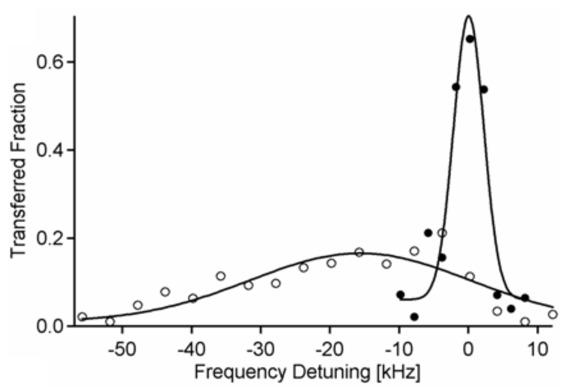
Radio-Frequency Spectroscopy of Ultracold Fermions

Radio-frequency techniques were used to study ultracold fermions [1]. By starting with a sample in one quantum state (state 2) and driving it to another state (state 3) we verified the prediction of the absence of mean-field “clock ”shifts, the dominant source of systematic error in current atomic clocks based on bosonic atoms. This absence is a direct consequence of fermionic antisymmetry which prevents two atoms in the same state to interact with contact interactions.

Resonance shifts proportional to interaction strengths were observed in a three-level system when the transition between states 2 and 3 was driven in the presence of atoms in a third state (state 1). When the interactions were weak, the observed shifts agreed with theoretical calculations. However, in the strongly interacting regime, these shifts became very small, reflecting the quantum unitarity limit and many-body effects. This insight into an interacting Fermi gas is relevant for the quest to observe superfluidity in this system.



Measurement of the mean-field energy in an interacting Fermi gas. The fraction of atoms transferred by the radio-frequency pulse from state 2 to state 3.with atoms in state 1absent (solid circles)and present (open circles). The mean-field shift due to the presence of atoms in state 1 is computed from Gaussian fits to the data (solid lines).

1. S. Gupta, Z. Hadzibabic, M.W. Zwierlein, C.A. Stan, K. Dieckmann, C.H. Schunck, E.G.M.v. Kempen, B.J. Verhaar, and W. Ketterle, *RF Spectroscopy of Ultracold Fermions*, Science **300**, 1723 (2003).