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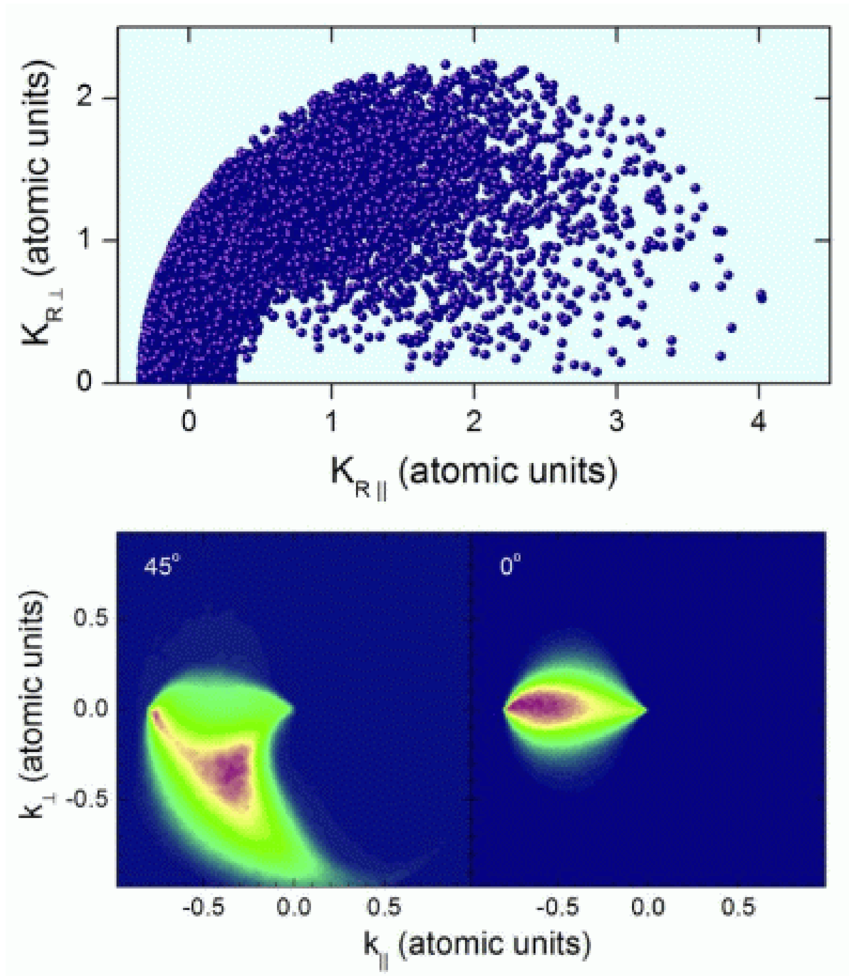
A smoking gun evidence on the dynamics of the continuum electron-positron-proton three-body system

A recoiling ion probes the whereabouts of the emitted electron in positron-atom ionization collisions.



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In the story 'Dead Man's Mirror' by Agatha Christie it is told how, after the bullet failed to appear in the scene of a crime, M Hercule Poirot stopped looking for it and concentrated his attention on the gun. By doing so he found out that, travelling in a straight line, the missing bullet had passed through an open door and ended in the next room, a place where the police had never thought to look for it. Similarly, a recoiling proton can provide evidence on the whereabouts and behaviour of the emitted electron and impinging positron in positron-atom ionisation collisions.

Researchers from the Bariloche Atomic Centre in Argentina have recently proposed to study the ionization of an atom by the impact of a positron, not by the standard approach of analysing the velocity spectra of the emitting electron and/or the scattered projectile, but by looking at the proton left behind (published in 2012 *J. Phys. B: At. Mol. Opt. Phys.* **45** 065202 (http://iopscience.iop.org/0953-4075/45/6/065202/article) , see also 2011 *J. Phys. B:*

At. Mol. Opt. Phys. **44** 075205 (http://iopscience.iop.org/0953-4075/44/7/075205/)). The receding ion, playing the role of a smoking gun, is shown to give detailed information on the electron and the positron after the collision.

The very slowly receding ion carries a great deal of information about the collision process. For instance, it can tell whether the two light particles fly free or if they ended up bound to each other. But much more than that, it also gives valuable and precise information about the spectra of both escaping particles and the nature of their interactions.

This approach was first proposed theoretically by Rodríguez and coworkers several years ago to investigate swift proton-helium collisions. Five years later these predictions were confirmed experimentally using a reaction microscope to obtain the recoil-ion momentum (RIM) distribution for the component parallel to the incident velocity.

In the case of light projectiles, such as positrons, the relatively high probability of projectile deflection complicates both the theoretical analysis and the feasibility of experimental confirmation. However, ongoing experimental progress towards the use of reaction microscopes in conjunction with positron and positronium impact (such as those recently reported in 2010 *J. Phys.: Conf. Ser.* **199** 12025 (http://iopscience.iop.org/1742-6596/199/1/012025)) promises new research possibilities in a field where the extremely valuable study of differential cross sections has been mainly devoted to total and single differential cross sections and over very limited ranges.

As an aid to these novel experiments the authors propose and test theoretically a set of Jacobi coordinates, simply related to the recoil-ion momentum, suitable for analysing the electron-positron system.

More details (http://iopscience.iop.org/0953-4075/45/6/065202/article) of the authors' work are published in *Journal of Physics B: Atomic, Molecular and Optical Physics*.

About the author


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Juan Fiol (http://images.iop.org/objects/jio/labtalk/3/4/8/Fiol.jpg)