Rydberg Atoms and Electron Transfer to the Continuum Spectra

Recently Vager *et al.*[1] reported that for fast-ion bombardment of foil (or gas) targets, projectile Rydberg atoms and convoy electrons produced by electron transfer to the continuum (ETC) emerge with comparable probabilities; consequently a substantial contribution from field ionization of these Rydberg atoms in the deflector field of the spectrometer used may have to be considered in the discussion of experimental ETC spectra.

In Fig. 1 we exhibit a test for such "Rydberg electrons" which was performed with our double-focusing coaxial cylindrical mirror analyzer,[2] a schematic cross section of which is shown in the inset. Forward-emitted electrons that originate from the beam spot S on a foil target are focused at F where they traverse a 0.5-mm-diam orifice. Under these optimum conditions spectrum 1(a) is obtained as a function of the voltage V applied to the deflector. Spectrum 1(b) results when the said orifice is slightly (0.5 mm) displaced in the direction of the arrow. This allows some electrons from spectrometer-field-ionized Rydberg atoms to be recorded along with the ETC electrons; they appear as a slight hump at the high-energy wing of the cusp. When, as shown in spectra 1(c) and 1(d), a positive bias voltage is applied to the foil target, the main peak is shifted towards correspondingly lower spectrometer voltages. The small peak that corresponds to Rydberg electrons is now clearly discernible; its position is not affected by the applied bias (with increasing bias the displaced ETC peak is progressively deteriorated because the deceleration field distorts the electron trajectories). Finally, in 1(e) the "Rydberg peak" disappears because for a bias of 30 V the highly excited projectiles are already ionized in the proximity of the foil. We remark that when the peak shown in 1(a) was shifted by applying a bias voltage, no undisplaced Rydberg peak was discernible.

The purpose of this Comment was to point out and show that a suitably designed electron spectrometer, such as the one used in this test as well as in previous measurements performed in this laboratory,[2,3] and probably others with well-defined source and image collimation, is able to sort out and even not to transmit electrons that originate from Rydberg atoms ionized in the deflector field.

We also observe that the zero signal seen in the corners of the distribution shown in Fig. 2(b) of Ref. 1 and in Figs. 3(a) and 3(c) down to angles as small as 50 mrad disagrees with known evidence according to which the emitted electrons cover an extensive angle-energy area around the cusp.

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[1]Z. Vager *et al.*, Phys. Rev. Lett. 48, 592 (1982).
[2]W. Meckbach, I. B. Nemirovsky, and C. R. Garibotti, Phys. Rev. A 24, 1793 (1981).
[3]V. H. Ponce, E. Gonzalez Lepera, W. Meckbach, and I. B. Nemirovsky, Phys. Rev. Lett. 47, 572 (1981).

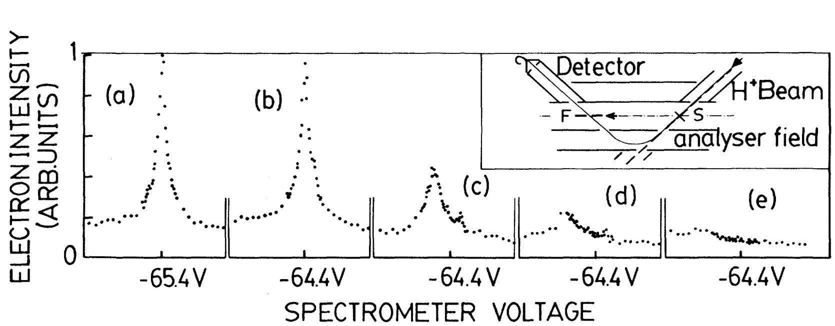

FIG. 1. Electron energy distributions (forward direction) for a 170-keV H^+ beam incident on a 2-$\mu g/cm^2$ carbon foil. Inset: schematic of coaxial mirror spectrometer. (a) Cusplike peak obtained with target grounded and electron exit orifice on spectrometer axis in the focus position F; (b) with orifice displaced by 0.5 mm in the direction of the arrow. Spectra (c), (d), and (e) obtained as in (b), but with 10-, 20-, and 30-V bias, respectively, applied to target S.