

Shocks and Particle Shock Acceleration

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Shocks are ubiquitous in the Cosmos

Produced by super-magnetosonic flows or evolution of compressive structures

Observed in:

The laboratory

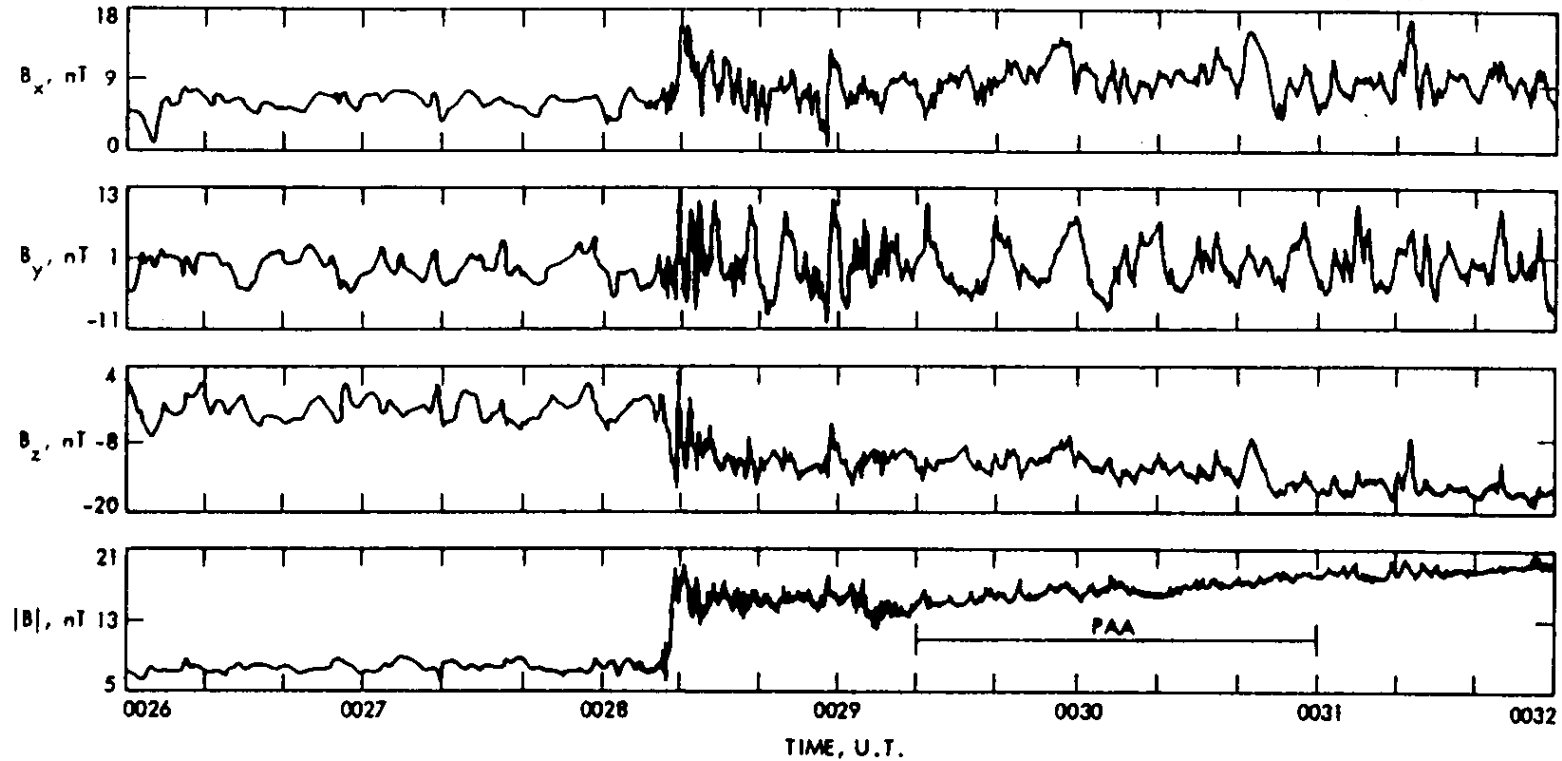
The Heliosphere

Astrophysical sites

Collisionless Shock on 11/12/78: ISEE-3

DAY 316, 1978
NOVEMBER 12
ISEE-3

$\hat{n} = (-.96, .28, .09)$
 $\theta_B = 22^\circ$
 $M_s = 4.7$
 $\beta = 0.5$

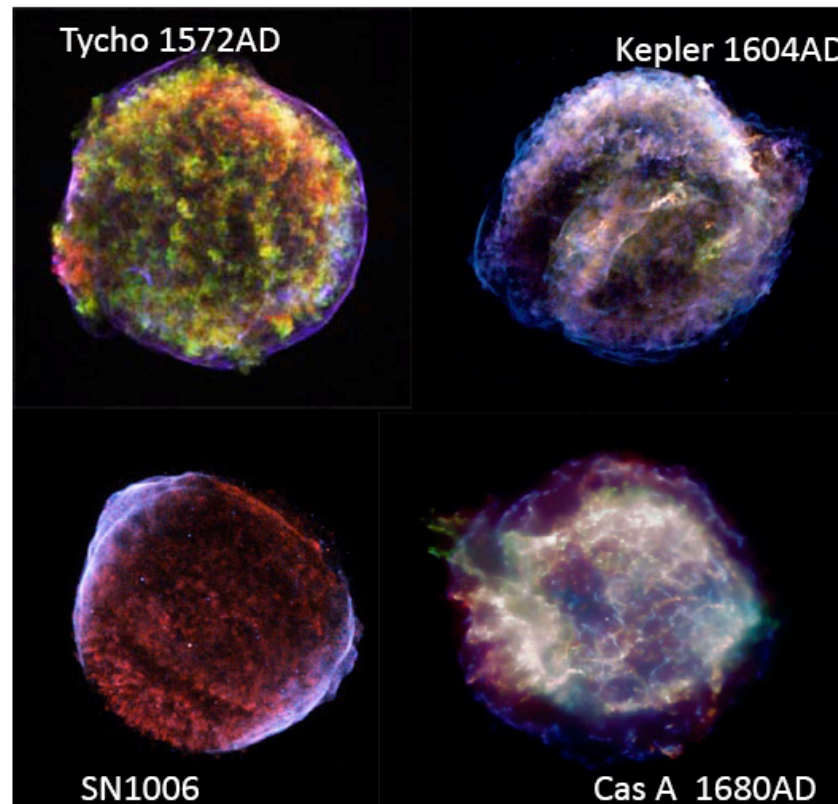


Tsurutani et al., 1983

Supernovae Remnant Shocks

Evidence for magnetic field amplification at shock

(Vink & Laming, 2003; Völk, Berezhko, Ksenofontov, 2005)



Bell, 2009

Chandra observations

NASA/CXC/Rutgers/
J. Hughes et al.

NASA/CXC/Rutgers/
J. Warren & J. Hughes et al.

NASA/CXC/NCSU/
S. Reynolds et al.

NASA/CXC/MIT/UMass Amherst/
M.D. Stage et al.

Shocks and Particle Shock Acceleration

A. Importance of Shocks in the Cosmos

B. Key Questions

1. Dependence of Shock Structure on Flow Parameters
2. Are Shocks in the Cosmos Planar and Stationary?
3. Particle Injection and Diffusive Shock Acceleration
4. Amplification of the Magnetic Field at Shocks
5. What is the Role of Turbulence in Shock Structure?

C. Numerical Simulations of Shocks

D. Laboratory Experiments on Shocks

E. Discovery and Exciting Shock Case Studies

1. Supernovae Shocks and the Origin of Galactic Cosmic Rays
2. Heliospheric Shocks: Examples in Different Domains of Plasma Parameter Space

F. Concluding Statement

Shock WG Presentations

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|---------------|----------------------------|
| M. Lee | Introduction |
| J. R. Jokipii | Heliospheric Shocks |
| R. Lin | Coronal Shocks and SEPs |
| A. Spitkovsky | SNR and Other Astro Shocks |
| R. Cowsik | Origin of GCRs |
| D. Burgess | Simulations |
| C. Niemann | Laboratory Experiments |