On the response of charge transfer sensitive levels to the pulsations of a plasma generator

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The process of charge transfer can be a relevant excitation mechanism in an Inductively Coupled Plasma (ICP), where different species are imbedded in an argon plasma. An example of such a reaction is

$$Ar_1 + Mg_r^+ \Longleftrightarrow Ar^+ + Mg_1 \quad (1)$$

where Mg_r^+ refers to the charge transfer sensitive levels in the MgII system. The relevant levels are shown in figure 1.

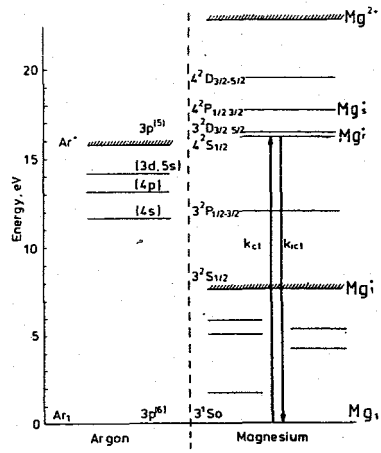

Figure 1. Charge transfer between Mg and Ar.

This process has been studied before [1] in the recombination zone of a stationary ICP. Another way of investigating the charge transfer is by measuring the time dependent response of the charge transfer sensitive level to pulsations of the RF–generator. By comparing this response to those of other Mg–levels and to those of Ar, the importance of the charge transfer reaction can be estimated. In figure 2a and 2b the responses are shown of respectively the Ar(5d) level and the Mg^+(3p) level. The response of Ar(5d) is dominated by the Saha balance and shows a rapid upward jump caused by the cooling of the electrons to the heavy particle temperature when the generator

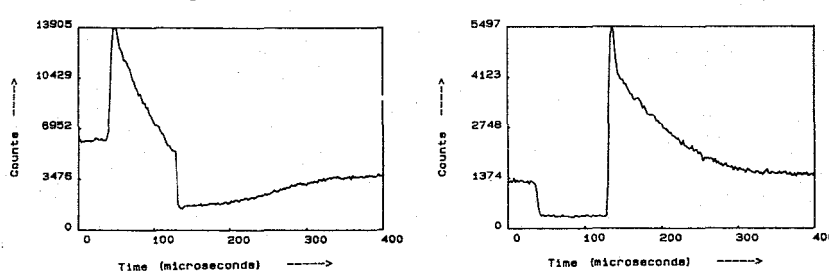

Figure 2. a. Response of Ar(5d), b. Response of Mg^+(3p)

is switched off and a rapid downward jump due to the heating of the electrons when the generator is switched on again. In the recombination period we see a slow decline. The $Mg^+(3p)$ level, dominated by the Boltzmann balance, shows a rapid downward cooling jump at the offset and an rapid upward jump at the onset.

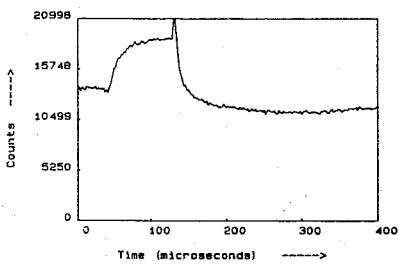

Figure 3. Response of Mg_r^+

The response of Mg_r^+ is totally different to the one of $Mg^+(3p)$ which is representative for all other Mg levels that are not affected by charge transfer. At the offset we see (fig 3.) a slow increase, a saturation effect during recombination and a small jump upward at the onset.
The absence of a rapid response on cooling indicates that electron induced transitions are less important. The slow increase may be related to the fact that recombination in the MgI system increases the Mg_1 density which pulls the balance 1 to the left. The rapid response to heating may be interpreted as a population of the Mg_r^+ level via the adjacent lower level in the MgII system, $Mg^+(3p)$. This level (cf. fig. 2b) in its turn is ruled by the Boltzmann balance of electron induced excitation from and deexcitation to the ground state of the MgII system.

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[1] J.A.M. van der Mullen, I.J.M.M. Raaijmakers, A.C.A.P. van Lammeren, D.C. Schram, B. van der Sijde, H.W.J. Schenkelaars, Spectrochim. Acta, **42B**, 1039 (1987)