

スピン自由度を持つフェルミ縮退混合気体を用いたクロスオーバー領域の研究

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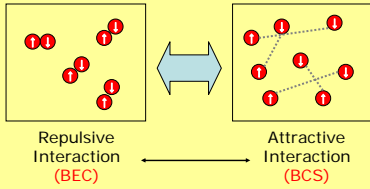


Motivation

2-component Fermion

BEC-BCS crossover

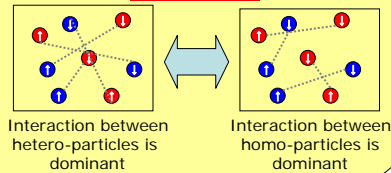
e.g. [C. A. Regal *et al.*, PRL **92**, 040403 (2004)]



Mixture of 2-component Fermions

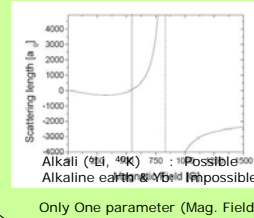
Attractive case

Possibility of New type of crossover (change of pair partner)

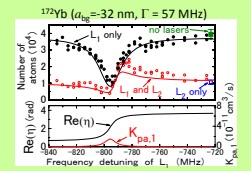


How to change interaction

Magnetic Feshbach resonance



Optical Feshbach resonance



($K_{pa} < 10^{-11} \text{ cm}^2/\text{s} @ -\Delta\eta/k \sim \Delta\alpha \sim 30 \text{ nm}$)

[K. Enomoto *et al.*, PRL **101**, 203201 (2008)]

Alkali (^6Li , ^{40}K): Large atom loss
Alkaline earth & Yb: Small atom loss

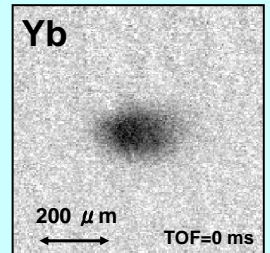
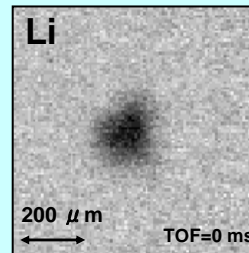
Many parameters (multi-color is possible!)

Good Candidates : $^6\text{Li} + ^{171}\text{Yb}$, $^6\text{Li} + ^{173}\text{Yb}$

Simultaneous Magneto-Optical Trap

Magneto-Optical Trapping (MOT) of ^6Li and ^{174}Yb atoms

Absorption Images (atom density profiles) of the Li and Yb MOT



The atom number and the temperature of ^6Li MOT are
 $N = 7 \times 10^3$ and $T = 640 \mu\text{K}$

The atom number and the temperature of ^{174}Yb MOT are
 $N = 7 \times 10^4$ and $T = 60 \mu\text{K}$

[M. Okano *et al.*, Appl. Phys. B]

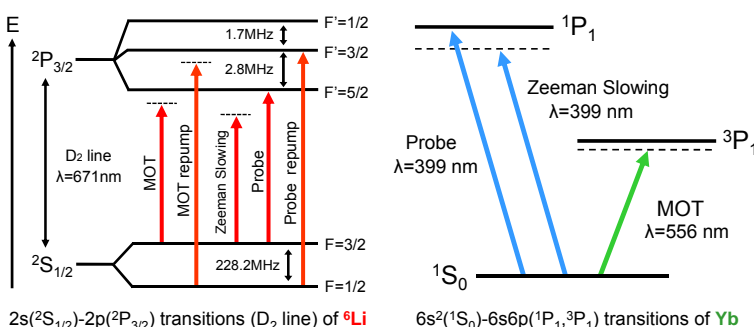
Too short lifetime in MOT (<500ms) due to bad vacuum pressure ($\sim 10^{-9}$ Torr)

Current work:

Replace of vacuum chamber, and successfully obtained good vacuum ($\sim 10^{-11}$ Torr)



Energy Levels and Transitions of ^6Li and Yb



Future prospects

- Optimization of simultaneous MOT
- Optical Trap (FORT) CO_2 laser ($\lambda = 10.6 \mu\text{m}$) or a high-power fiber laser
- Evaporative cooling to Fermi degeneracy
- Estimation of scattering length

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