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Preface

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Magnetic reconnection is a fundamental plasma-physical process by which energy stored in a magnetic field is converted, often explosively, into heat and the kinetic energy of the charged particles that constitute the plasma. It occurs in a variety of astrophysical settings, ranging from the solar corona to pulsar magnetospheres and winds, as well as in laboratory fusion experiments, where it is responsible for sawtooth crashes. First proposed by R.G. Giovanelli in the late 1940s as the mechanism responsible for solar flares, magnetic reconnection was invoked at the beginning of the space age to explain not just solar flares but also the transfer of energy, mass, and momentum from the solar wind to Earth's magnetosphere and the subsequent storage and release of the transferred energy in the magnetotail. During the half century or so that has followed the seminal theoretical works by J.W. Dungey, P.A. Sweet, E.N. Parker, and H.E. Petschek, in-situ measurements by Earth-orbiting satellites and remote-sensing observations of the solar corona have provided a growing body of evidence for the occurrence of reconnection at the Sun, in the solar wind, and in the near-Earth space environment. The last thirty years have also seen the development of laboratory reconnection experiments at a number of institutions. In parallel with the efforts of experimentalists in both space and laboratory plasma physics, theorists have investigated, analytically and with the help of increasingly powerful MHD, hybrid, and kinetic numerical simulations, the structure of the diffusion region, the factors controlling the rate, onset, and cessation of reconnection, and the detailed physics that enables the demagnetization of the ions and electrons and the topological reconfiguration of the magnetic field. Moreover, the scope of theoretical reconnection studies has been extended well beyond solar system

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and laboratory plasmas to include more exotic astrophysical plasma systems whose strong (10^{14}–10^{15} G) magnetic fields require that models of reconnection in these systems incorporate quantum electrodynamical, special relativistic, and radiative effects.

The papers collected in this topical issue of *Space Science Reviews* cover different aspects of recent theoretical and observational work on magnetic reconnection in solar and space physics, astrophysics, and laboratory plasma physics. They derive from presentations given at a workshop on magnetic reconnection held in the Yosemite National Park, February 8–12, 2010. The intent of the workshop was to stimulate, through a combination of tutorial talks, shorter focused talks, and extensive informal discussions, an interdisciplinary dialogue among members of the different research communities working on the problem of magnetic reconnection.

One of the motivating considerations for holding the workshop was its relevance to NASA's Magnetospheric Multiscale (MMS) mission, scheduled for launch in 2014. The four identically instrumented MMS spacecraft are designed to study reconnection in Earth's magnetosphere and, specifically, to probe the electron diffusion region in order to determine the microphysical processes that enable the change in the topology of the magnetic field. Building on the achievements of the multispacecraft Cluster and THEMIS missions, MMS will use the magnetosphere as an astrophysical plasma laboratory in which to test, through in-situ measurement of the plasma, energetic particles, and electric and magnetic fields, various models and theories that have emerged during the past twenty years, a period of extraordinarily productive theoretical and observational work.

We gratefully acknowledge the MMS Project's support of both the workshop and this publication. We would also like to thank the referees who took the time to comment on the papers collected here. Finally, we are pleased to acknowledge Cyndi Kempe's excellent job in organizing the workshop.