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978-0-521-11061-7 - Heliophysics: Plasma Physics of the Local Cosmos

Edited by Carolus J. Schrijver and George L. Siscoe

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HELIOPHYSICS: PLASMA PHYSICS OF THE LOCAL COSMOS

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Heliophysics is a fast-developing scientific discipline that integrates studies of the Sun's variability, the surrounding heliosphere, and the environment and climate of the planets. Over the past few centuries, our understanding of how the Sun drives space weather and climate on the Earth and other planets has advanced at an ever increasing rate. The Sun is a magnetically variable star and, for planets with intrinsic magnetic fields, planets with atmospheres, or planets like Earth with both, there are profound consequences.

This volume, the first in a series of three heliophysics texts, integrates these diverse topics for the first time as a coherent intellectual discipline, providing a core resource for courses and seminars at the advanced undergraduate and graduate level. It emphasizes the physical processes that couple the realm of the Sun to that of our planet and provides insights into the interaction of the solar wind and radiation with the Earth's magnetic field, atmosphere, and climate system. In addition to its utility as a textbook, it also constitutes a foundational reference for researchers in the fields of heliophysics, astrophysics, plasma physics, space physics, solar physics, aeronomy, space weather, planetary science, and climate science. Additional online resources, including lecture presentations and other teaching materials, can be accessed at www.cambridge.org/9780521110617.

CAROLUS J. SCHRIJVER is an astrophysicist studying the causes and effects of magnetic activity of the Sun, and of stars like the Sun, and the coupling of the Sun's magnetic field into the surrounding heliosphere. He obtained his doctorate in physics and astronomy at the University of Utrecht in The Netherlands in 1986 and has since worked for the University of Colorado, the US National Solar Observatory, the European Space Agency, and the Royal Academy of Sciences of the Netherlands. Dr Schrijver is currently principal physicist at Lockheed Martin's Advanced Technology Center, where his work focuses primarily on the magnetic field in the solar atmosphere. He is an editor or editorial board member of several journals including *Solar Physics*, *Astronomical Notices*, and *Living Reviews in Solar Physics*, and has co-edited three other books.

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Preface

Over the past few centuries, our awareness of the coupling between the Sun's variability and the Earth's environment, and perhaps even its climate, has been advancing at an ever increasing rate. The Sun is a magnetically variable star and, planets with intrinsic magnetic fields, planets with atmospheres, or planets like Earth with both, there are profound consequences and impacts. Today, the successful increase in knowledge of the workings of the Sun's magnetic activity, the recognition of the many physical processes that couple the realm of the Sun to our galaxy, and the insights into the interaction of the solar wind and radiation with the Earth's magnetic field, atmosphere and climate system have tended to differentiate and insularize the solar heliospheric and geo-space sub-disciplines of the physics of the local cosmos. In 2001, the NASA Living With a Star (LWS) program was initiated to reverse that trend.

The recognition that there are many connections within the Sun–Earth systems approach has led to the development of an integrated strategic mission plan and a comprehensive research program encompassing all branches of solar, heliospheric, and space physics and aeronomy. In doing so, we have developed an interdisciplinary community to address this program. This has raised awareness and appreciation of the research priorities and challenges among LWS scientists and has led to observational and modeling capabilities that span traditional discipline boundaries. The successful initial integration of the LWS sub-disciplines, under the newly coined term “heliophysics”, needed to be expanded into the early education of scientists. This series of books is intended to do just that: aiming at the advanced undergraduate and starting graduate-level students, our aim is to teach heliophysics as a single intellectual discipline. Heliophysics is important both as a discipline that will deepen our understanding of how the Sun drives space weather and climate at Earth and other planets and also as a discipline that studies universal astrophysical processes with unrivaled resolution and insight possibilities. The goal

of this series is to provide seed materials for the development of new researchers and new scientific discovery.

Richard Fisher, Director of NASA’s Heliophysics Division
Madhulika Guhathakurta, NASA/LWS program scientist

Heliophysics

helio-, prefix, on the Sun and environs; from the Greek *helios*.
physics, n., the science of matter and energy and their interactions.

Heliophysics is the

- *comprehensive new term for the science of the Sun–solar-system connection.*
- *exploration, discovery, and understanding of our space environment.*
- *system science that unites all the linked phenomena in the region of the cosmos influenced by a star like our Sun.*

Heliophysics concentrates on the Sun and its effects on Earth, the other planets of the solar system, and the changing conditions in space. Heliophysics studies the magnetosphere, ionosphere, thermosphere, mesosphere, and upper atmosphere of the Earth and other planets. Heliophysics combines the science of the Sun, corona, heliosphere and geospace. Heliophysics encompasses cosmic rays and particle acceleration, space weather and radiation, dust and magnetic reconnection, solar activity and stellar cycles, aeronomy and space plasmas, magnetic fields and global change, and the interactions of the solar system with our galaxy.

From NASA’s *Heliophysics. The New Science of the Sun–Solar-System Connection: Recommended Roadmap for Science and Technology 2005–2035*.