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Observation of a smooth polaron-molecule transition in a degenerate Fermi gas YOAV SAGI, GAL NESS, CONSTANTINE SHKEDROV, YANAY FLORSHAIM, Technion - Israel Institute of Technology — Understanding the behavior of a spin impurity strongly-interacting with a Fermi sea is a long-standing challenge in many-body physics. For short-range interactions and zero temperature, most theories predict a first-order phase transition between a polaronic ground state and a molecular one. We study this question with an ultracold Fermi gas, utilizing a novel high-sensitivity Raman spectroscopy probing technique that allows us to isolate the quasiparticle contribution [1-3]. We find that for increasing interactions, there is a smooth transition from a polaronic to a molecular response, with no evidence of a first-order phase transition. We determine the polaron energy, molecule binding energy, and the contact parameter. The later follows the molecular branch, in contrast to the prediction that it will have a clear change of behavior as the ground state changes its nature. The emerging physical picture is of a smooth transition between polarons and molecules and coexistence of both in the region around the expected phase-transition. [1] C. Shkedrov, Y. Florshaim, G. Ness, A. Gandman, and Y. Sagi, PRL 121, 093402 (2018). [2] C. Shkedrov, G. Ness, Y. Florshaim, and Y. Sagi, PRA 101, 013609 (2020). [3] G. Ness, C. Shkedrov, Y. Florshaim, and Yoav Sagi, arXiv:2001.10450 (2020).

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