INFLUENCE OF PERTURBATION ON POPULATION PROCESSES OF 4p ARGON LEVELS

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Population of argon 4p levels in a decaying plasma was found to be predominantly due to the dissociative recombination of molecular argon ions[1][2]. This selective process of population was suggested by Lorents[3], although no special difference between the various 4p levels has been pointed out.

An attempt was made in this study to develop the 4p levels population problem further. For this purpose four spectral lines were selected and their intensities were monitored in a DC regime as well as during the decay of a perturbed argon plasma. Rather interesting behaviour of population densities for the various perturbation energy was found, although the linear dependence of population on the gas pressure was recorded. Highest 4p level (upper level of the 7503,37 Å line) was practicaly under all conditions more populated in decaying plasma, what was not the case for the lower lying upper level of 8115,31 Å line.

Experiment. The main discharge was driven between the water cooled electrodes in a special U-shaped tube. Part of the positive column of 4.5 cm length was perturbed by an electric pulse applied to two ring electrodes immersed in the plasma. Short, approximately 3 ns pulses were supplied in a repetitive fashion from the Blumlein line of capacitance 2180 pF. The line was charged to 5, 6 and 8 kV, what gives, supposing about 80% of energy is transfered to plasma, the values of perturbation energies $2.2 \cdot 10^{-2}$, $3.1 \cdot 10^{-2}$ and $5.6 \cdot 10^{-2}$ Joule. Continous flow of the spectroscopicaly pure argon was sustained at 16 liters per minute. Spectral lines were selected by Zeiss SPM 2 monochromator and recorded using EMI 9569B photomultiplier directly coupled to Tektronix 7704 oscilloscope, or for DC regime to galvanometer.

Results. In order to find the more detailed information on population of 4p levels of argon, four spectral lines were selected: two of them originating from transitions between primed levels (7503,87 Å and 7948,18 Å; corresponding transitions in the Pashen notation are $1s_2-2p_1$ and $1s_3-2p_4$) and also two from the other set of levels (7514,65 Å and 8115,31 Å from transitions $1s_4-2p_5$ and $1s_5-2p_9$). Energy difference between highest $2p_1$ and lowest $2p_9$ levels is 3260 cm^{-1} or 0.404 eV.

Short perturbation pulse applied to a plasma will cause initialy a rapid line intensity enhancement. This first peak lasted for some tens of nanoseconds. All the lines from 4p to 4s transitions have a second intensity max-imum, 0.5 to 1 μs later depending on the pressure[4]. Intensity measurements were done at the second maximum. Typical results for population of the four levels in relative units versus pressure with perturbation energy as a parameter are given in figures 1 and 2.

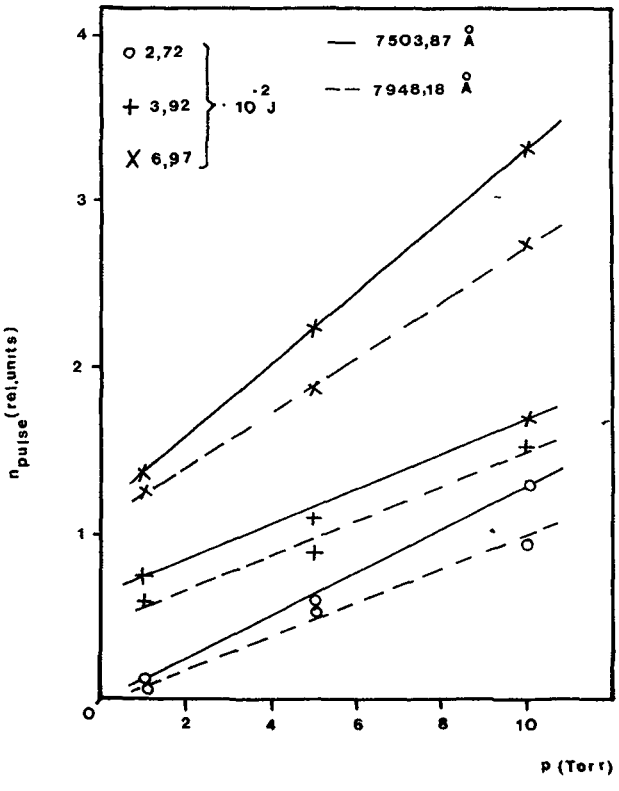

Figure 1

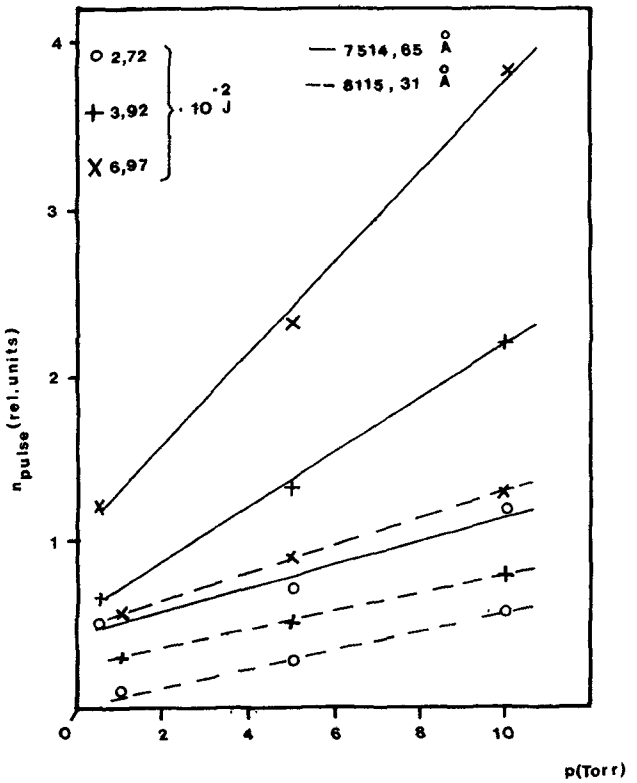

Figure 2.

Rations of populations of highest $2p_1$ and lowest $2p_9$ levels for DC plasma and for the perturbed plasma versus pressure are given in figure 3, perturbation energy being a parameter.

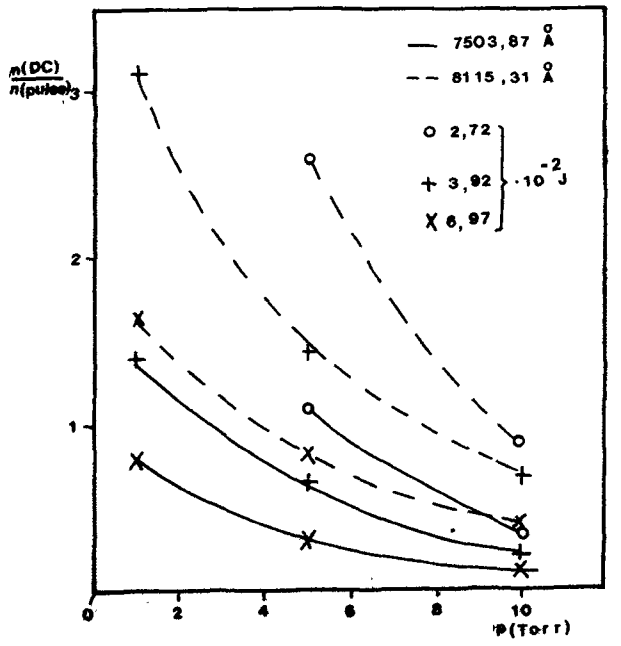

Figure 3.

While the population densities of $2p_1$ level in the whole pressure range are higher than in DC, population of low $2p_9$ level reaches the DC population just at higher pressure and maximum perturbation energy.

Ratios of DC to pulse population presented in figure 3 reveals clearly that the high $2p_1$ level is practicaly always more populated in a decaying plasma. There are probably the favourable conditions for molecular ions formation under these conditions. Comparison of population densities of all the 2p levels observed in a decaying plasma shows that $2p_5$ level becomes the hoghest populated level in the case of 10 Torr pressure and high perturbation energy, although in all the other cases the $2p_1$ level population is predominant.

References

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