

# THE PHYSICS OF COLLISIONLESS SHOCKS

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## CONTENTS

Preface.....	xi
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### SESSION 1

#### OVERVIEW

An Introduction to the Physics of Collisionless Shocks.....	3
C. T. Russell	

### SESSION 2

#### SHOCK STRUCTURES: MICROSCOPIC AND KINETIC

Electron Acceleration and Structure in the Quasi-Perpendicular Collisionless Shock .....	17
D. Burgess	
On Kinetic Structure of Quasi-Perpendicular Collisionless Shocks .....	22
M. Scholer and S. Matsukiyo	
Global Hybrid Simulations of the Bow Shock .....	27
N. Omidi, X. Blanco-Cano, and C. T. Russell	
Ion Dynamics at Shocks: Ion Reflection and Beam Formation at Quasi-Perpendicular Shocks .....	32
H. Kucharek and E. Möbius	
Multi-Spacecraft Observations of Interplanetary Shocks.....	37
A. Szabo	
Classical MHD Shocks: Theory and Numerical Simulation.....	42
N. V. Pogorelov	
Issues for Hybrid Simulations of Collisionless Shocks .....	50
D. Winske and L. Yin	
A New Simulation Technique for Study of Collisionless Shocks: Self-Adaptive Simulations .....	56
H. Karimabadi, Y. Omelchenko, J. Driscoll, R. Fujimoto, K. Perumalla, and D. Krauss-Varban	
Magnetohydrodynamics of Shocks with Reflected Particles: Rankine-Hugoniot Relations .....	64
B. Dasgupta, G. P. Zank, R. Bedros, and G. M. Webb	
Electrons at Shocks.....	72
K. W. Ogilvie	

## SESSION 3

### PLANETARY BOW SHOCKS, STRUCTURE AND WAVES

<b>The Electric Potential at the Earth's Quasi-Parallel Bow Shock: Initial Cluster Results</b> .....	79
R. Behlke, H. Kucharek, S. D. Bale, M. André, and E. A. Lucek	
<b>On Increasing Accuracy of Bow Shock Shape and Position Predictions</b> .....	84
J. Merka	
<b>Field-Aligned and Gyrating Ion Beams in a Planetary Foreshock</b> .....	89
C. Mazelle, K. Meziane, M. Wilber, and D. Le Quéau	
<b>The Locations and Shapes of Jupiter's Bow Shock and Magnetopause</b> .....	95
R. J. Walker, S. P. Joy, M. G. Kivelson, K. Khurana, T. Ogino, and K. Fukazawa	
<b>Bow Shock and Upstream Waves at Jupiter and Saturn: Cassini Magnetometer Observations</b> .....	109
C. Bertucci, N. Achilleos, C. T. Russell, M. K. Dougherty, E. J. Smith, M. Burton, B. T. Tsurutani, and C. Mazelle	
<b>A Review of Field-Aligned Beams Observed Upstream of the Bow Shock</b> .....	116
K. Meziane, M. Wilber, C. Mazelle, G. K. Parks, and A. M. Hamza	
<b>Methods of Plasma Turbulence Analysis: Application to Shock Studies</b> .....	123
M. A. Balikhin and S. N. Walker	
<b>Observations of Turbulence near Interplanetary Travelling Shocks</b> .....	129
R. Kallenbach, K. Bamert, M. Hilchenbach, and C. W. Smith	
<b>Nonresonant Alfvén Waves Driven by Cosmic Rays</b> .....	135
D. Melrose	
<b>Hamiltonian Approach to Nonlinear Travelling Whistler Waves</b> .....	141
G. M. Webb, J. F. McKenzie, E. Dubinin, and K. Sauer	
<b>Upstream Gyrating Ion Events: Cluster Observations and Simulations</b> .....	146
K. Sauer, M. Fränz, E. Dubinin, C. Mazelle, A. Korth, H. Rème, I. Dandouras, and K.-H. Glaßmeier	
<b>Ion Thermalization and Wave Excitation Downstream of Earth's Bow Shock</b> .....	151
Y. C.-M. Liu, M. A. Lee, and H. Kucharek	

## SESSION 4

### PARTICLE ACCELERATION AT SHOCKS

<b>Surfing Acceleration of Ions at Relativistic, Oblique Shocks</b> .....	159
D. Üçer and V. D. Shapiro	
<b>Simulated 2D vs. 3D Shock Waves: Implications for Particle Acceleration</b> .....	165
F. C. Jones	

<b>Particle Acceleration at Collisionless Shocks: An Overview</b> .....	170
G. P. Zank, G. Li, G. M. Webb, J. A. le Roux, V. Florinski, X. Ao, and W. K. M. Rice	
<b>The Energetic Storm Particle Event on 2003 October 24: A Test of Diffusive Shock Acceleration Theory</b> .....	180
D. Lario, R. B. Decker, G. C. Ho, Q. Hu, C. W. Smith, M. I. Desai, and A.-F. Viñas	
<b>The Role of Quasi-Perpendicular Shocks in Solar Energetic Particle Events</b> .....	185
A. J. Tylka	
<b>Energetic Particle Transport in Strong Compressive Wave Turbulence Near Shocks</b> .....	191
J. A. le Roux, G. P. Zank, G. Li, and G. M. Webb	
<b>Anomalous Diffusion of Energetic Particles: Implications for Diffusive Particle Acceleration at a Quasi-Perpendicular Shock</b> .....	196
O. P. Verkhoglyadova and J. A. le Roux	
<b>Simulation of SEP Acceleration and Transport at CME-Driven Shocks</b> .....	201
J. Kóta, W. B. Manchester, J. R. Jokipii, D. L. de Zeeuw, and T. I. Gombosi	
<b>Diffusive Acceleration of Ions at Interplanetary Shocks</b> .....	207
M. G. Baring and E. J. Summerlin	
<b>The Importance of Field-Line Meandering in Particle Acceleration at Shocks</b> .....	213
J. Giacalone	
<b>Energetic Particles Accelerated by Shocks in the Heliosphere: What is the Source Material?</b> .....	219
G. M. Mason, M. I. Desai, J. E. Mazur, and J. R. Dwyer	
<b>Solar Energetic Particle Spectral Breaks</b> .....	227
R. A. Mewaldt, C. M. S. Cohen, G. M. Mason, A. W. Labrador, M. L. Looper, D. E. Haggerty, C. G. MacLennan, A. C. Cummings, M. I. Desai, R. A. Leske, G. Li, J. E. Mazur, E. C. Stone, and M. E. Wiedenbeck	
<b>Upstream Turbulence and the Particle Spectrum at CME-Driven Shocks</b> .....	233
G. Li, Q. Hu, and G. P. Zank	
<b>Generation of Turbulence at Shocks</b> .....	240
M. A. Lee	
<b>Relationship of Solar Flare Accelerated Particles to Solar Energetic Particles (SEPs) Observed in the Interplanetary Medium</b> .....	246
R. P. Lin	
<b>Pickup Ions Upstream and Downstream of Shocks</b> .....	252
G. Gloeckler, L. A. Fisk, and L. J. Lanzerotti	

## SESSION 5

### SHOCKS IN THE OUTER HELIOSPHERE

<b>Observations of Energetic Ions and Electrons in the Distant Heliosphere: 2001 - 2005.0</b> .....	261
F. B. McDonald, E. C. Stone, L. F. Burlaga, A. C. Cummings, B. C. Heikkila, N. Lal, N. F. Ness, J. D. Richardson, and W. R. Webber	
<b>Search for the Heliospheric Termination Shock (TS) and Heliosheath (HS)</b> .....	267
N. F. Ness, L. F. Burlaga, M. H. Acuña, E. C. Stone, and F. B. McDonald	
<b>Characteristics of the Termination Shock: Insights from Voyager</b> .....	273
A. C. Cummings and E. C. Stone	
<b>Voyager Observations of Interplanetary Shocks</b> .....	278
J. D. Richardson and C. Wang	
<b>Charged-Particle Acceleration at the Heliospheric Termination Shock</b> .....	283
J. R. Jokipii	
<b>A Global V-Shaped Channel Structure of the Termination Shock Due to a Magnetic Pressure Effect, and Its Physical Connection to Bipolar Flow Type Planetary Nebulae</b> .....	289
H. Washimi, T. Tanaka, and G. P. Zank	
<b>The Termination Shock and Beyond: MHD Modeling</b> .....	294
R. Ratkiewicz, J. Grygorczuk, and L. Ben-Jaffel	
<b>Comparison of Voyager Shocks in Solar Cycle 23</b> .....	299
J. Ashmall and J. Richardson	
<b>Initial Comparison between a 3D MHD Model and the HAFv2 Kinematic 3D Model: The October/November 2003 Events from the Sun to 6 AU</b> .....	304
D. S. Intriligator, T. Detman, M. Dryer, C. D. Fry, W. Sun, C. Deehr, and J. Intriligator	

## SESSION 6

### OTHER SHOCK RELATED PHENOMENA

<b>3-D Hybrid Simulation of Quasi-Parallel Bow Shock and Its Effects on the Magnetosphere</b> .....	313
Y. Lin and X. Y. Wang	
<b>3D Global Simulation of the Interaction of Interplanetary Shocks with the Magnetosphere</b> .....	320
C. Wang, Z. Huang, Y. Hu, and X. Guo	
<b>Spiral Shocks in Astrophysical Disks</b> .....	325
W. K. M. Rice, G. Lodato, and P. J. Armitage	
<b>On the Fitting of Ion-Ion Drifting Plasma</b> .....	331
E. K. Kaghshvili, G. P. Zank, and B. J. Vasquez	

<b>Coronal Shock Waves Observed in Images.....</b>	<b>336</b>
H. S. Hudson	
<b>Proton, Electron and Ion Temperatures in Fast Shocks.....</b>	<b>342</b>
J. C. Raymond and K. E. Korreck	
<b>Author Index.....</b>	<b>347</b>

## PREFACE

Collisionless shocks are both a physicist's best dream and worst nightmare. The effects of a collisionless shock on a magnetized plasma (such as the solar wind) are dramatic and important. The shock affects the bulk parameters and the thermal properties of the plasma, and accelerates a small non-Maxwellian portion of plasma particles to even ultra-relativistic energies in the largest of shocks. The collisionless shock is rich in the physical processes that it nurtures. At the same time it is extremely complex. As plasma parameters change, even so subtly as a change in the magnetic field direction, the processes at work can vary drastically. Quiescent processes become turbulent. High energy particles suddenly appear. These energetic particles can damage space systems (shuttles and satellites) and lead to over-exposure in astronauts. Is it safe for human beings to venture beyond the Earth's magnetosphere to be able to set foot on Mars? The answer to this question lies in determining the efficiency and frequency of collisionless shock generation of harmful levels of relativistic particles.

Collisionless shocks are important both in the inner and the outer heliosphere. The solar wind must ultimately stop when it encounters the interstellar plasma. Since it is supersonic, it must pass through a standing shock (the termination shock) before it can be slowed by the interstellar plasma. On December 18, 2004, just before the conference was convened, the termination shock was finally crossed by spacecraft Voyager I. In its 28 year journey, Voyager I had encountered many collisionless shocks: CME-driven shocks originating from the sun, shocks associated with stream interactions, the standing bow shocks around the planets including the Earth and now finally the termination shock.

Over the last decade, tremendous progress in the understanding of the physics of collisionless shock has been made and this was the driving force for this year's IGPP International Astrophysics Conference. From February 27th to March 3rd, 2005, more than 70 scientists from all over the world in various sub-fields of collisionless shock physics gathered together in Palm Springs, California. Over five days, progress on the topics of 1) the micro-structure of collisionless shocks, 2) upstream and downstream wave activity at collisionless shocks, 3) particle acceleration at collisionless shocks and 4) collisionless shocks in outer-heliosphere, was reviewed.

This proceedings contains 54 papers. It is intended that this proceedings will serve both as a summary of our current understanding of collisionless shock physics as well as a starting point for future research, especially for young scientists in this field. The study of collisionless shocks, although already fifty years old since T. Gold first suggested their existence in 1955, still remains one of the most active research areas in space physics, plasma physics and astrophysics.

The conference organizers wish to express their thanks to all participants and especially to those who reviewed manuscripts in this volume. Finally, we would like to thank Ms. Adele Corona for her help in organizing and managing the conference.

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