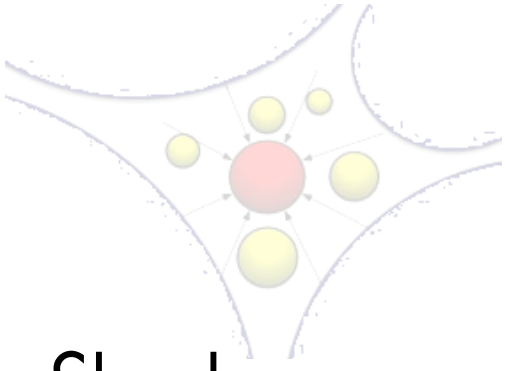

Analytical Modeling of Cosmic Accretion Shocks: The Role Of Environment

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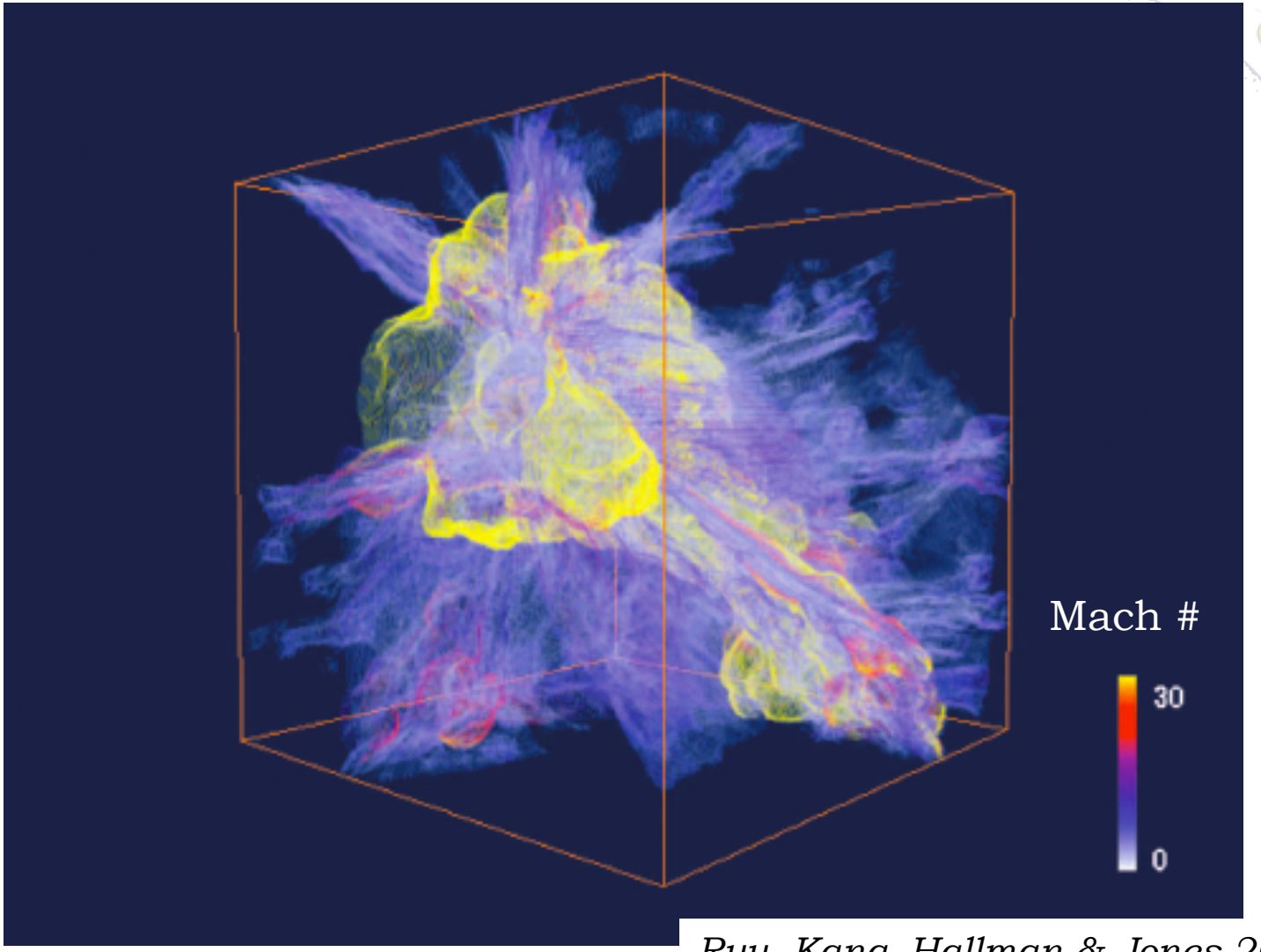
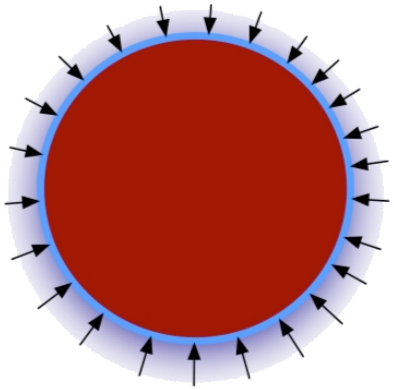
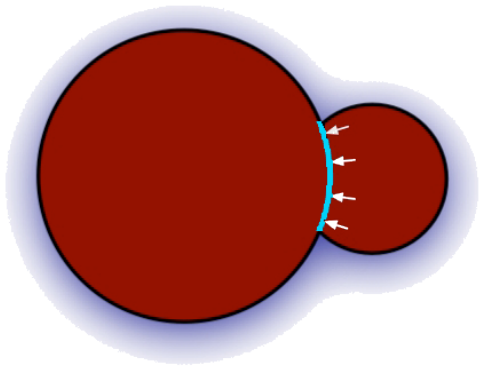
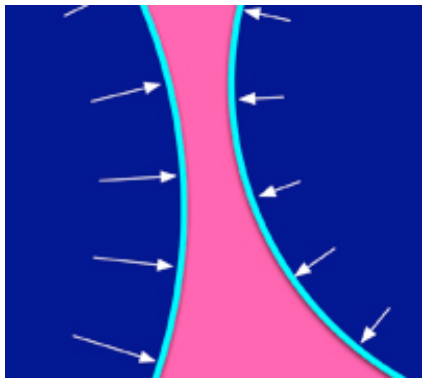
TeV Particle Astrophysics Workshop *15 Jul 2005*



Ryu, Kang, Hallman & Jones 2003

Cosmic Shock Taxonomy

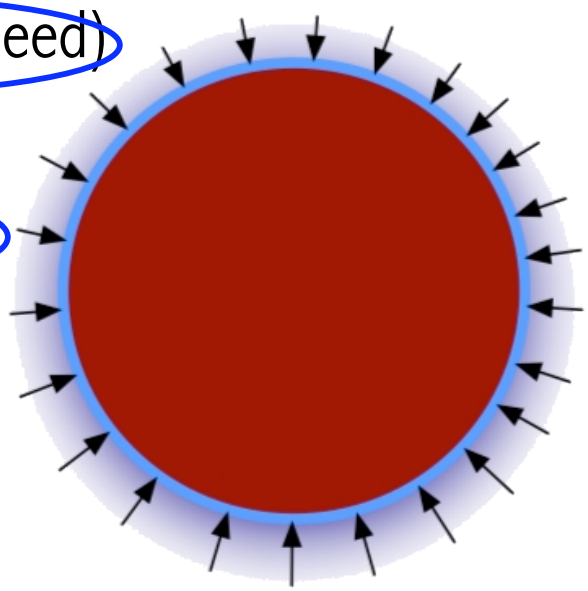
Classification according to driving mechanism

shock type	Accretion	Merger	Filament
driving mechanism	gravity of accretor	mutual gravitational attraction	expansion of void
artist's impression			

Accretion Shocks and Environment

Properties of single shock:

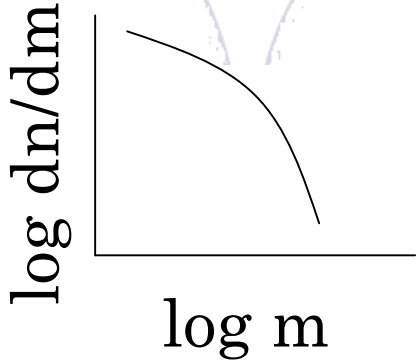
- **Mach number**
  $= f$(accretion velocity, external sound speed)
- **Mass current**
  $= f$(accretion velocity, external density)
- **Kinetic power**
  $= f$(accretion velocity, external density)



accretor mass **accretor environment**

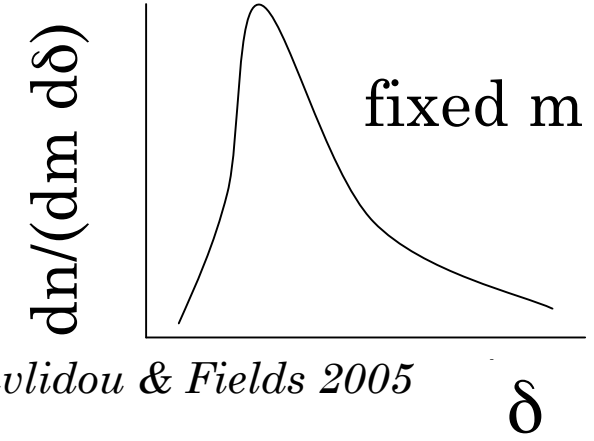
Analytic Description of Accretor Mass and Environment

✓ Analytic description of **mass** distribution:
Press-Schechter mass function



✓ Analytic Description of **mass**+**environment** distribution:
Double Distribution of cosmic structures

- Parametrizes "environment" using local overdensity, $\delta = \rho_{local}/\rho_{cosmic} - 1$
- Integrates back to Press-Schechter

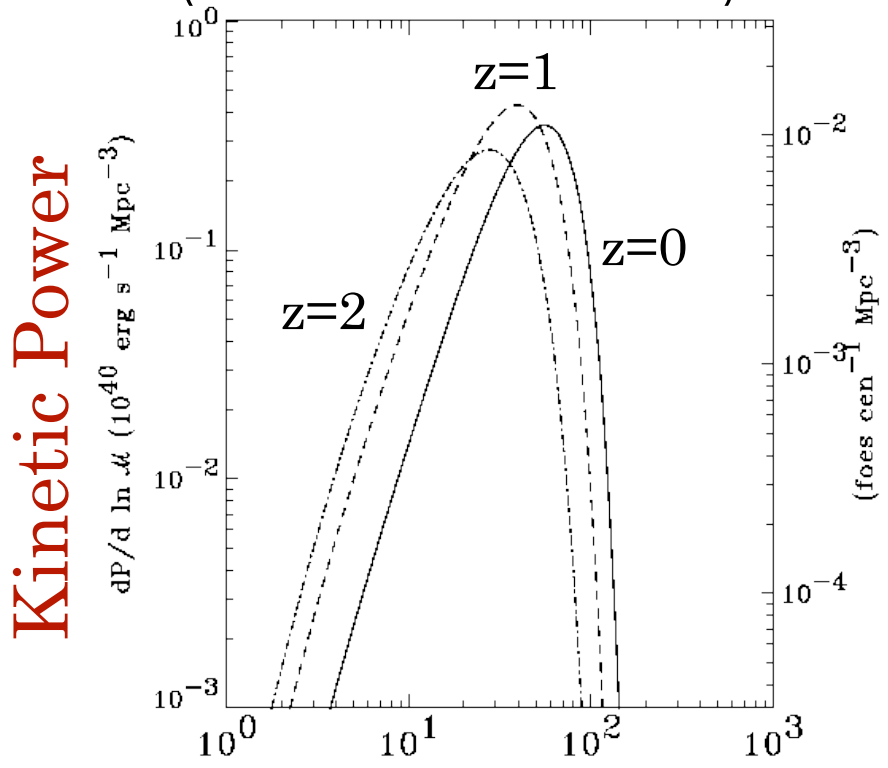


Pavlidou & Fields 2005

Two Models for Cosmic Accretion Shocks

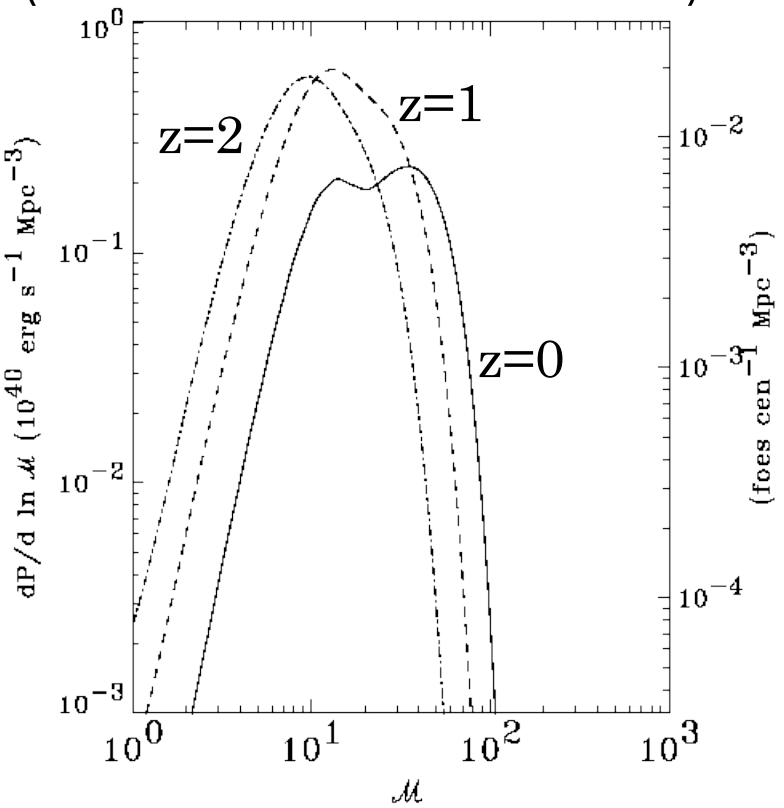
Press-Schechter–based

(no environmental effects)

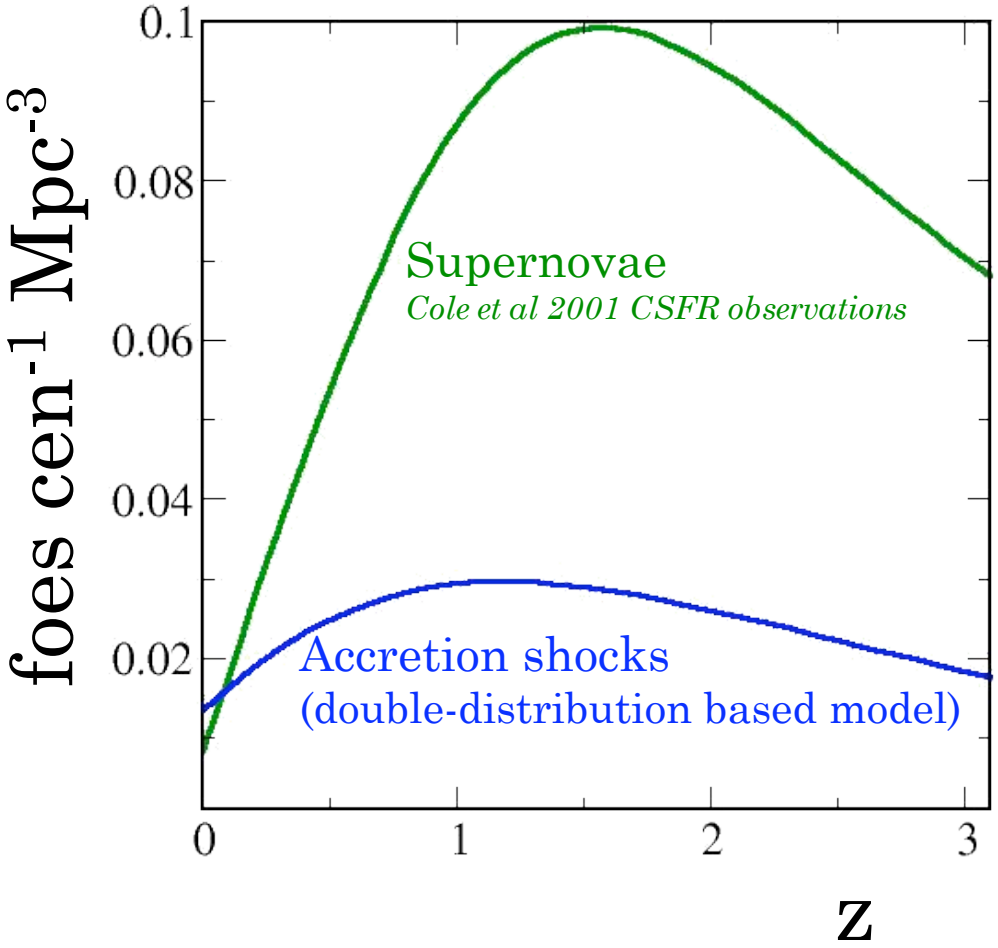


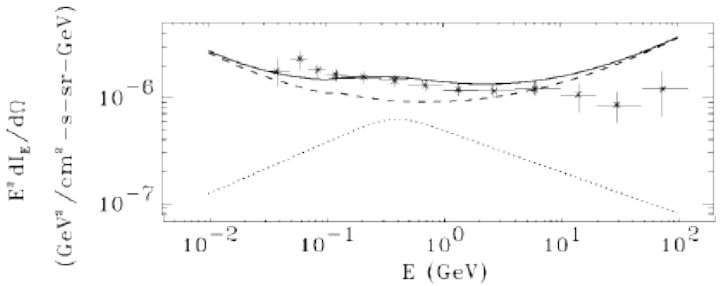
Double-Distribution–based

(includes environmental effects)



Energetics of Cosmic Accretion Shocks in Context

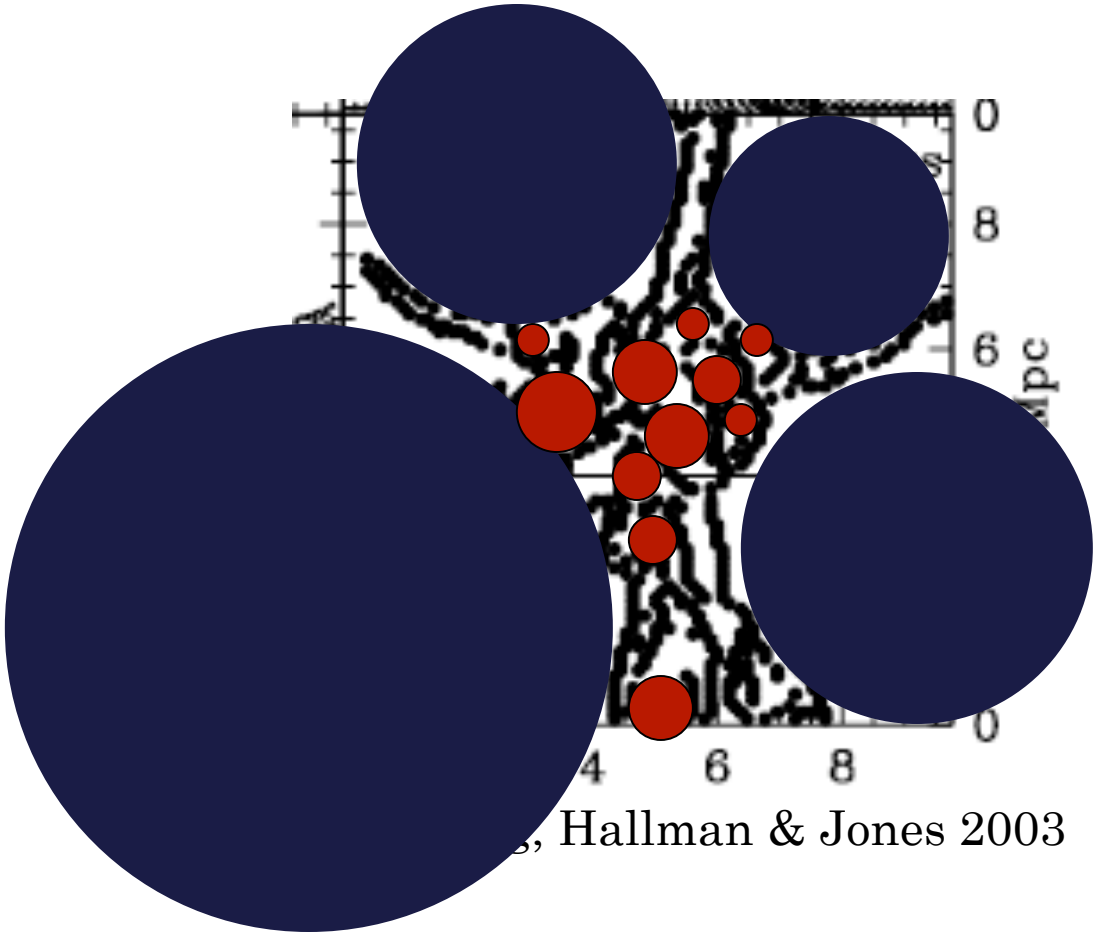




The Extragalactic Gamma-Ray Background
Data points: Sreekumar et al 1998,
Models: Stecker & Salamon 1996 (blazars)
Pavlidou & Fields 2002 (galaxies)

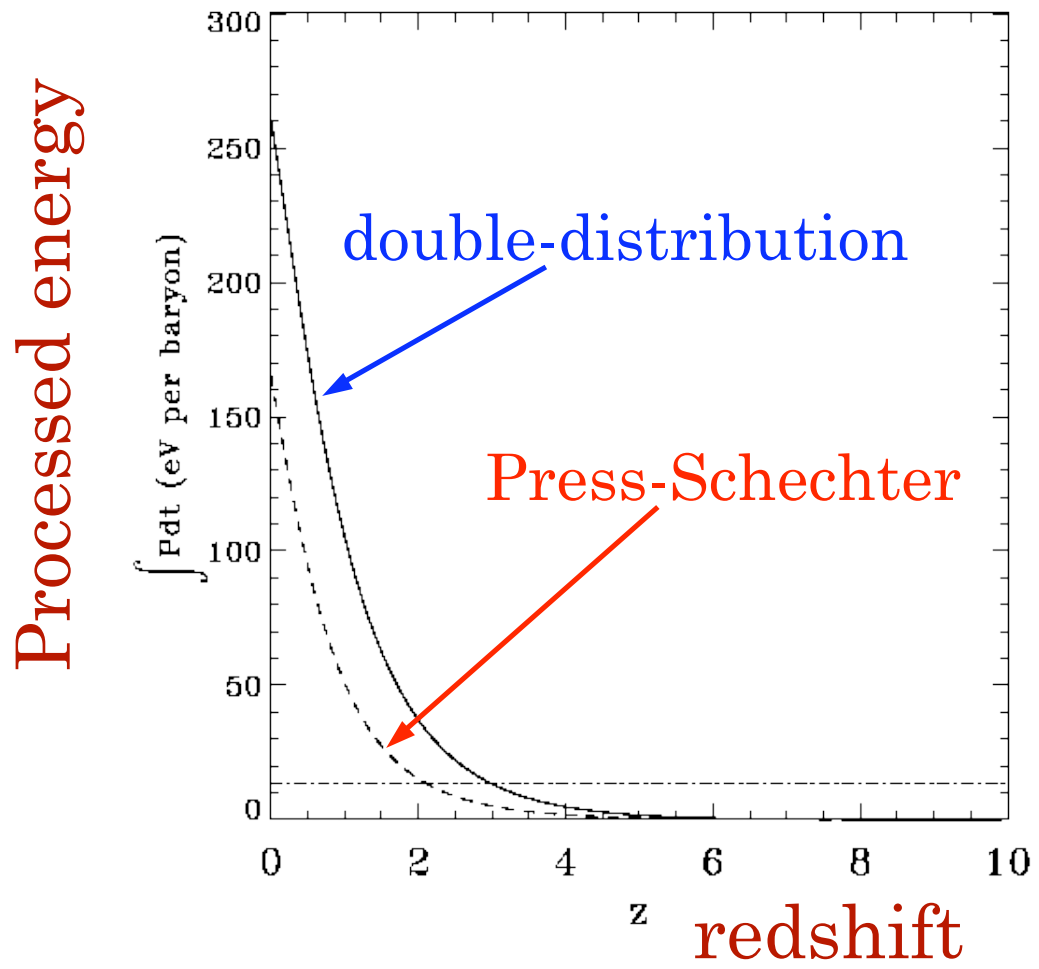
Conclusions

- ✓ Cosmic shocks: accretion, merger, filament (depending on driving mechanism)
- ✓ Double distribution of cosmic structures can be used to investigate effect of environment on cosmic accretion shocks
- ✓ Inclusion of environmental effects distributes energy processed by shocks among broader range of Mach numbers
- ✓ Energy processed by accretion shocks ~ 1/3 of supernovae at high z, overtakes supernovae output in local universe



, Hallman & Jones 2003

Energetics of Cosmic Accretion Shocks in Context



Two Models for Cosmic Accretion Shocks

1. **Press-Schechter based** (no environmental effects)
   - **identical environment** for all collapsed structures at given z:
   - All shock properties = f(**accretor mass**)
   - Distribution of accretor masses ≡Press-Schechter mass function

2. **Double-Distribution based** (includes environmental effects)
   - **distribution of possible environments** for each accretor mass
   - All shock properties = f(**accretor mass, local overdensity**)
   - Distribution of accretor masses + local overdensities ≡ Double Disribution of Cosmic Structures