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Feshbach resonances in a hybrid atom-ion system

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We present the first observation of Feshbach resonances between neutral atoms and ions. [1,2] While Feshbach resonances are commonly utilized in neutral atom experiments, however, reaching the ultracold regime in hybrid traps is challenging, as the driven motion of the ion by the rf trap limits the achievable collision energy. [3] We report three-body collisions between neutral 6Li and 138Ba+, where we are able to resolve individual resonances. We demonstrate the enhancement of two-body interactions through an increase in the sympathetic cooling rate of the ion by the atomic cloud measured by spatial thermometry of Ba in the ODT; and molecule formation evidenced by subsequent three-body losses. This paves the way to new applications such as the coherent formation of molecular ions and simulations of quantum chemistry. [4]

[1] WECKESSER, Pascal, et al. Observation of Feshbach resonances between a single ion and ultracold atoms. *arXiv preprint arXiv:2105.09382*, 2021.
[2] SCHMIDT, J., et al. Optical traps for sympathetic cooling of ions with ultracold neutral atoms. *Physical review letters*, 2020, 124. Jg., Nr. 5, S. 053402.
[3] CETINA, Marko; GRIER, Andrew T.; VULETIĆ, Vladan. Micromotion-induced limit to atom-ion sympathetic cooling in Paul traps. *Physical review letters*, 2012, 109. Jg., Nr. 25, S. 253201.
[4] BISSBORT, Ulf, et al. Emulating solid-state physics with a hybrid system of ultracold ions and atoms. *Physical review letters*, 2013, 111. Jg., Nr. 8, S. 080501.

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