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Positron scattering in gases – first results from the low-energy spectrometer in Trento

Positron interactions in gases constitute important tests for quantum mechanical scattering theories and the molecular structure itself. The positron - target molecule interaction is weaker than for electron scattering, due to a partial compensation between the polarization potential which is attractive and the static potential which is repulsive.

Theoretical attractiveness of positron scattering is contrasted by experimental difficulties – positron have to be created from artificial radio-nuclides or MeV-energy electron bremstrahlung and the brightness of positron beams is 10 orders of magnitude less than that of monochromatic, low-energy electron beams. In Trento a new apparatus for low-energy (<10eV) scattering has been constructed [1]. Here, we present first measurement results.

In benzene (C_6H_6) the total cross section rises in the low energy limit, to unexpectedly high values of about 100 A^2 at 1 eV (30 A^2 is the cross section for electron scattering at the same energy [2]). In order to check if this high cross section is due to trapping of positron inside the benzene ring, the cross sections in aniline ($C_6H_5NH_2$) has been measured. We expected smaller cross sections due to the effect of localization of hybridized sp^2 electrons. Unexpectedly, the aniline cross section is identical to that in benzene, within our experimental error bar (less than 5%) in the entire 1-20 eV energy range.

Both benzene and aniline cross sections show a „bump" slightly above the respective thresholds for positronium formations (which is the ionization energy minus ½ Ry). In order to check if these „bumps" can be attributed to the positronium formation, we subtracted the cross sections for the positronium formation in atomic hydrogen [3] from our total cross sections. The result is negative: the broad shoulder structures in the 10-15 eV range can be ascribed by the positronium formation with hydrogen atoms but not the near-to-threshold „bump". We note, that near-to-threshold resonant maxima have been recently discovered in vibrational excitation of molecules like CO_2 and N_2O [4] by electrons and are know also for numerous other inelastic electron scattering processes.

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