Hydrogen Wave Function

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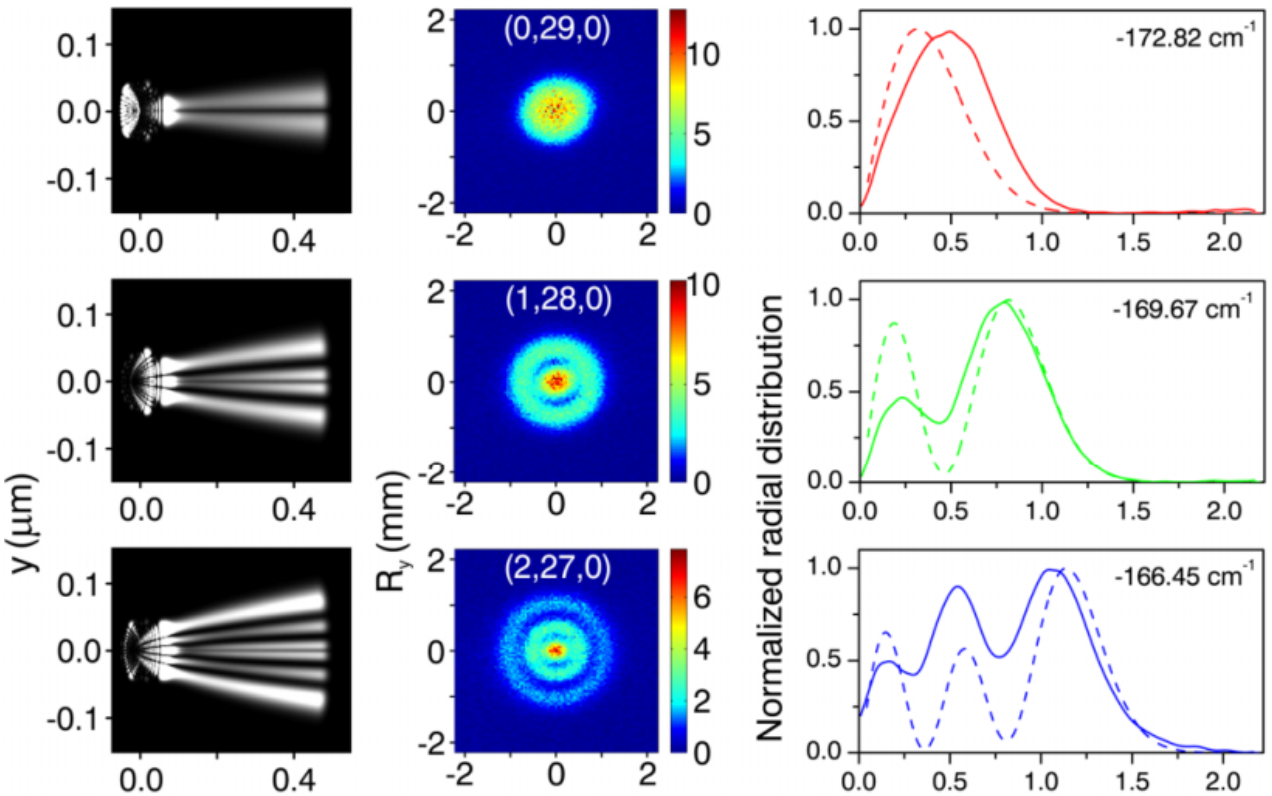
Reviewed article

A. S. Stodolna et al.,

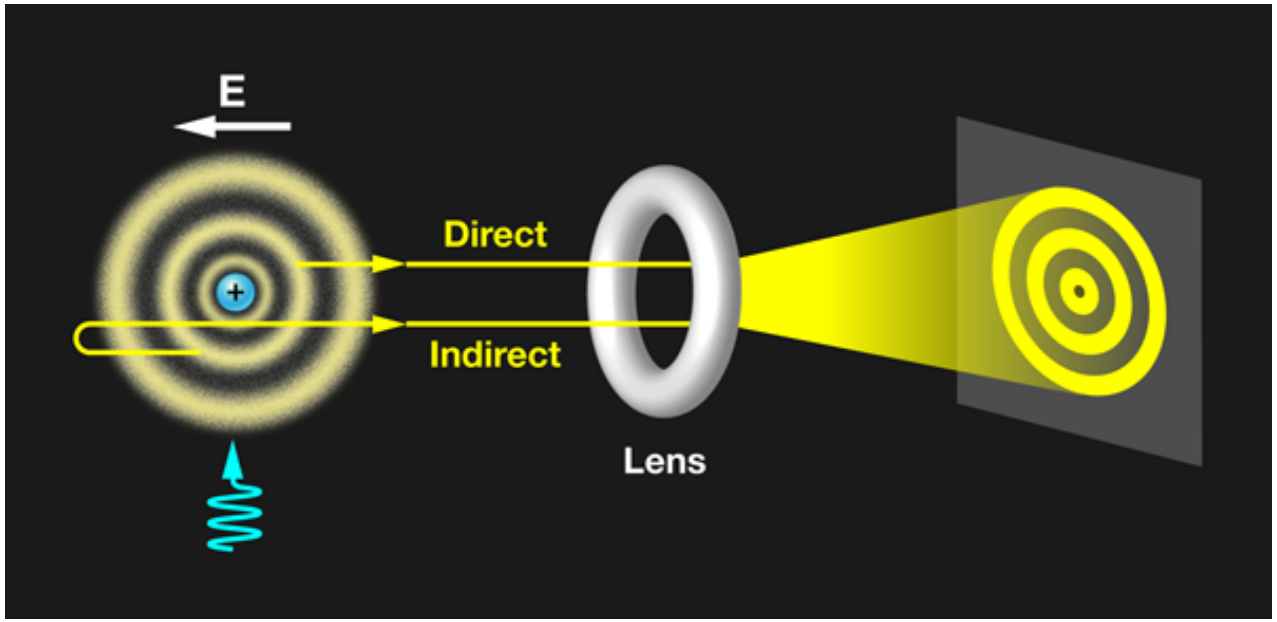
Hydrogen Atoms under Magnification: Direct Observation of the Nodal Structure of Stark States

Phys. Rev. Lett. 110, 213001 (2013).



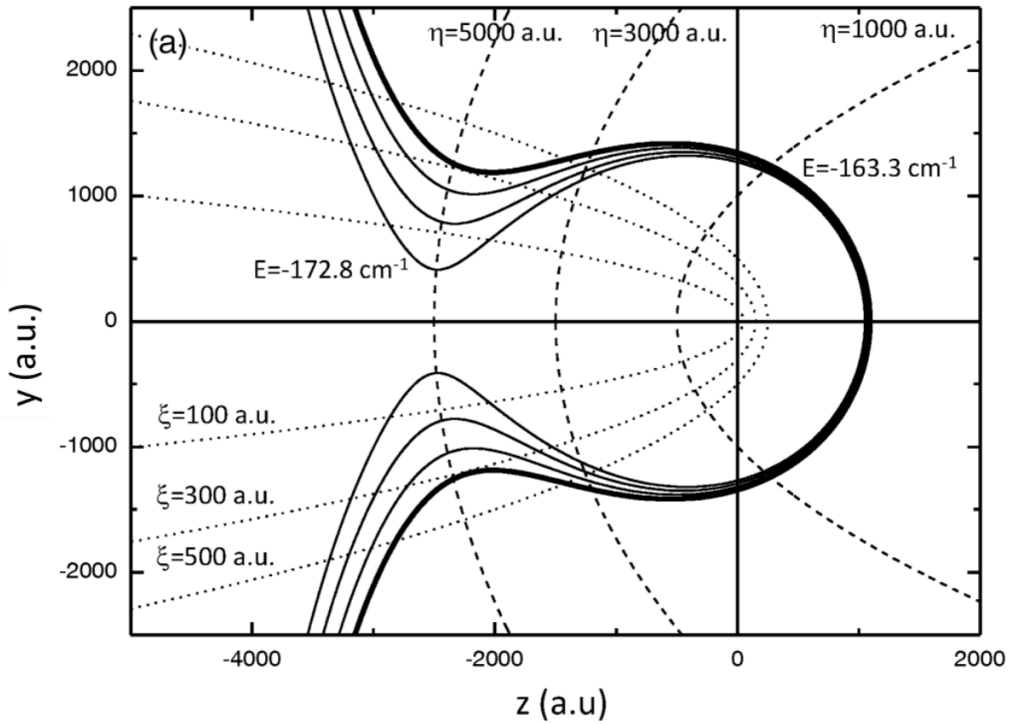
Idea of «quantum microscope»

✗ making many weak measurements of a quantum system
✓ a series of strong measurements on identically prepared systems



✓applying a dc electric field that defines a quantization axis in hydrogen and aligns the orbitals before measuring them

Geometry of the problem



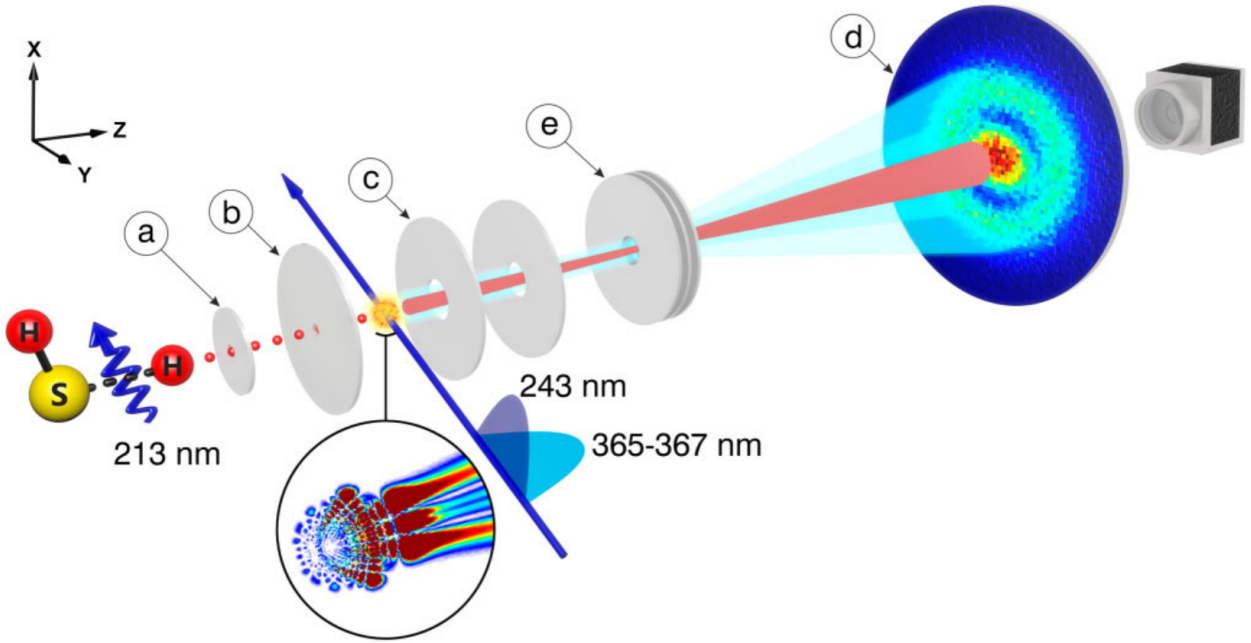
For z — displacement along the electric field. And r — electron-proton distance.

$$\eta = r - z$$
$$\xi = r + z$$

$$\Psi(\xi, \eta, \varphi) = \frac{1}{\sqrt{2\pi\eta\xi}} \chi_1(\xi)\chi_2(\eta)e^{im\varphi}$$

Preparation of state

✓ An atomic hydrogen beam was formed by photodissociating H_2S.

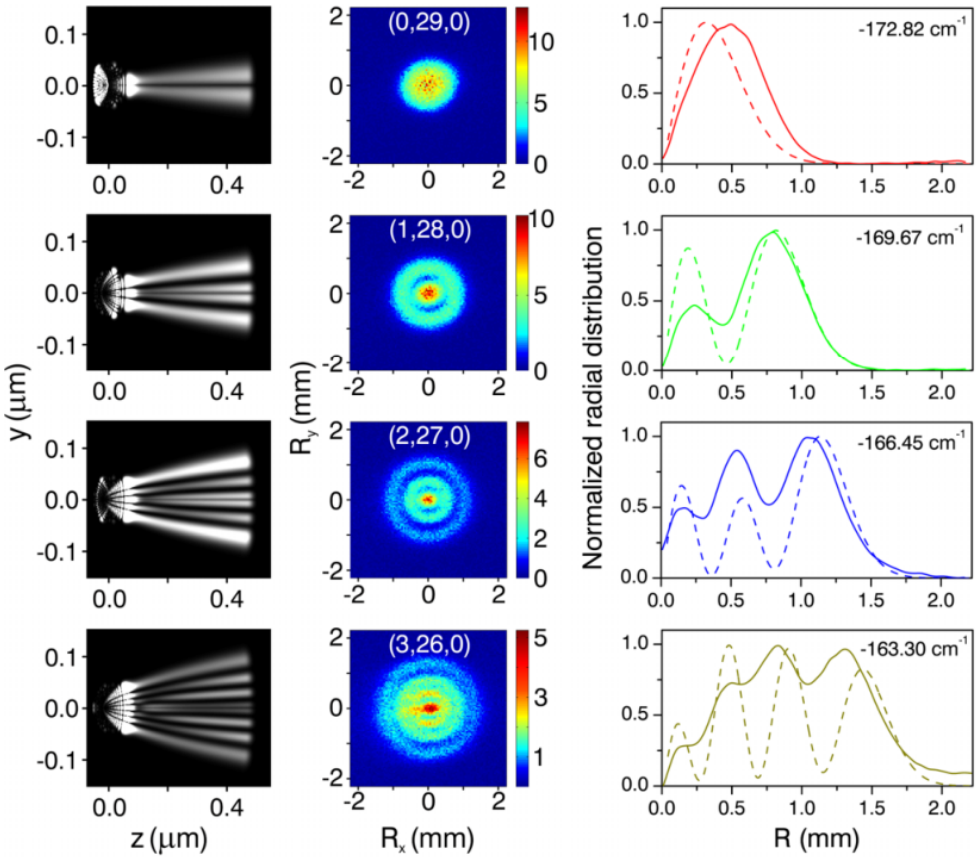


✓ The ground state hydrogen atoms were ionized into a highly excited Rydberg state.

✓ By applying a voltage difference across the repeller (b) and extractor (c) electrodes, the photoelectrons were accelerated towards a two-dimensional detector (d).

Experimental observation

Experimental observation of the transverse nodal structure of four atomic hydrogen Stark states



States (n_1, n_2, m)

✓m — the magnetic quantum number.

✓n_1, n_2 — related to the principal quantum number as

$$n = n_1 + n_2 + |m| + 1$$

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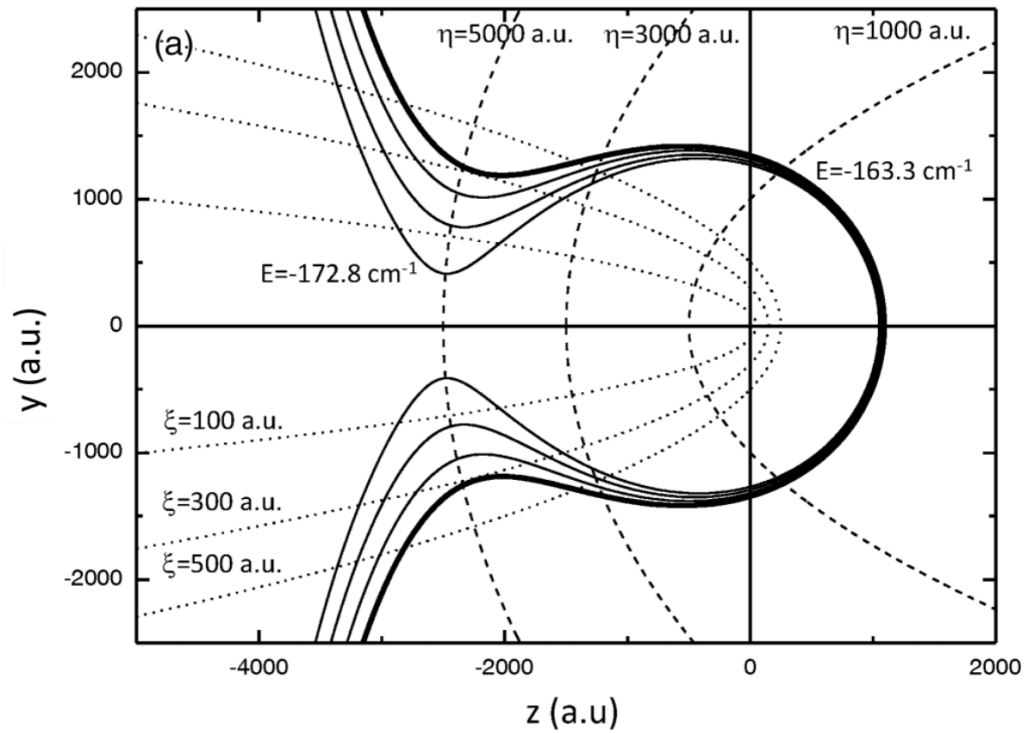

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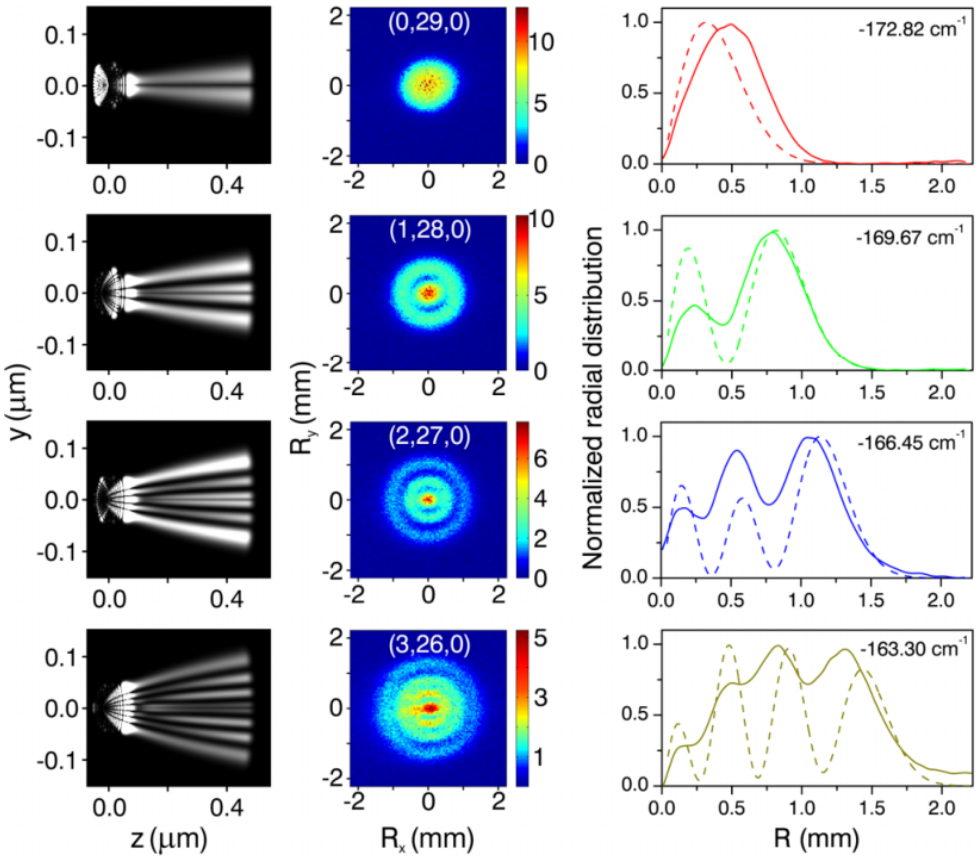

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Thank you for your attention!

Latest works

Photoelectrons are recorded by a velocity map–imaging (VMI) spectrometer, which measures their two-dimensional projection onto a detection plane.

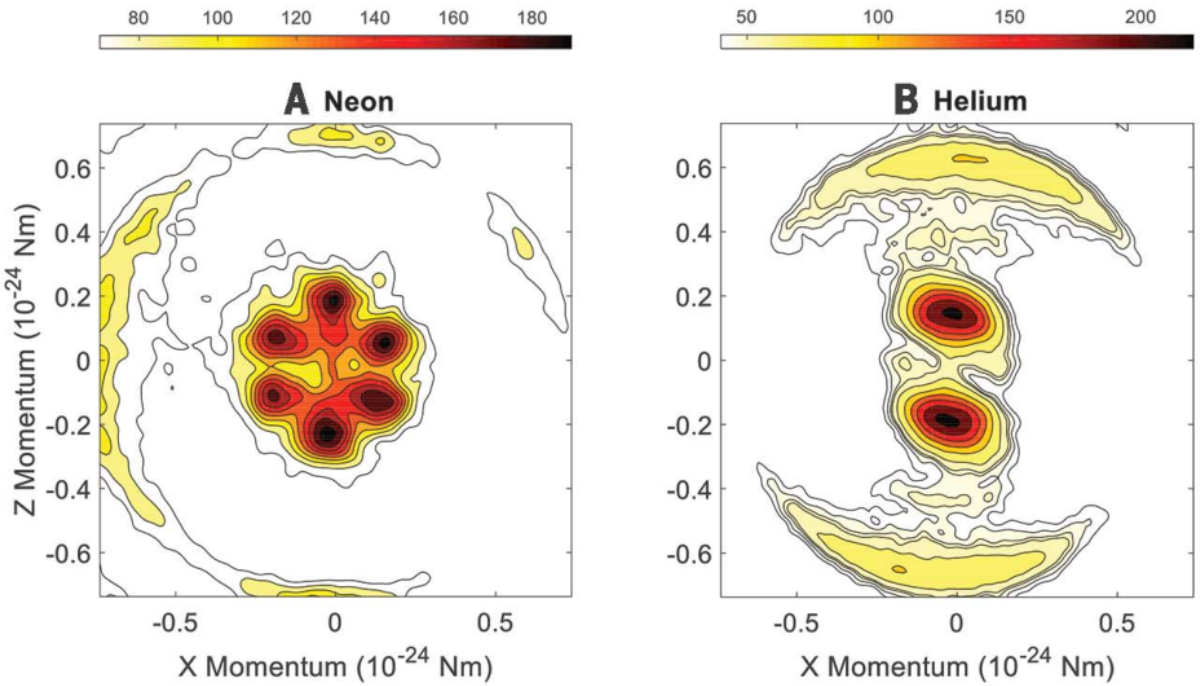

Figure 1: Experimental velocity-map electron images using an attosecond XUV pulse train synchronized

On-resonance ionization