Current state of the attoclock and tunnelling time debate

A.W. Bray[1], V. Serov[2], S. Eckart[3], U.S. Sainadh[4], N. Douguet[5], I. Ivanov[6], K. Bartschat[7], I.V. Litvinyuk[8], R.T. Sang[8], and A.S. Kheifets[1]

[1]*Research School of Physical Sciences, The Australian National University, Canberra, ACT 0200, Australia*
[2]*Department of Theoretical Physics, Saratov State University, Saratov 410012, Russia*
[3]*Institut für Kernphysik, Goethe-Universität, Max-von-Laue-Str. 1, 60438 Frankfurt, Germany*
[4]*Solid state institute, Physics department, Technion, Haifa, 32000, Israel*
[5]*Department of Physics, University of Central Florida, Orlando, Florida 32789, USA*
[6]*Centre for Relativistic Laser Science, Institute for Basic Science, 123 Cheomdangwagiro, Buk-gu, Gwangju, 500-712, Korea*
[7]*Department of Physics and Astronomy, Drake University, Des Moines, Iowa, 50311*
[8]*Australian Attosecond Science facility, Centre for Quantum Dynamics, Griffith University, Nathan, QLD 4111, Australia*

The "attoclock" for a given target makes use of the rotating electric field vector of a (near) circularly-polarized strong laser pulse to map temporal aspects of the resulting tunnel ionisation into spatial features of the photoelectron momentum distribution in the polarization plane (Fig. 1). However, despite more than a decade passing since the approach's inception [1], lack of consensus persists over its interpretation [2-4], namely with regards to that of a tunnelling time [5]. This talk will present an overview of the current controversy [6] and potential paths towards its resolution [7].

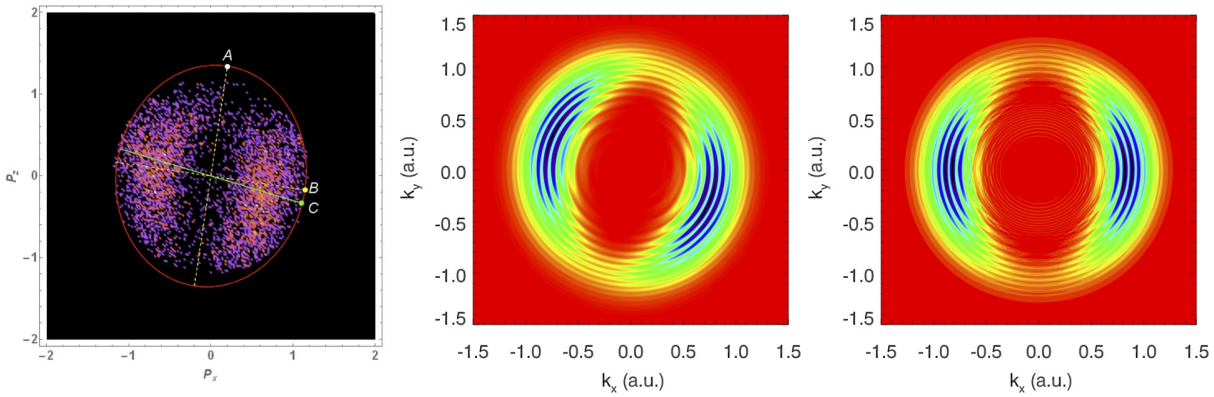

Figure 1: Left: Experimental attoclock signal from atomic hydrogen exposed to 770 nm 6 fs FWHM radiation of peak intensity 1.95×10^{14} W/cm^2 and ellipticity 0.85. Centre: 3D-TDSE calculated photoelectron spectra (CEP averaged) at a peak intensity of 1.5×10^{14} W/cm^2. Right: As for centre but from a Yukawa potential ($a = 1$) of hydrogenic binding energy.

[1] P. Eckle *et al.* 2008 *Nat. Phys.* **4** 565-570
[2] L. Torlina *et al.* 2015 *Nat. Phys.* **11** 503-508
[3] U.S. Sainadh *et al.* 2019 *Nature* in press
[4] A.W. Bray, S. Eckart, and A.S. Kheifets 2018 *Phys. Rev. Lett.* **121** 123201
[5] A.S. Landsman and U. Keller 2015 *Phys. Rep.* **547** 1-24
[6] C. Hofmann, A.S. Landsman, and U. Keller 2019 *arXiv* 1901.07015
[7] N. Douguet and K. Bartschat 2019 *Phys. Rev. A* **99** 023417