Preface

Exoplanetology is one of the fastest-growing fields in present day astrophysics and space science. Nineteen years after the discovery of 51 Peg b, the first Jupiter-type gas giant outside our Solar System, more than 1,100 exoplanets have been detected. Although most of the exoplanets have been discovered with the radial velocity method, recently an increasing the number of exoplanets with sizes from super-Earths to sub-Neptunes and Jupiter-type gas giants have been observed by using the transit detection technique. The discovery of these planets occurred because of the efforts of several international ground-based transit search projects as well as the capabilities of the CoRoT (COnvection, ROtation and planetary Transits) and Kepler space observatories. The detection of exoplanets at orbital distances $\leq$0.05 AU raises questions regarding their atmosphere structure, their interactions with the extreme stellar radiation and plasma environment, the role of possible magnetospheres for atmospheric protection, destructive tidal forces between the host star and the planets, the formation of plasma tori, comet-like escaping planetary plasma tails, as well as the stability of their upper atmospheres against thermal and nonthermal mass loss processes. The spectral and temporal behavior of exoplanet host stars is relevant to models related to the atmospheric chemistry and evolution of planetary atmospheres. Because of this relationship, recent observational and theoretical efforts aimed at a better understanding of the ultraviolet spectra of dwarf stars will be discussed.

The chapters and sections of this book address the analysis of observational findings during Hubble Space Telescope (HST) observations of transiting exoplanets in the ultraviolet (UV) and the application of advanced numerical models for characterizing planetary upper atmosphere structures and stellar environments. In addition to HST observations, the discovery of atoms and molecules by NASA's Spitzer telescope in the atmospheres of hot Jupiters during their secondary eclipses in the infrared (IR) will also be discussed. Observations of that kind are helpful in characterizing the temperature structure of the lower thermosphere with hydrodynamic and empirical upper atmosphere models. The observation and characterization of the upper atmosphere-magnetosphere-plasma environment of hydrogen-rich exoplanets in orbital locations less than 0.1 AU can also be used for the understanding of non-hydrostatic upper atmospheric conditions, the identification of magnetic obstacles and the validation of complex numerical models.

The authors of the various interdisciplinary, but connected, articles have been members of a team led by us with the title *Characterizing Stellar and Exoplanetary Environments via Observations and Advanced Modelling Techniques* supported by the Swiss-based International Space Science Institute (ISSI) in Bern which studied these processes during the past two years. The results summarized by these researchers will show that the study of exoplanets under extreme stellar radiation and plasma conditions will also help the planetary community to understand how terrestrial planets, including early Venus, Earth, and Mars, and their atmospheres evolved during the host star's active early phase. These observational and theoretical investigations and discoveries are timely and important in the context of the next generation of space telescopes, such as James Webb Space Telescope (JWST), which will have the capability of acquiring spectra in the far-infrared and mid-infrared. ESA's CHaracterizing ExOPlanets Satellite (CHEOPS) mission, and Europe's next Generation Planet Finder (PLATO 2.0), as well as NASA's Transiting Exoplanet Survey Satellite (TESS) mission, the Russian-led international UV space observatory World Space Observatory-UV (WSO-UV) and the planned European astrometry mission Nearby Earth Astrometric Telescope (NEAD).

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