Competition of charge exchange and molecular breakup processes for ion beams of few keV/nucleon

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One of the most important steps for starting an AMS program, as we expect to offer in the Laboratório de Implantação Iônica (LIO), is the installation of a gas stripper in one of the beam lines, allowing the breakup of molecular beams that interferes in the identification of the mass of interest, as in the case of the molecular beam of $^{12}CH_2$ for ^{14}C measurements. The design of our gas stripper was idealized for minimizing the variation of pressure inside the beam lines, aiming to preserve the conditions of the plasma in the Penning ion source, keeping as constant as possible the production of the ion beams. The installed experimental setup was tested measuring the cross sections for the charge exchange and molecular breakup processes for different beams extracted from the ion source (Ar^+, Ar^{2+}, CO^+, CO_2^+, O_2^+) using a 30 kV accelerating voltage as a function of the gas pressure injected in the stripper. As expected, results show a clear tendency of neutralization of the incoming atomic beam or the atoms from the breakup of molecular beams, indicating that in this energy region the neutral channel is the most probable. Nevertheless, data also show that the process of breakup of molecular beams occur even for energies as low as a few tenths of keV, suggesting that AMS measurements can be done even in these conditions. It can be seen in the figure below, contributions of C^+, O^+ and CO^+ are identified after the passage of a CO_2^+ beam through the gas stripper even for low pressures. Data also show that CO^+ contribution decreases faster with gas pressure than other two atomic contributions, indicating higher values for the breakup cross section. In order to investigate the influence of different atoms in the competition of the two processes, the same incident beams were tested for three gases: He, Ne and Xe. The comparison pointed out higher cross section values for the exchange and breakup processes when using Xe gas. It was not verified a clear change in the competition of the two processes.

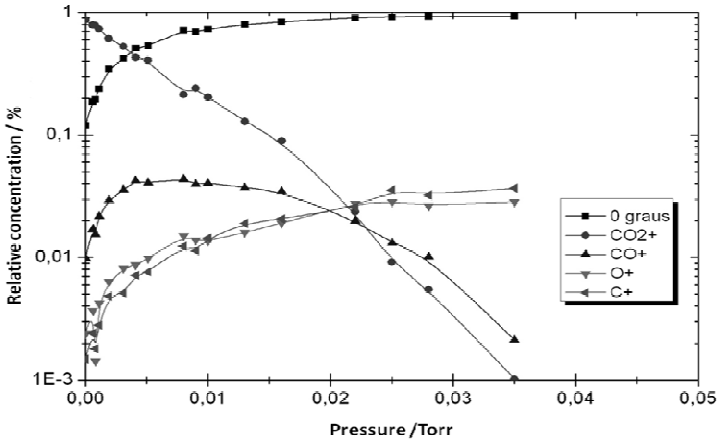

Figure: Relative concentration of ejectiles from a CO_2^+ beam passing through a He gas stripper

[1] M.A.P. Carmignotto – Msc Thesis IFUSP (2009) [in portuguese]