Imaging the correlated two-electron wave function of a hydrogen molecule

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The toolbox for imaging molecules is well-equipped today. Some techniques visualize the geometrical structure, others the electron density or electron orbitals. Molecules are many-body systems for which the correlation between the constituents is decisive and the spatial and the momentum distribution of one electron depends on those of the other electrons and the nuclei. Such correlations have escaped direct observation by imaging techniques so far. We implemented an imaging scheme which visualizes correlations between electrons by coincident detection of the reaction fragments after high energy photofragmentation [1]. With this technique, we examined the H_2 two-electron wave function in which electron–electron correlation beyond the mean-field level is prominent. We visualize the dependence of the wave function on the internuclear distance. High energy photoelectrons are shown to be a powerful tool for molecular imaging. Our study paves the way for future time resolved correlation imaging at FELs and laser based X-ray sources.

[1] M. Waitz et al., 2017, *Nat. Com.* **8**, 2266.