Experimental values for this level in the literature. However, atomic data of some elements are incomplete or even missing, particularly for the infrared wavelength region. In our studies, the focus is on the infrared region and neutral species that are present in cool stars. Here we present a study of neutral magnesium, Mg I, with laboratory measurements together with atomic calculations to improve uncertain atomic data lead to false abundances, and it is thus important to have complete and accurate atomic data.

Introduction

In order to understand the formation and evolution of our Galaxy, the observed spectra of stars are combined with their dynamics. By modelling stellar atmospheres, a synthetic spectrum is fitted to the observed one to derive stellar abundances. A model atmosphere requires stellar parameters as well as atomic parameters. Incorrect or uncertain atomic data lead to false abundances, and it is thus important to have complete and accurate atomic data.

Comparison between experimental and theoretical log(gf) values of this work and theoretical calculations of this work (red circles) and Kurucz, 2009 (black squares).

Calculations

We performed our calculations using the multi configuration Hartree-Fock approximation (MCHF). In this approximation, atomic state functions are represented as linear combinations of configuration state functions (CSF):

$$\Psi(\ell S) = \sum \psi_i \Phi(\ell S)$$

We started with Hartree-Fock (HF) calculations and improved the atomic state functions using the MCHF code. The valence and core-valence electron correlation were accounted for.

The figure on the left hand side shows a partial energy level diagram of Mg I. We marked the transitions that were observed in our experiments. Our calculations include all the transitions from the levels that are on the figure such as all transitions from 4f configurations. The figure shows a comparison of the oscillator strengths for 34 lines for transitions up to n=7. Most of these experimental f-values were measured for the first time. Our calculations agrees with our experimental data and complement the missing transition of our experiment. We present an evaluated set of transitions along with realistic uncertainties as low as 6%.

Oscillator Strengths, log(gf)

Log(gf) values are important for stellar abundance analysis. By measuring the equivalent width of the line and knowing accurate atomic data, one can derive elemental abundances using the equation below,

$$f = \frac{E_W}{\lambda} = \log(\text{Abundance}) + \log(gf) - \theta g - \log(C)$$

The oscillator strength of a spectral line is proportional to the transition probability,

$$f = \frac{E_W}{\lambda}$$

In this study, we derived the oscillator strengths both from experiments and from theoretical calculations.

Results

The log(gf) values of the figure above are for the transitions from 4f configurations. The figure shows a comparison of log(gf) values between theoretical values of this work and experimental values of this work (red circles) and Kurucz, 2009 (black squares).