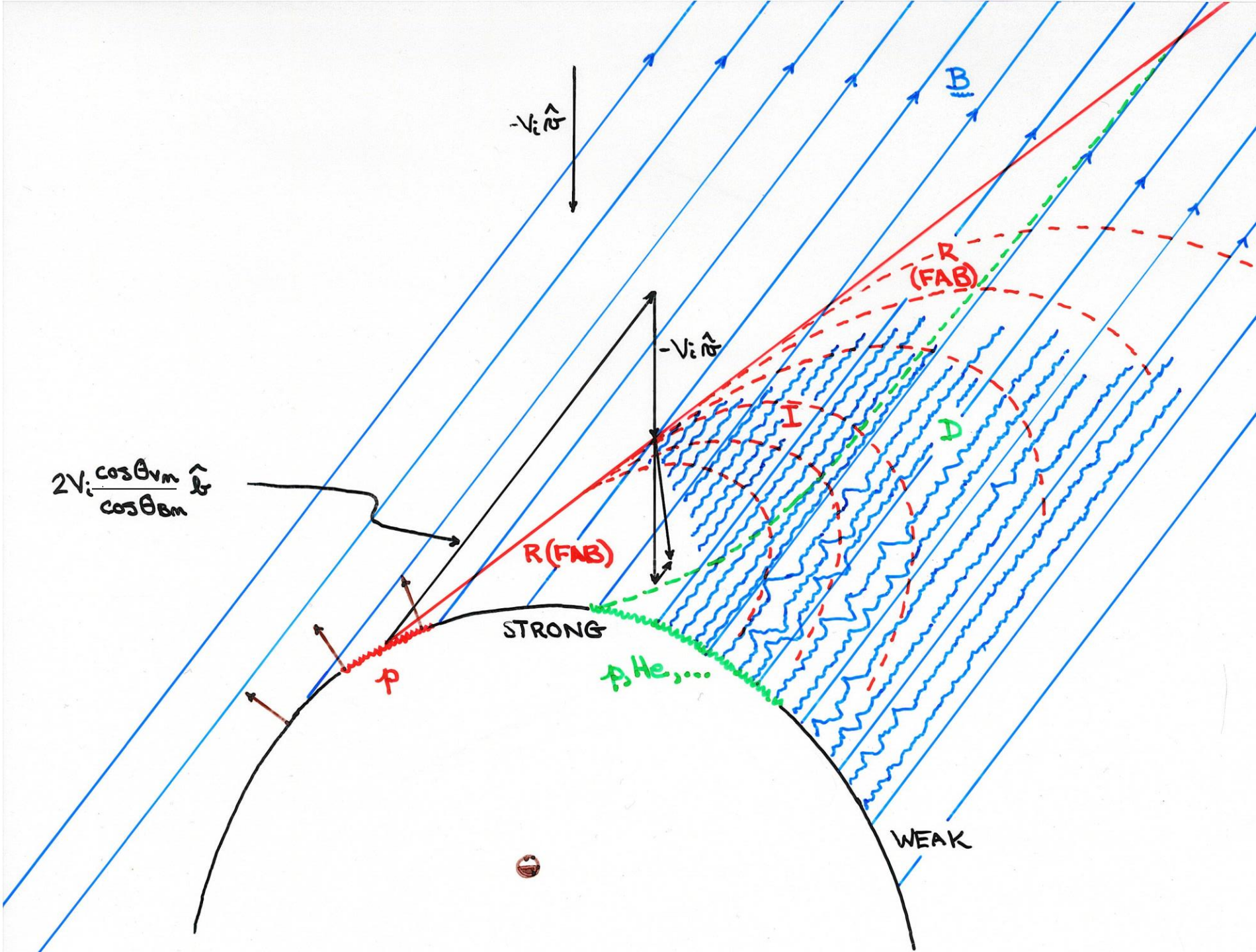
Mo=2 Maximum = 4.9



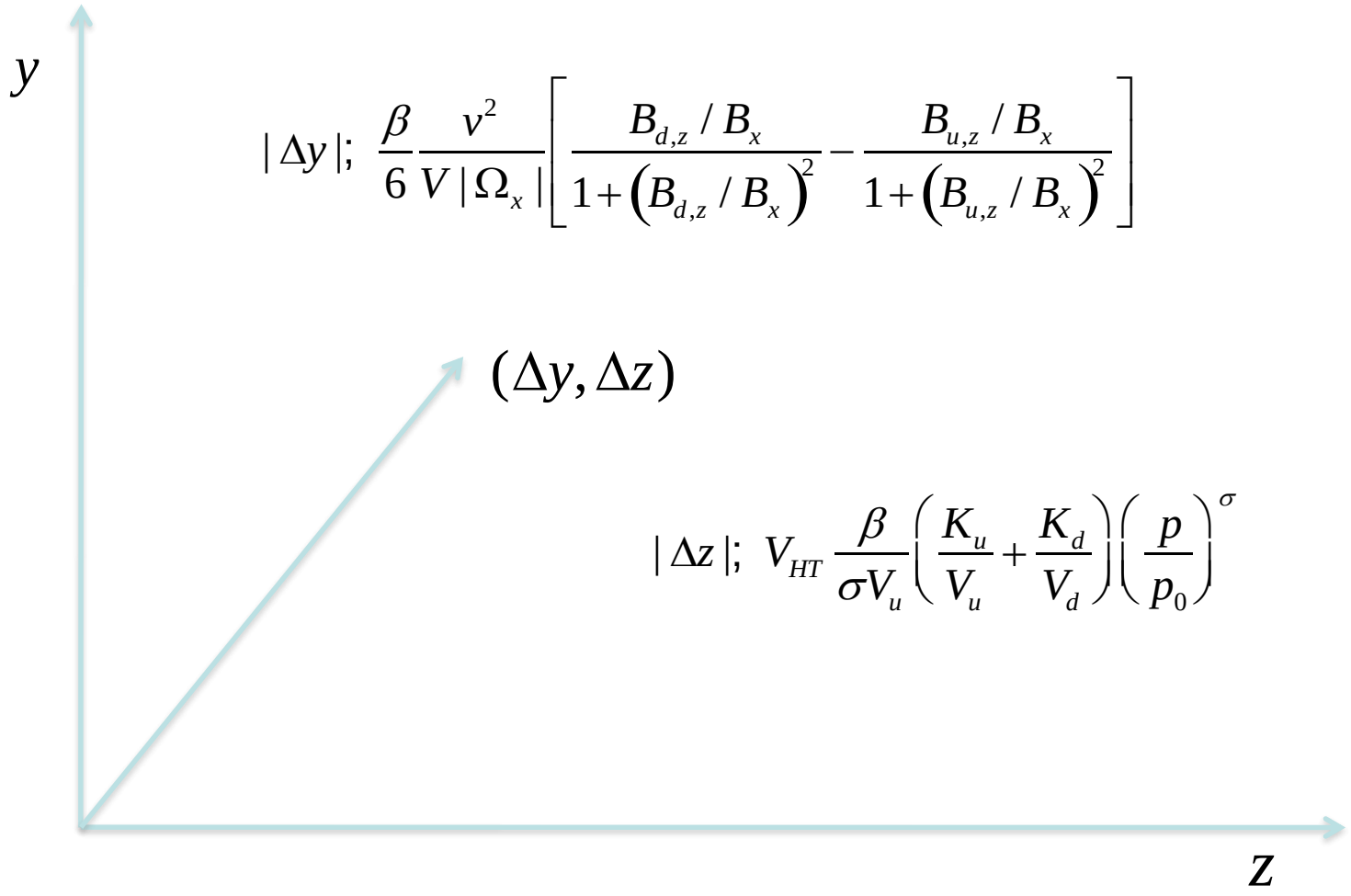


Fisk et al., 2010

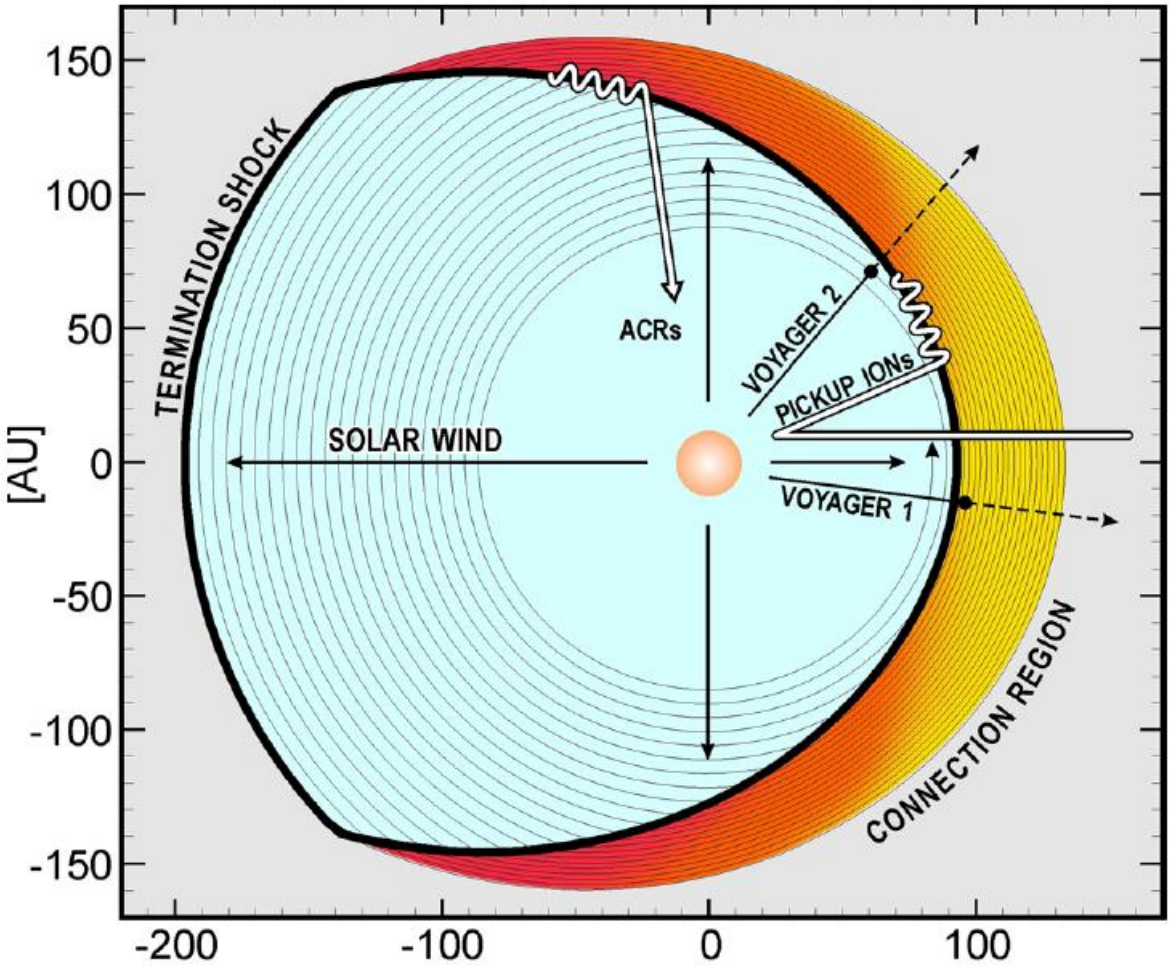
Ion Injection, Drift, and Wave Excitation


B
$-V_i \hat{n}$
$-V_i \hat{n}$
$2V_i \frac{\cos\theta_{vm}}{\cos\theta_{Bm}} \hat{t}_B$
R (FAB)
R (FAB)
I
D
STRONG
WEAK
p
p, He, ...

Particle Drift Along Shock

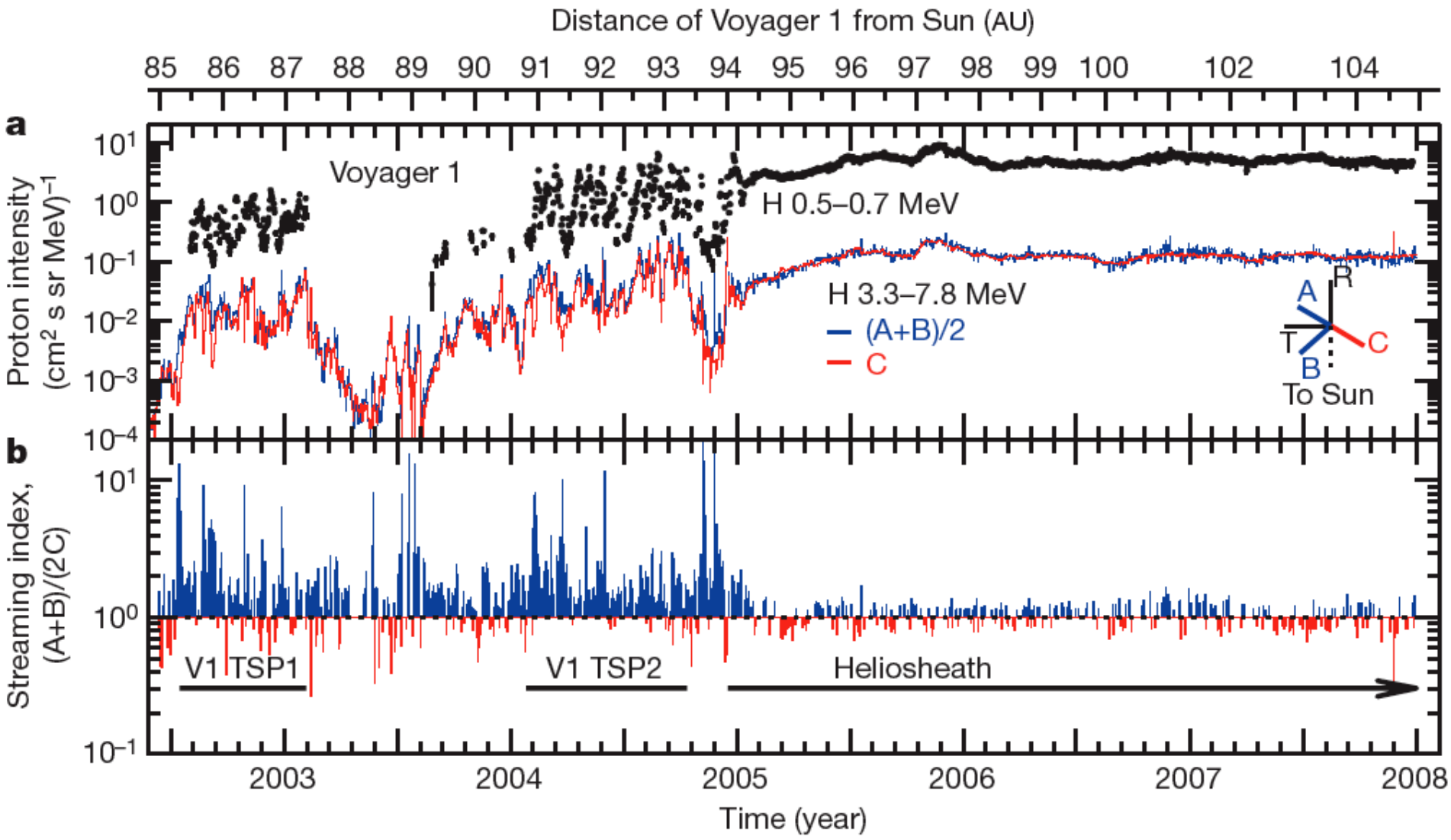


The Blunt Termination Shock

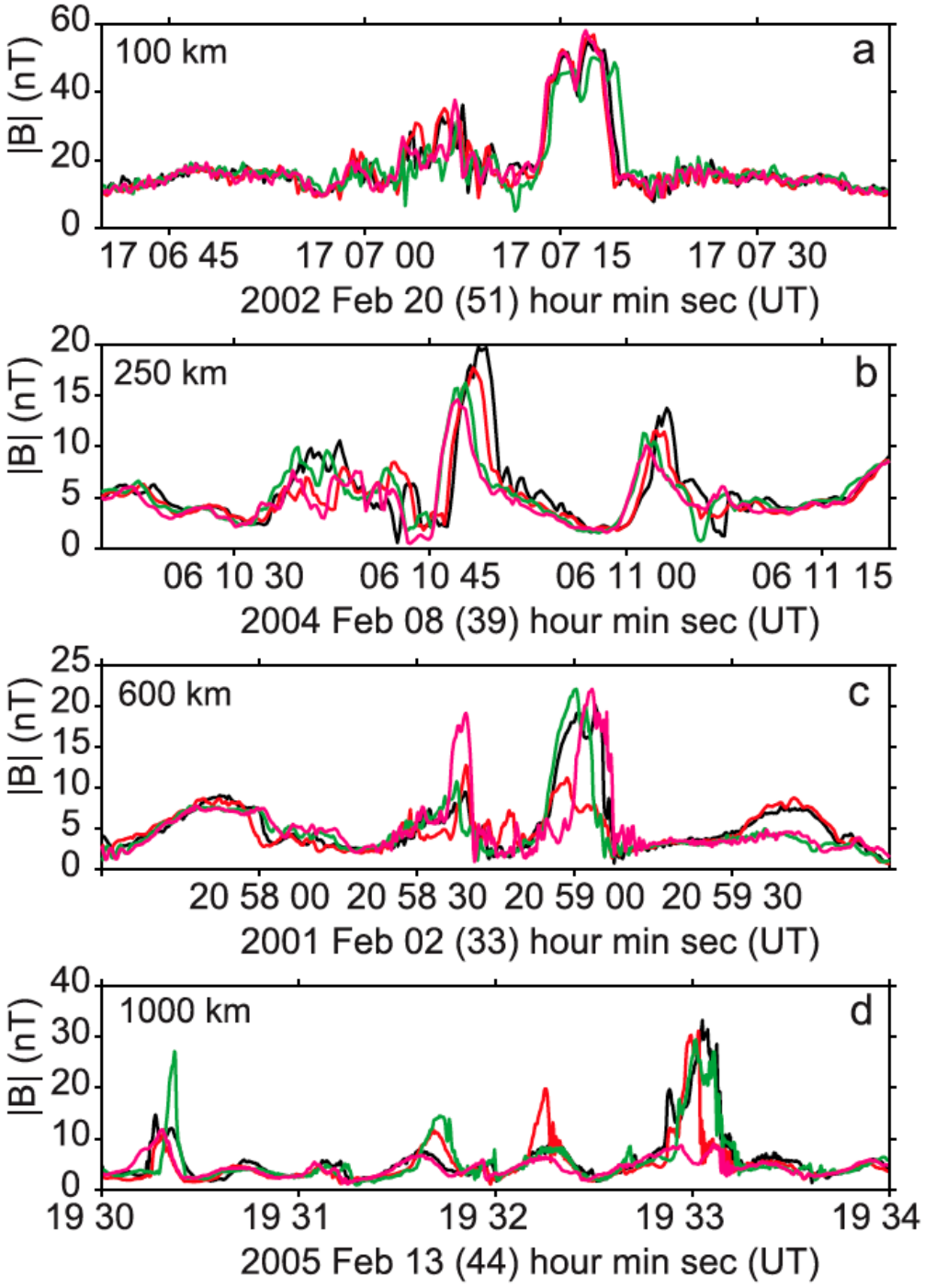


McComas and Schwadron, 2006

Acceleration at Perpendicular Shocks



Stone et al., 2008

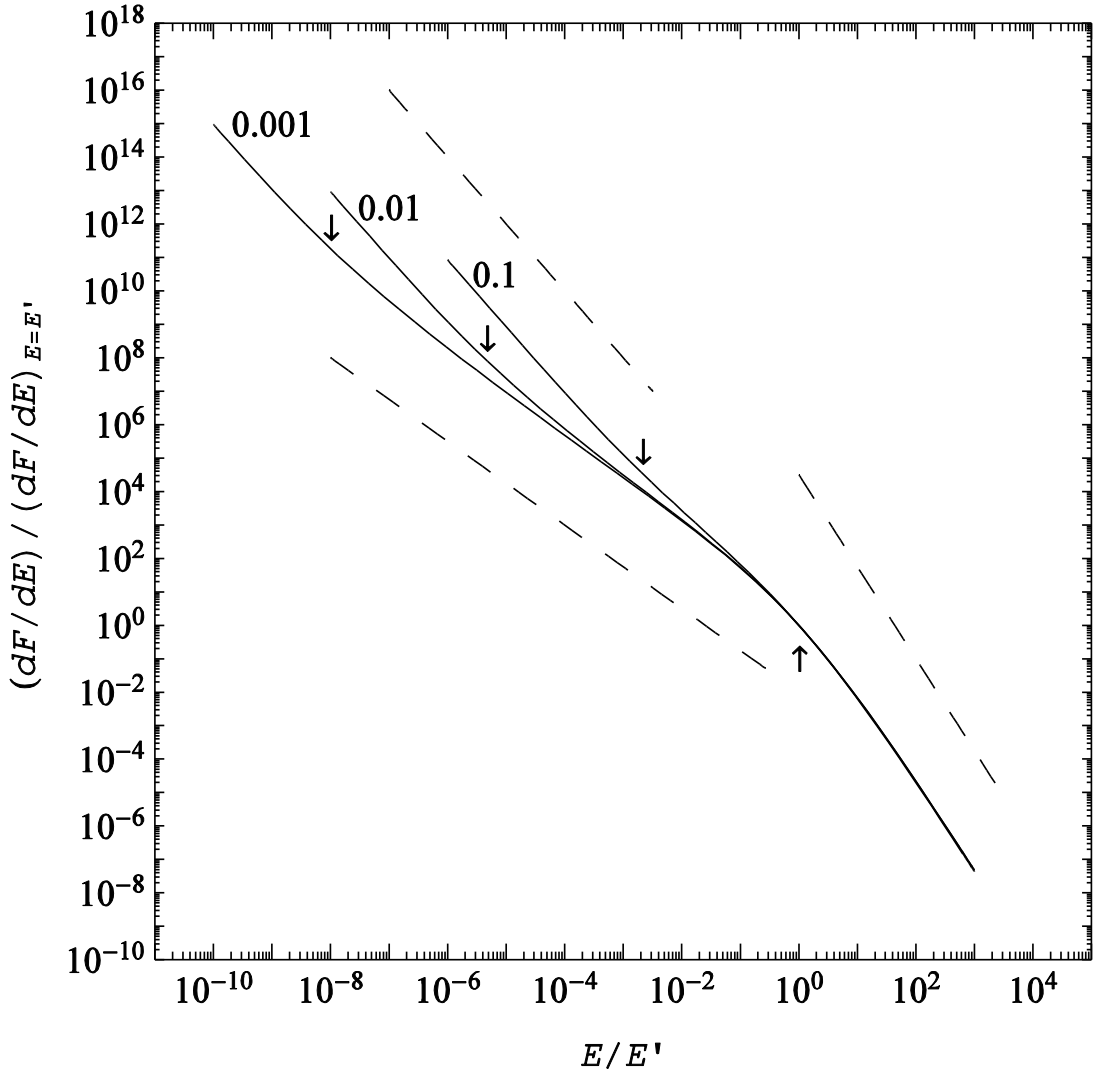


SLAMS

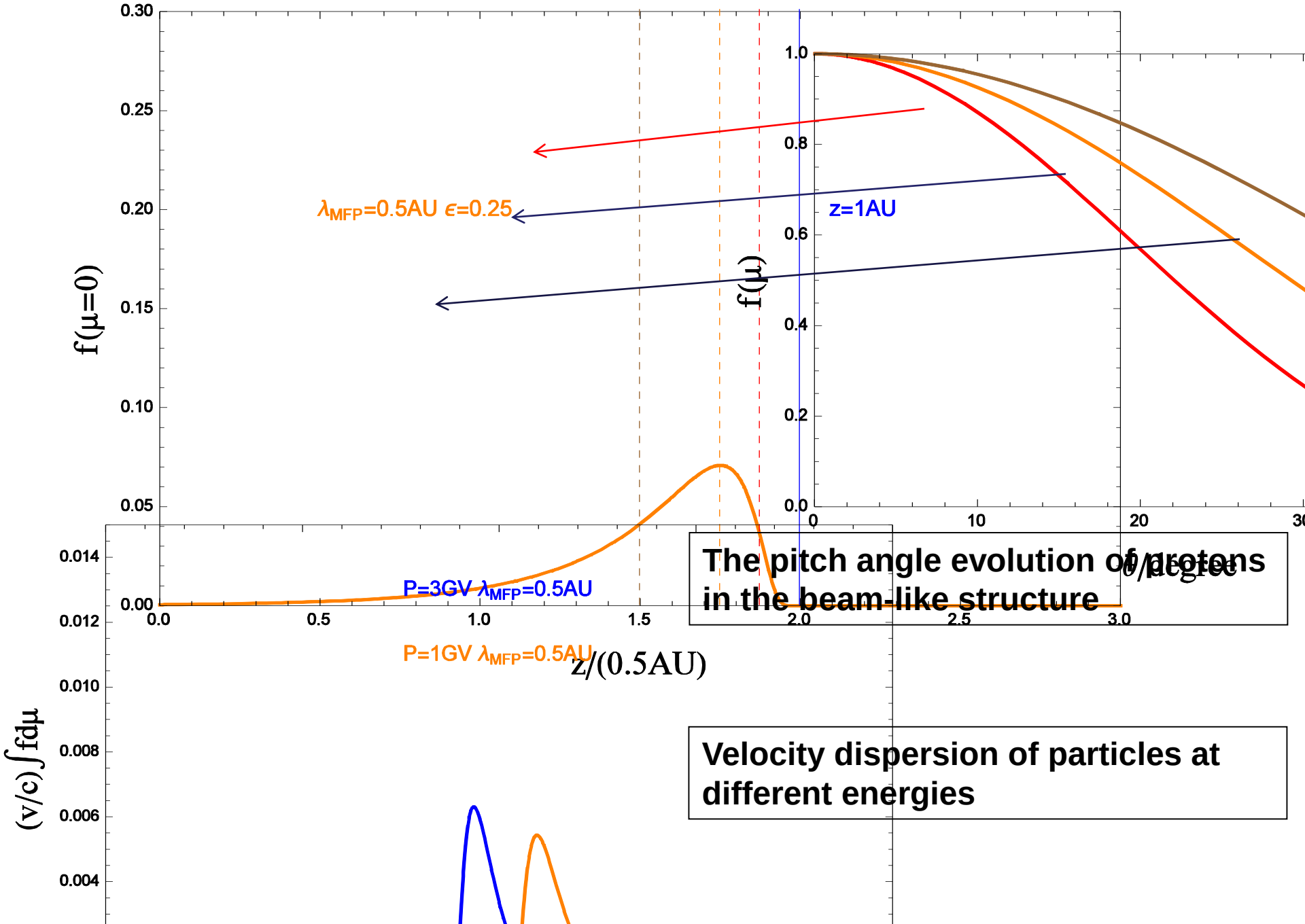
Lucek et al., 2008

Transport from Shock to Observer

A Schematic Graph of the Fluence



$\eta = 1.5$

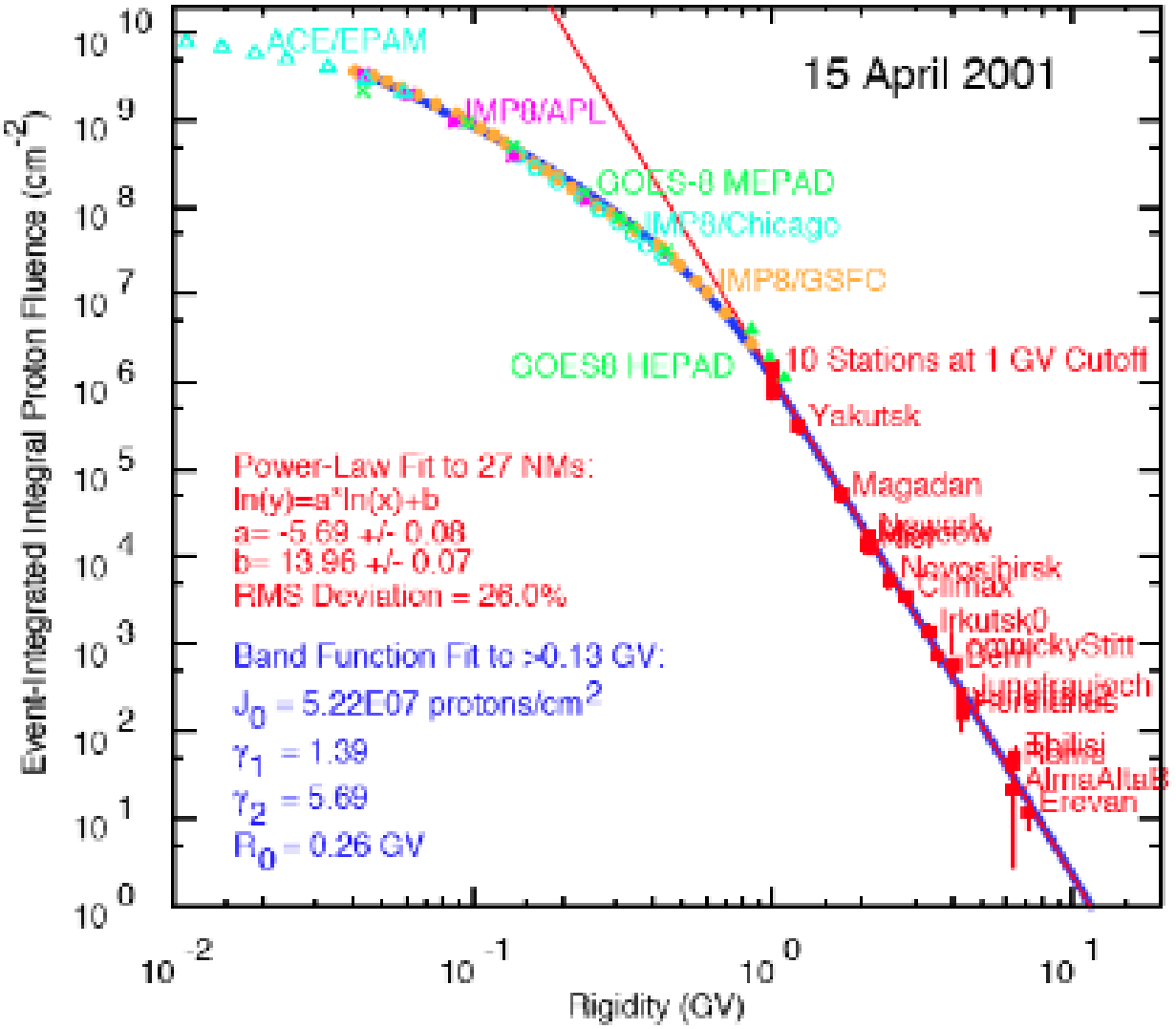


The pitch angle evolution of protons in the beam-like structure

Velocity dispersion of particles at different energies

High-Energy Spectral Rollover

GLE Event of 15 April 2001



Tylka and Dietrich, 2009

Differential Intensity of Escaping Protons

$$J_i(E) = (r_s / r)^2 v^2 H_i(v) G_i(v) \Lambda_i(v)$$

Lee, 2005