Bose Einstein Condensation of He$^*$

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Outline

- Helium beam
- Magnetic trap loading scheme
- Results
- BEC
- Conclusion
Source TOF Distributions
Second He* Beamline

1.5 mm Hole
First Magneto-optic Trap
Second Beamline Schematic

- Trapped Atoms
- Mot Beam
- 2-D Collimation
  - $1 \times 10^{10}$ a/s
  - $V_{mp} \sim 40$ m/s
  - $V_{trans} \sim 1$ m/s
  - $D \sim 1$ cm

Push Laser Beam

Shadow
Magnetic Trap Setup

- Trapped Atoms
- Mot Beam
- Shadow
- Push Laser Beam
- 2-D Collimation
- Mag. Trap Coils
- 1 cm
Magnetic Trap
Magnetic Trap

- $f_r \sim 93$ Hz
- $f_a \sim 1.1$ KHz (@ 1 G)
Magnetic Trap
Magnetic Trap

10 Turns  18 Turns
Magnetic Trap
Magnetic Trap
Magnetic Trapping Setup

Atoms
Starting Conditions

- $5 \times 10^8$ Atoms
- $T = 1 \text{ mK}$
- $R_l \sim 3.5 \text{ mm} \quad R_s \sim 2 \text{ mm}$

![Graph showing $T = 1 \text{ mK}$]
Transfer: Compression

\[ \delta = -20\Gamma \]

\[ \delta = -10\Gamma \]

5 Fold Density Increase
Transfer: Molasses

\[ \delta = -10\Gamma, \quad I \sim 50I_{\text{sat}} \quad \rightarrow \quad \delta \sim -3\Gamma, \quad I \sim I_{\text{sat}} \]

\[ T = 1 \text{ mK} \]

\[ T = 200 \text{ } \mu\text{K} \]
Transfer: Bring up Magnetic Trap

- $N \sim 3 \times 10^8$
- $T \sim 600 \, \mu k$
Cooling

- After Transfer, apply 1-D Doppler Cooling $\sim 200 \, \mu K$
- Lower bias, achieving tighter trap frequencies
- And apply Doppler cooling again, once again $\sim 200 \, \mu K$
Evaporation

Atom Number vs Evaporation Time

Atom Number

Time (sec)
Phase Space Density

Phase Space Density During RF Evaporation

![Graph showing phase space density over time](image-url)
He* BEC

![Graph showing the behavior of He* BEC with different frequencies and parameters.](image)
Output coupling “Atom Laser”
Output coupling “Atom Laser”
Where We’re Heading

• Look at $g^{(2)}$ during onset of condensation (HBT) type experiments.
• Observe Macroscopic fringes $\sim 1$ mm period.
• How phase develops as a function of detected atoms
• Visibility vs elastic collision rate (Walls et. al.)
Implosion