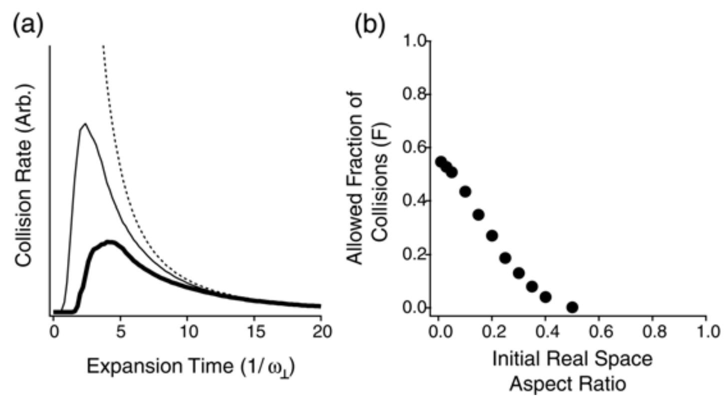
Collisions in zero temperature Fermi gases

The smoking gun of Bose-Einstein condensation has been the anisotropic "superfluid" expansion of elongated condensates released from the trap. Similarly, superfluid Fermi gas would show anisotropic expansion due to superfluid hydrodynamics [1]. A recent observation of anisotropic expansion of an ultracold, interacting, two-spin fermionic mixture [2] has created considerable excitement and raised the question under what conditions is this expansion a signature of fermionic superfluidity and not of collisional hydrodynamics.

We examined the collisional behavior of two-component Fermi gases released at zero temperature from a harmonic trap [3]. Using a phase-space formalism to calculate the collision rate during expansion, we find that Pauli blocking plays only a minor role for momentum changing collisions. As a result, for a large scattering cross-section, Pauli blocking will not prevent the gas from entering the collisionally hydrodynamic regime. In contrast to the bosonic case, hydrodynamic expansion at very low temperatures is therefore not evidence for fermionic superfluidity.



(a) Collision rate as a function of expansion time in the perturbative approximation for an initial aspect ratio of 0.03. Dashed line: total classical collision rate, thin line: classical rate for momentum changing collisions, thick line: collision rate for fermions. (b) Allowed fraction of collisions for a zero-temperature two-spin Fermi gas. For an initial aspect ratio of 0.05, the fraction is 0.5, and approaches 0.55 for large anisotropy.

1. C. Menotti, P. Pedri, and S. Stringari, *Expansion of an interacting Fermi gas*, Phys. Rev. Lett. **89**, 250402 (2002).
2. K.M. O'Hara, S.L. Hemmer, M.E. Gehm, S.R. Granade, and J.E. Thomas, *Observation of a Strongly Interacting Degenerate Fermi Gas of Atoms*, Science **298**, 2179 (2002).
3. S. Gupta, Z. Hadzibabic, J.R. Anglin, and W. Ketterle, *Collisions in zero temperature Fermi gases*, preprint, cond-mat/0307088.