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Cold Collisions of Ultracold Atoms in a Miniature Laser-based Accelerator

Monday, 31 July 2023 10:10 (35 minutes)

I present results from experiments exploring two types of scattering resonances in the collision of ultracold clouds of atoms —shape resonances[1] and Feshbach resonances[2,3]. Using a laser-based accelerator that capitalizes on the energy resolution provided by the ultracold atomic setting, we unveil these resonance phenomena in their quintessential form by literarily photographing the halo of outgoing scattered atoms. Such images for example capture the quantum mechanical interference between partial waves and the interplay between S-matrix poles. In particular, the tunability of magnetic Feshbach resonances opens up a unique possibility to experimentally[4] record the imprint from a flow of S-matrix poles in the complex energy plane[5].

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2 M. S. J. Horvath, R. Thomas, E. Tiesinga, A. B. Deb, and N. Kjærgaard, Above-threshold scattering about a Feshbach resonance for ultracold atoms in an optical collider, Nature Communications 8, 452 (2017).
3 R. Thomas, M. Chilcott, E. Tiesinga, A. B. Deb, and N. Kjærgaard, Observation of bound state self-interaction in a nano-eV atom collider, Nature Communications 9, 4895 (2018).
4 Matthew Chilcott, Ryan Thomas & Niels Kjærgaard,
Experimental observation of the avoided crossing of two S-matrix resonance poles in an ultracold atom collider, Physical Review Research **3**, 033209 (2021)
[5] H.M. Nussenzveig, The poles of the S-matrix of a rectangular potential well of barrier, Nuclear Physics **11**, 499 (1959)

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