Near-threshold photoelectron holography beyond the strong-field approximation

XuanYang Lai* [1], ShaoGang Yu*, Carla Figueira de Morisson Faria†, and XiaoJun Liu*

* State Key Laboratory of Magnetic Resonance and Atomic and Molecular Physics and Center for Cold Atom Physics, Wuhan Institute of Physics and Mathematics, Chinese Academy of Sciences, Wuhan 430071, China
† Department of Physics and Astronomy, University College London, Gower Street, London WC1E 6BT, United Kingdom

Synopsis By using a newly developed approach, we provide a novel and unique intake on a near-threshold fan-shaped structure in the photoelectron spectra, and more importantly, we associate the structure to a photoelectron holography (PH), showing a direct physical insight on how the PH forms in the presence of the Coulomb potential.

By analogy with optical holography, strong-field photoelectron holography (PH) [1] has been viewed as an important tool for dynamic imaging of matter at the sub-femtosecond scale, which can be applied to a myriad of systems, from atoms to complex molecules. Recently, accumulating evidence has shown that the ionic Coulomb potential may modify the holographic patterns, resulting in, e.g., the reduced fringe spacing in the "fork"-like holographic structure [1]. However, how the Coulomb potential affects the PH, and, more importantly, how a specific PH pattern forms under the influence of Coulomb potential, is still far from being understood. This greatly hinders a comprehensive understanding of PH and its potential applications in strong field and attosecond physics.

In our work, we study a near-threshold fan-shaped structure in the photoelectron spectra, for which the influence of the Coulomb potential is significant. With the help of a newly developed Coulomb quantum-orbit strong-field approximation (CQSFA) theory [2], we provide a novel and unique intake on the structure, and more importantly, we associate the structure to a near-threshold PH from quantum interference of direct and forward-scattered orbits. For the first time, our work provides a direct explanation of how the fan-shaped structure is formed. Furthermore, by analyzing the change of the phase of electron trajectory with/without the Coulomb potential, we provide direct physical insight on how the PH forms in the presence of the Coulomb potential. The present work paves the way for understanding the influence of the binding potential in time-resolved holographic structures and is expected to be used in more complex PH.

References

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[1] E-mail: xylai@wipm.ac.cn