Need for atomic/molecular data for Gaia astrophysical parametrization

Andreas Korn (Uppsala Astronomical Observatory (UAO), Sweden, akorn@astro.uu.se),
Paul Barklem (UAO, Sweden, paul.barklem@astro.uu.se),
Lionel Bigot (Observatoire de la Côte d'Azur, France, lionel.bigot@obs-nice.fr),
Yves Frémat (Royal Observatory of Belgium, Brussels, Belgium, yves.fremat@oma.be),
Alessandro Lanzafame (Department of Physics and Astronomy, University of Catania, Italy, alanzafame@oact.inaf.it) and
Bertrand Plez (GRAAL, Montpellier, France, bertrand.plez@graal.univ-montp2.fr)

18 November 2005 Report no.: GAIA-C8-TN-UAO-AK-001 version 1

1 Reasoning

Besides collecting complete 6D phase space information, Gaia will attempt to parameterize the physical nature of its targets, that is, determine from BBP and MBP photometry and RVS spectroscopy fundamental stellar parameters like effective temperatures ($T_{\rm eff}$), surface gravitational accelerations ($\log g$), metallicities ([Fe/H]), α-element-to-iron ratios ([α/Fe]), projected rotational velocities ($v \sin i$) and ages (t). This shall be done with the best available input physics which will likely change/be improved over the course of the overall Gaia-mission timescale (2006-2018).

In this document, we define some of the current hot spots of incomplete atomic/molecular data which will have a direct influence on Gaia astrophysical parametrization. It is hoped that laboratory physicists and theoreticians understand the need for this data and take Gaia as a motivation to work on them. We emphasize that this work needs to start immediately.

The data requests are grouped by wavelength, that is, Section 2 highlights data needed for the construction of model atmospheres and the computation of stellar fluxes, while Section 3 focuses on the RVS spectral range (848-874 nm). This list is by no means exhaustive and will be updated from time to time. More specific information can be obtained from the respective author(s).

2 Atomic/molecular data for photometry

- Molecular opacities for constructing reliable model atmospheres for carbon stars, foremost the dominant bands of C_2H_2, C_3 and C_2 (Plez),
- cross-sections for inelastic collisions of atoms with H for non-LTE calculations, foremost for Ca I, Mg I and Fe I and their singly-ionized species (Barklem, Korn).

3 Atomic/molecular data for the RVS spectral range

- Improved line data (gf values, damping parameters) for Fe I $\lambda\lambda$851.407, 851.511, 857.180, 858.226, 859.295, 861.180, 867.474, 868.862, 869.945, 871.039 and Si I $\lambda\lambda$ 859.596, 868.055, 868.635, 874.245 (these lines show large discrepancies in 3D modelling; Bigot),
- atomic data for the Ca II infrared triplet lines, cross-sections for Ca II + e^- (e.g. R matrix computations, for non-LTE calculations; Lanzafame, Korn),
- accurate line data for TiO, CN and FeH (foremost wavelengths and gf values) for cool stars (Plez),
- accurate line data for He I (computed including fine structure) for hot stars (Frémat).