

Density Profiles of Trapped Polarized Fermi Gases

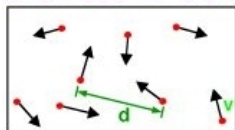
Gianluca Bertaina

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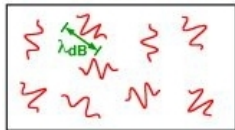
Physics PhD Workshop 2008, Trento, December 5th



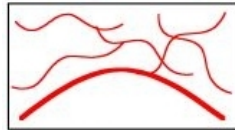
What is Bose Einstein Condensation?



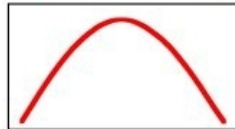
High Temperature T:
thermal velocity v
density d^{-3}
"Billiard balls"



Low Temperature T:
De Broglie wavelength
 $\lambda_{dB} = h/mv \propto T^{-1/2}$
"Wave packets"

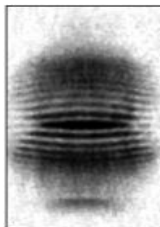


T=T_{crit}:
Bose-Einstein Condensation
 $\lambda_{dB} = d$
"Matter wave overlap"

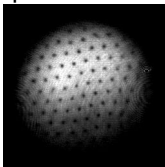


T=0:
Pure Bose condensate
"Giant matter wave"

Coherence:
interference fringes...

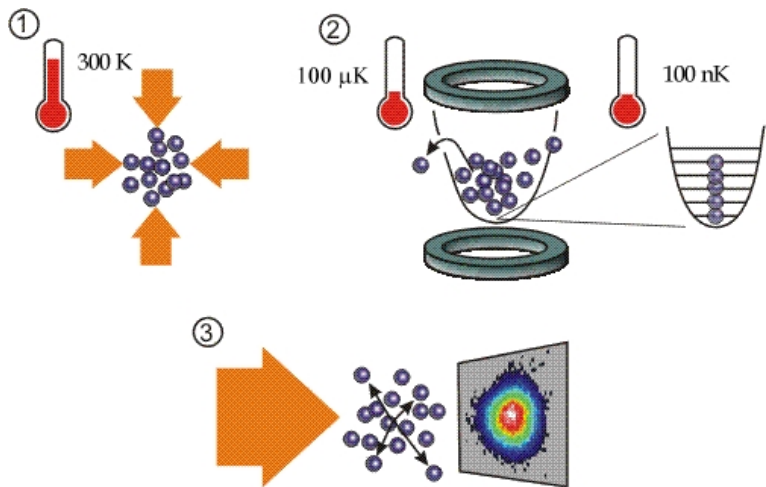


Superfluidity:
no viscosity,
quantized vortices...



Images from MIT webpage

What is done in experiments?



Images from Jila webpage

Quantum Monte Carlo for Ultracold Gases in Trento



Head

Stefano Giorgini



Post-Doc

Sebastiano Pilati



PhD student

Gianluca Bertaina

Current research:

Bosons at $T > 0$, with disorder (Path Integral Monte Carlo)

Fermions at $T = 0$, in 3D and 2D (Diffusion Monte Carlo)

Collaborations:

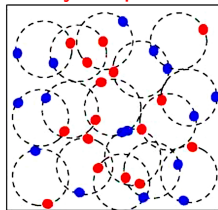
Theory: UPC (Barcelona), [Astrakharchik](#), Boronat, Casulleras
UMass (Amherst), Prokof'ev

Exp: Ecole Normale (Paris), Dalibard
IQOQI (Innsbruck), Grimm
MIT (Boston), Ketterle

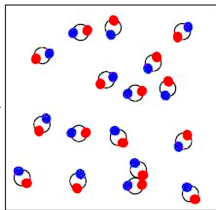
Two species of fermions (spin \uparrow spin \downarrow) with attractive interaction

Change interaction at $P = 0$:

Always superfluid



Fermionic superfluid (BCS)



Bosonic superfluid (BEC)

BCS-BEC crossover

Change spin polarization $P > 0$

From normal gas to superfluid

Quantum phase transition
Chandrasekhar-Clogston
limit

Homogeneous system: DMC calculations (*Pilati, Giorgini*)

Density Profiles of the (3D) Trapped Gas

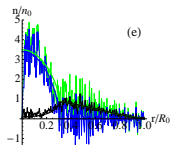
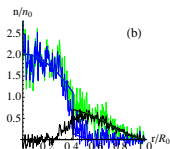
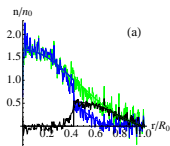
Interaction
Polarization

$$\frac{1}{k_F^0 a} = 0$$
$$P = 0.43$$

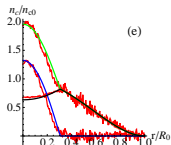
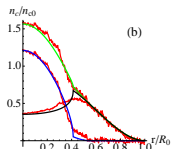
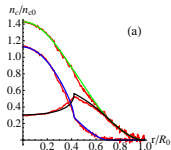
$$\frac{1}{k_F^0 a} = 0.35$$
$$P = 0.52$$

$$\frac{1}{k_F^0 a} = 1.59$$
$$P = 0.73$$

Radial Density



Column Density



Local Density
Approximation

Minimize
Grandcanonical
potential

Spin up
Spin down
Difference