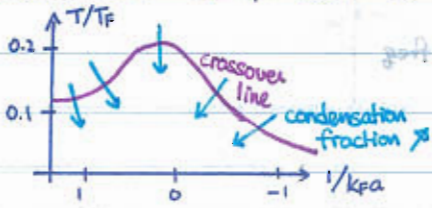
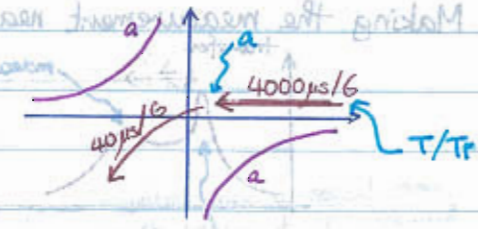
Cold Atom Experiment (II) [Jin]

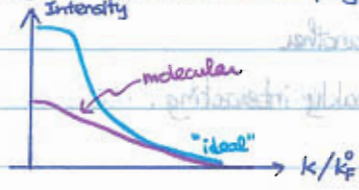
- Map out phase diagram:

  Parameters: T/T_F and a



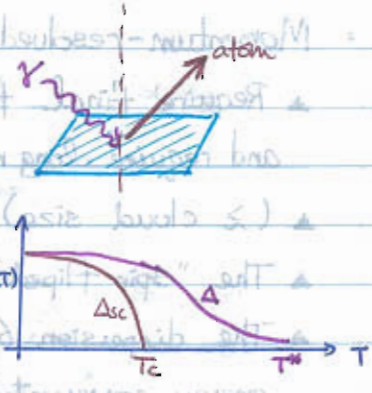


- Alternative measurements
  - ▲ Vortices
  - ▲ Thermodynamics (circumvent "projection onto molecular state" trick)

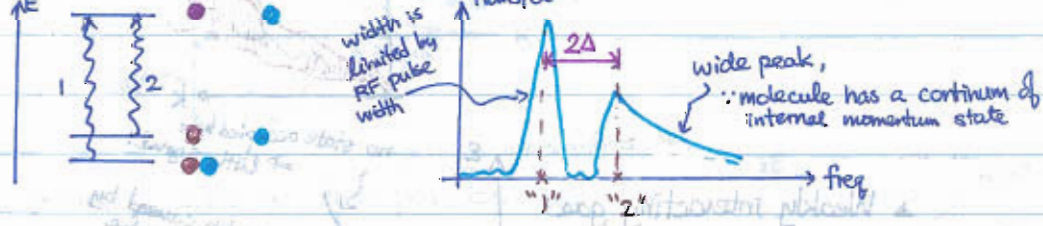


For molecular, k smear out as tightly-binded molecule
$\Longrightarrow$ high momentum in constituents

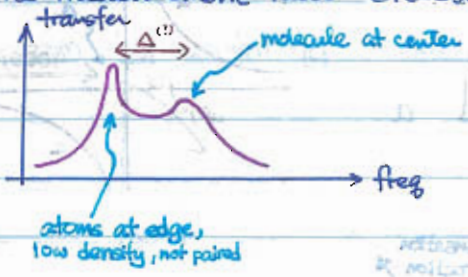
- Photoemission Spectroscopy:
  - ▲ Used to measure Δ, where it is defined so that $2\Delta \equiv$ energy needed to break a pair.



- RF Spectroscopy: History (measuring binding energy)
  - ▲ Use a third state & measure difference is peak transfer



- Making the measurement near crossover

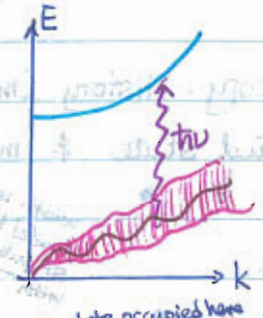


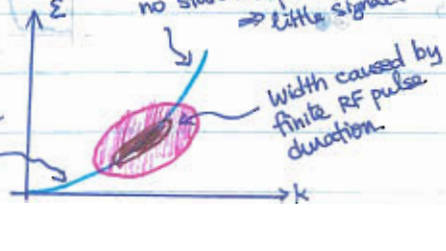
- Issues with measurement
  - ▲ Non-homogenous trap depth ⟶ non-homogenous gas density
  - ▲ Final state effect

  - ▶ Can be circumvent by taking transition to another spin state that is weakly interacting.

- Momentum-resolved RF Spectroscopy (~ARPES)
  - ▲ Require weak final-state effect and require long mean-free path. ($\gtrsim$ cloud size)

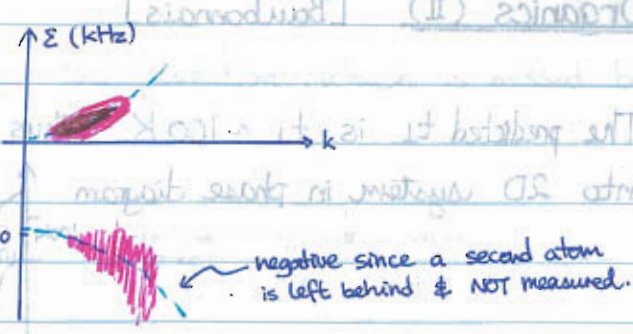
  - ▲ The "spin fliped" particle is distinguished by its spin state.
  - ▲ The dispersion of the single particle state obtained by energy conservation



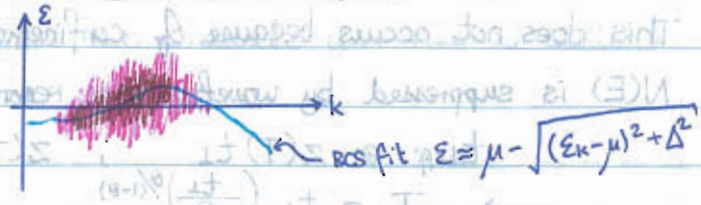


  - ▲ Weakly interacting gas:

▲ On BEC side,
(near T_c, small condensate fraction)



▲ Strongly interacting Fermi gas (essentially at $a \sim \infty$)
$T/T_c \approx 0.9$



▲ Issue: As interaction is tuned up, the gas in known to contract. Thus $\varepsilon_f \neq \varepsilon_f^0$.

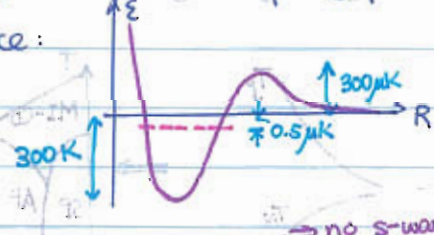
◦ Additional use of momentum-resolved RF spectroscopy, e.g. p-wave pairing.

◦ P-wave pairing

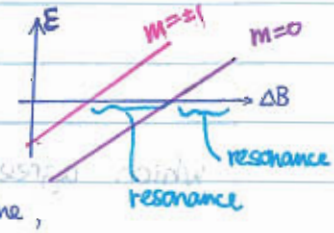
▲ Examples: ^3He

▲ New features: anisotropic gap, multiple superfluid phases, narrow reso

▲ Resonance:



▲ Experiment done on spin-polarized gas. ⇒ no s-wave interaction



▲ New resonance (quasi-bound) state can be seen:

▲ Molecule lifetime ~1.2s (~1 collision)

▲ Quasi-bound state shows $\sim \varepsilon^{-3/2}$ dependence in lifetime, as expected.