POLARIZATION SPECTROSCOPY OF IONIZED GASES

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POLARIZATION SPECTROSCOPY OF IONIZED GASES

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Cover: Electrons and protons accelerated above the surface of the Sun in the corona are precipitating on the solar atmosphere. As a result the atmosphere is heated and a hot ionized plasma rises in the corona. Particle acceleration takes place in regions where magnetic fields are present and the ionized hydrogen plasma is then trapped in gigantic magnetic loops. When it cools, the ionized hydrogen recombines with local electrons, becomes neutral and starts emitting in the Red Balmer α line. At the base of the loop, the accelerated protons and electrons are bombarding the atmospheric neutral hydrogen leading to linearly polarized Balmer α line emission. The measurement of this polarization provides information on the nature and velocity distribution of the accelerated particles. Courtesy of Z. Mouradian, DASOP, URA326, Observatoire de Paris.

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PREFACE

This book describes the physical principles of polarization spectroscopy and its applications to the remote sensing of ionized gases. Recent evolution of this technique allows for quantitative studies of energy transport and dissipation in various types of ionized gases states.

In the theoretical part, the basic phenomena of the ordering of the velocities of fast exciting charged particles, together with the polarization of the outer electron shells of the ensemble of excited atoms or molecules are described. A general approach based on the irreducible tensorial set representation of the rotation symmetry group is used. The effects of the polarization of the excited atoms or molecules are examined in more detail. Then the integral equation giving the intensity and polarization of the emitted lines is derived and methods to solve this equation are analysed.

Experimental applications of remote sensing are reviewed. Universal spectropolarimetric remote sensing has been applied to laboratory low pressure gas discharge plasmas and to non-thermal processes taking place in the solar atmosphere, illustrating the possibilities of this new method.

This book may be useful for researchers, Ph D students and graduate students utilizing optical methods for the remote sensing of various ionized gases: low temperature plasmas generated in different discharges and beam-gas systems, high temperature plasmas, solar plasmas, eruptive processes, ionized gases in the upper atmosphere of the earth where precipitating particles are present and various other cases.