RESONANCE CHARGE TRANSFER EFFECTS IN CARBON PLASMAS AND MEASURED POPULATION INVERSION*

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Resonance line CV and CVI plasma spectra in the 40 Å region indicate a reduced (N_n/ω_n) population density inversion of ~4X between n=4 and n=3 excited levels. Inversion between n=5 and n=3 is also observed. The ions are created from a graphite target by a 5 J, 16 ns Nd glass laser pulse focused to a 0.5 mm spot, i.e., 2×10^{11} W/cm^2. These ions expand into a gaseous atmosphere (H, He, Ne, Ar, ...). The greatest degree of inversion is observed at ~15 mm from the target surface at a pressure of 1-2 Torr in helium or hydrogen. At this distance both ions and neutrals are detected by space - and time-resolved spectroscopy, and an electron density of 5×10^{16} cm^{-3} is measured from Stark broadening.

The preferential population of the particular excited states is understood from carbon atom/ion resonance charge transfer reactions. The ion velocity in the vicinity of the observed inversions is measured to be ~5×10^6 cm/sec and is consistent with the requirements of Landau-Zener classical theory for the charge transfer process. The high probability for this process signifies a rapid electron attachment for plasma ions in the vicinity of neutral atoms.

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