Title:

Emergence of a micro-scale quantum emulsion from a strongly repulsive Fermi gas

Authors:

A. Amico[1,2], G. Del Pace[1,2], W. Kwon[1,2], F. Scazza[1,2], P. Tavares[1], M. Inguscio[1,2], M. Zaccanti[1,2], and G. Roati[1,2]

1) Istituto Nazionale di Ottica del Consiglio Nazionale delle Ricerche (INO-CNR), 50019 Sesto Fiorentino, Italy

2) LENS and Dipartimento di Fisica e Astronomia, Università di Firenze, 50019 Sesto Fiorentino, Italy

Abstract:

Cooper pairing and magnetic ordering represent two paradigmatic though antithetical manifestation of interactions between fermionic particles. While arbitrary weak attraction suffices for binding fermions into bosonic pairs, magnetism can only develop under strong inter-particle repulsion. In our experiment we show how the competition between pairing and ferromagnetic instability promotes the emergence of an emulsion phase, in which spin polarized atomic domains and molecules coexist in semi-stationary inhomogeneous configurations.

We employ radio-frequency pulses both to quench the interaction in a balanced spin mixture and to spectroscopically probe the many body system following the quench. For sufficiently strong repulsion, we observe that the interaction energy rapidly decreases after some transient time, signalling the emergence of a strongly correlated phase comprising phase separated atomic and molecular micro-domains. We directly probe the presence the system inhomogeneity by studying the density fluctuations employing standard absorption imaging. In close correspondence with the drop of interaction energy we observe a substantialy increase of density fluctuations. Moreover, the trend of the density-density correlation function suggests the presence of atomic clusters of few micrometers size.