VII SERBIAN CONFERENCE ON SPECTRAL LINE SHAPES IN ASTROPHYSICS
15-19 June 2009, Zrenjanin, Serbia
Book of Abstracts, Eds. L. Č. Popović, M. S. Dimitrijević, D. Jevremović and D. Ilić
Serbian Astronomical Society and Astronomical Observatory, Belgrade, 2009

Invited lecture

COLLISIONAL LINE BROADENING VERSUS COLLISIONAL ATOMIC DEPOLARIZATION AND ASTROPHYSICAL APPLICATIONS

Sylvie Sahal-Bréchot

Observatoire de Paris, LERMA CNRS UMR 8112,
5 Place Jules Janssen, 92190 Meudon, France
E-mail: sylvie.sahal-brechot@obspm.fr

As well known, interpretation of spectral line shapes is essential for spectroscopic modeling in laboratory and in astrophysics. Line broadening by collisions offers a tool for spectroscopic diagnostics of scalar physical quantities, especially densities of perturbers. Thanks to the growing accuracy and sensitivity of spectrpolarimetric observations and to the progresses of MHD modeling, interpretation of all the Stokes parameters of spectral lines nowadays becomes crucial and new tools leading to determination of vectorial (or anisotropic) physical quantities have been created and are of increasing interest. In particular, interpretation of atomic polarization enables to determine magnetic field vectors, velocity field vectors, and also to interpret anisotropic excitation of the atomic levels by collimated beams of energetic particles.

Atomic polarization leads to a global polarization of the observed line. It is a consequence of a departure from LTE between the Zeeman sublevels, and is due to an anisotropic excitation of the atomic levels. This anisotropic excitation is often the result of the incident radiation field absorption. However, isotropic collisions between Zeeman sublevels try to restore LTE and to destroy this atomic polarization. So, a quantitative interpretation of these spectropolarimetric observations must take into account collisional depolarization (and also the possible polarization transfer between levels). In some cases, collisional depolarization can also be used for determining densities of perturbers.

In fact, collisional line broadening and collisional depolarization are two complementary aspects of the same basic theory: the density matrix theory in the impact approximation. For collisional widths and shifts, we have the pioneering work by Baranger created in the end of the fifties, and followed by many fruitful developements. For atomic polarization, we have the theory of the master equation, created in the end of the sixties and seventies in the pioneering works by Cohen-Tannoudji and coworkers. It has also been followed by many fertile developments, in particular for astrophysics. The main aspects will be presented in parallel and astrophysical results, especially for solar physics, will be given.