Foreword

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The uppermost fully ionised and magnetically dominated part of the atmosphere of the Sun, the solar corona, has attracted researchers' attention for several decades. The main motivation of solar coronal studies is connected with the decisive role the corona plays in solar–terrestrial relations. Also, being a natural plasma laboratory, the corona provides us with a wide range and combination of plasma parameters, allowing us to gain knowledge important for controlled fusion efforts. Moreover, our interest in the corona is motivated by the fundamental questions of space physics and plasma astrophysics: why is the temperature of the coronal plasma two orders of magnitude larger than that of the solar surface? What are the mechanisms for the acceleration of solar and stellar winds? How is the vast amount of energy released in solar flares and coronal mass ejections, making them the most powerful physical phenomena in the solar system? The difficulties in answering these, and many other questions posed by the corona, are partly associated with the lack of precise and often even minimal knowledge of the physical conditions and parameters in this part of the solar atmosphere. Indeed, remote diagnostics of the hot, dynamic, sometimes non-equilibrium and often transparent plasma is a non-trivial task.

The discovery of spatially and temporally resolved wave processes in the solar corona, which was made 10 years ago with the use of the Solar and Heliospheric Observatory (SOHO) and the Transition Region and Coronal Explorer (TRACE), opened up new opportunities for coronal plasma diagnostics—magnetohydrodynamic (MHD) coronal seismology. As the parameters of waves, such as their spectra, characteristic speeds and signatures, spatial location and localisation, decay, etc., are affected by the medium supporting them, the coronal wave studies provide the solar research community with a novel and promising technique for revealing plasma conditions and parameters. The philosophy of this novel method

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of remote diagnostics of natural plasmas is analogous to the study of the Earth's interior by surface and body seismic waves, geoseismology. In solar physics, a similar technique for probing the solar interior with the use of pressure waves, helioseismology, has been successfully applied for a couple of decades. However, the research methods implemented in MHD coronal seismology are rather different from helioseismological studies. In contrast with helioseismology, in the corona one deals with at least three different kinds of wave motion: fast and slow magnetoacoustic, and Alfvén. Also, the medium is almost always transparent and hence the line-of-sight integration and wave polarisation effects are important. Moreover, often the observed oscillations are of low quality, rather wavelets, which prevents long integration that could enhance the signal-to-noise ratio. In addition, coronal waves have often a sufficiently large amplitude to be nonlinear. Similar approaches have been recently implemented in the diagnostics of the Earth's magnetospheric plasmas (known as magnetoseismology) and of astrophysical objects ("discoseismology" and seismology of neutron stars); and of laboratory plasmas (MHD spectroscopy of tokamaks).

In solar physics, the ideas of plasma diagnostics by MHD waves were independently suggested in three seminal theoretical papers. Uchida (1970) proposed the estimation of plasma parameters by a flare-excited MHD blast wave, what is now known as "global coronal seismology"; Zaitsev and Stepanov (1982) started the seismological use of quasi-periodic pulsations in flares; and Roberts et al. (1984) gave rise to what we now refer to as "local coronal seismology". Now, the technique of MHD coronal seismology is at the forefront of international efforts in solar physics. This Topical Issue presents the current trends in MHD coronal seismology, its recent achievements and modern challenges, in fifteen specialised review papers (listed alphabetically) written by the world experts in the field. The reviews are based upon the discussions that took place at dedicated scientific workshops supported by the International Space Science Institute (ISSI) in Bern, Switzerland. All the authors are grateful to ISSI for the support and for the inspiring and stimulating working environment.

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