DENSITY DEPENDENCE OF THE LINE EMISSION
OF BORON-LIKE CORONAL IONS*

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Abstract. Assuming steady state conditions, we calculated the occupation of 20 levels of the ion Si x
as a function of the electron density and temperature taking into account collisional processes
and spontaneous radiative ones. Between the two levels of the ground state also the photo-
absorption of the corresponding infrared radiation has been considered. The emission of the most
important UV-, X- and IR-lines is determined as a function of the electron density and temperature.
Intensity ratios are plotted versus electron density. The line emission as a function of the height of
the radiating layers is studied for UV- and X-ray lines. The resulting fluxes in earth distance are
compared with observations.

A large number of observed solar X- and UV-lines belong to ions with 3 electrons out-
side the closed shells, especially to boron-like ions. Up to now, in the literature only
the Al-like ion Fe xiv has been discussed (Blaha, 1971). In our investigation the B-like
ions S xii, Si x and Mg viii were considered. S xii has maximum abundance around
2.5 x 10^6 K, Si x at 1.6 x 10^6 K and Mg viii at 8 x 10^5 K. In the calculation of the level
occupation 20 levels have been taken into account. In the transitions between the
higher levels and the ground state levels X-ray lines are emitted; however, most of the
lines are in the UV-region above 100 Å.

Figure 1 shows the level scheme. It consists of doublet and quartet terms, the ground
state being a doublet P term. Various transitions are indicated, the collisional processes
are represented by continuous lines, the radiative ones are shown by dashed lines.
Assuming steady state conditions level populations have been computed as a function
of electron density and temperature.

The transition probabilities were taken from various sources. Most of the values
were taken from Shamey (1971), some from Garstang (1962) and some were obtained
by interpolation from Wiese’s tables (1969). For the transitions between the ground
term levels and the excited doublet S-terms of Si x the oscillator strengths of these
authors differ by factors of 2 to 3. Therefore the wavefunctions of this ion were cal-
culated by Dankwort and Trefftz (1974) using the multiconfiguration Hartree-Fock
method and taking into account spin–orbit interaction. The oscillator strengths ob-
tained with these wave functions by Dankwort and Trefftz were nearer to Garstang’s
values than to Shamey’s. Also for other important transitions f-values for Si x were
computed which were closer to Garstang’s results.

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Collision strengths were first obtained by scaling from the computed values for Fe xiv and compared with values obtained from gaunt factors. It turned out that for allowed transitions the scaling procedure yields reasonable values. Quantum mechanical calculations of collision strengths under Coulomb-Born approximation were performed for the most important transitions of Si x by Dankwort and Trefftz (1974). In the present state of the investigation a few of them are still being computed. The missing collision strengths of Si x and those for the other elements were obtained by scaling.

The occupation of the excited states essentially takes place through electron collisions from one of the two levels of the ground state. Between these two levels collisional as well as radiative transitions are important. The radiative transitions consist of not only the spontaneous emission but also the photoabsorption. Thus, radiation density enters into the calculation at the wavelength corresponding to the transition between the two ground term levels. These wavelengths lie in the infrared region. It is 0.76 $\mu$ for S xii, 1.43 $\mu$ for Si x and 3.03 $\mu$ for Mg viii. The spontaneous phototransition from the upper level of the ground state results in an infrared radiation of the corona