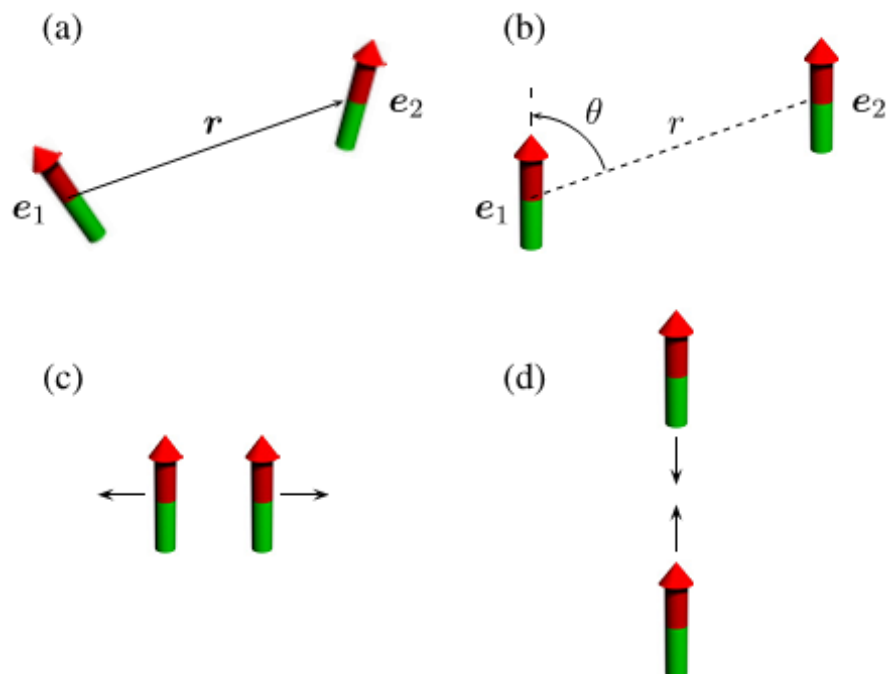


# Dipolar gases

Izabella Lovas

Group seminar  
2016.07.19.

- Long range
- Anisotropy

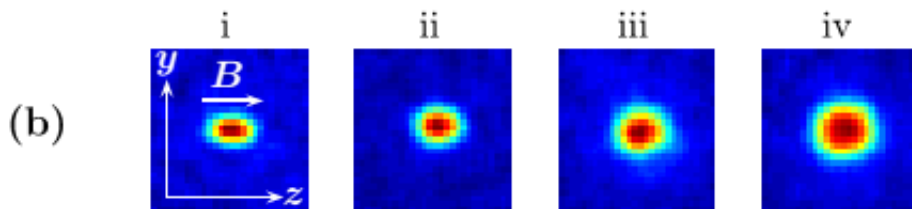
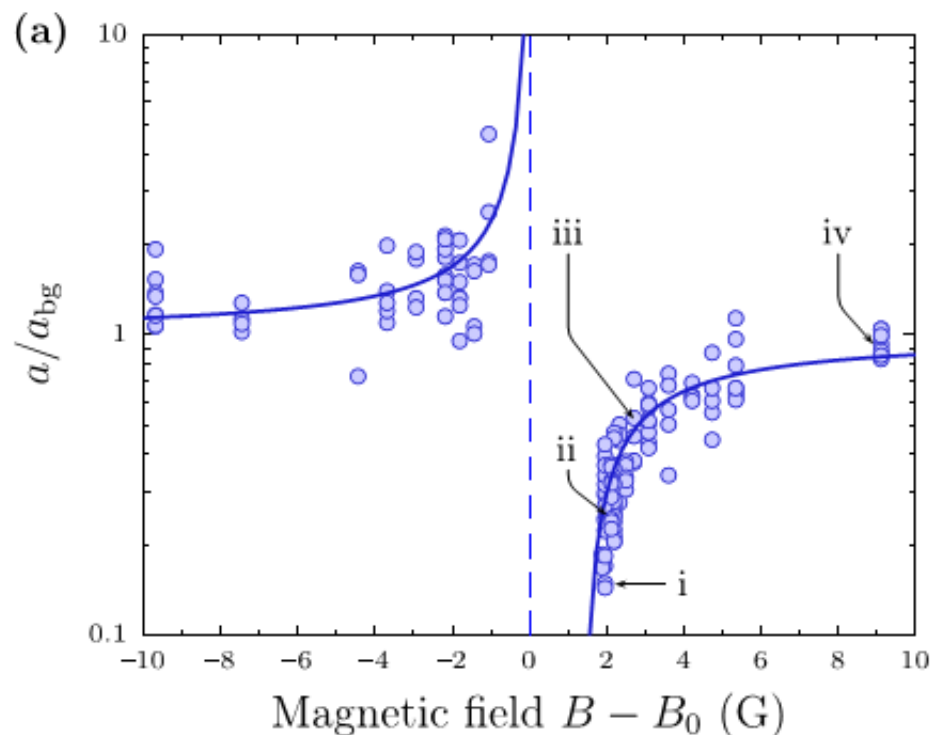


$$U_{dd}(r) = \frac{C_{dd}}{4\pi} \frac{1 - 3 \cos^2 \theta}{r^3}$$

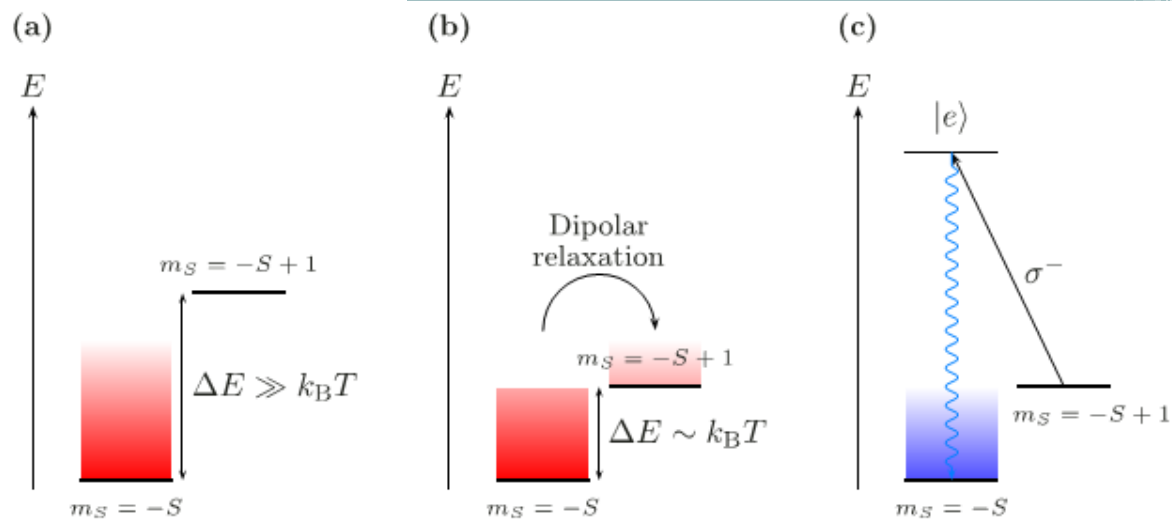
## Experimental observation

$^{52}\text{Cr}$

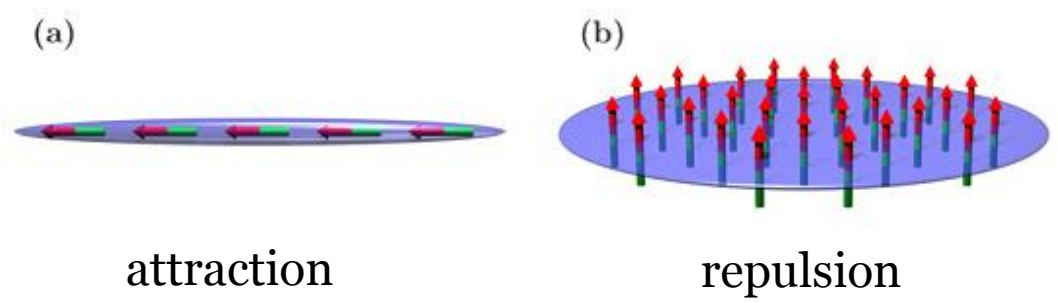
magnetic dipole moment of  $\mu = 6\mu_B$



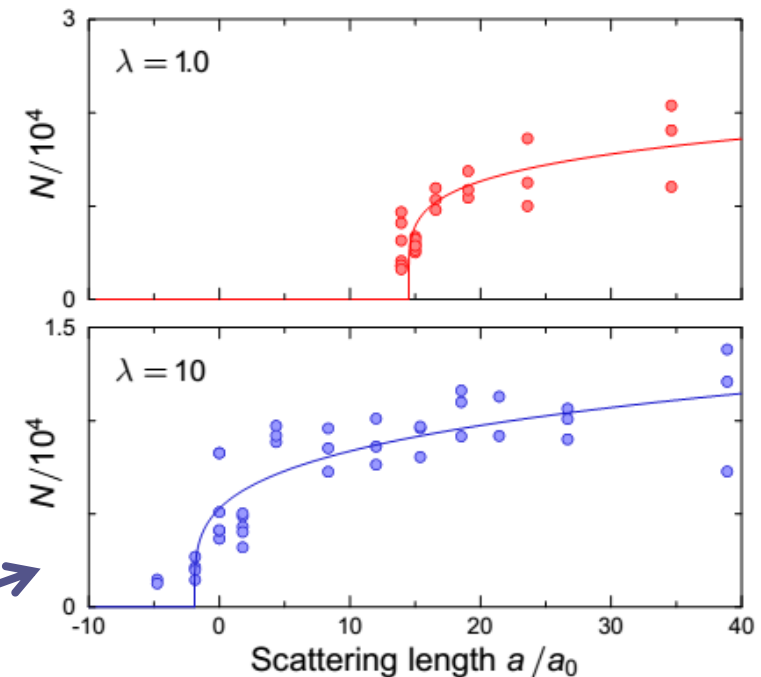
# Demagnetization cooling



# Geometry dependent stability

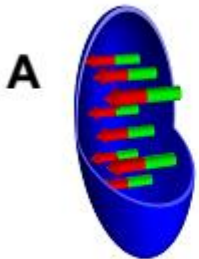


atom number in the condensate



# Stability diagram

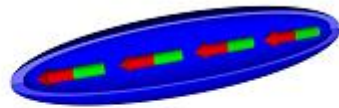
$^{52}\text{Cr}$



**A**

Oblate trap ( $\lambda > 1$ )

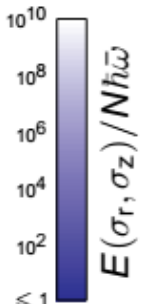
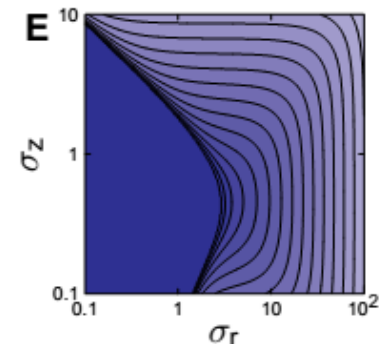
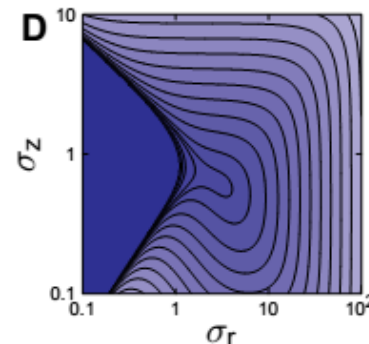
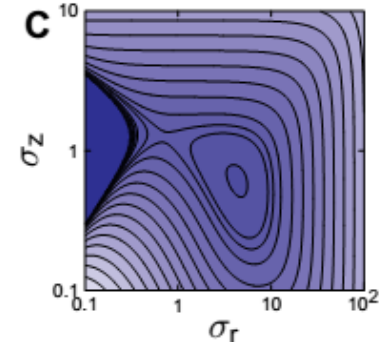
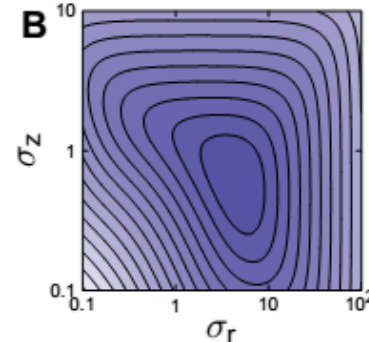
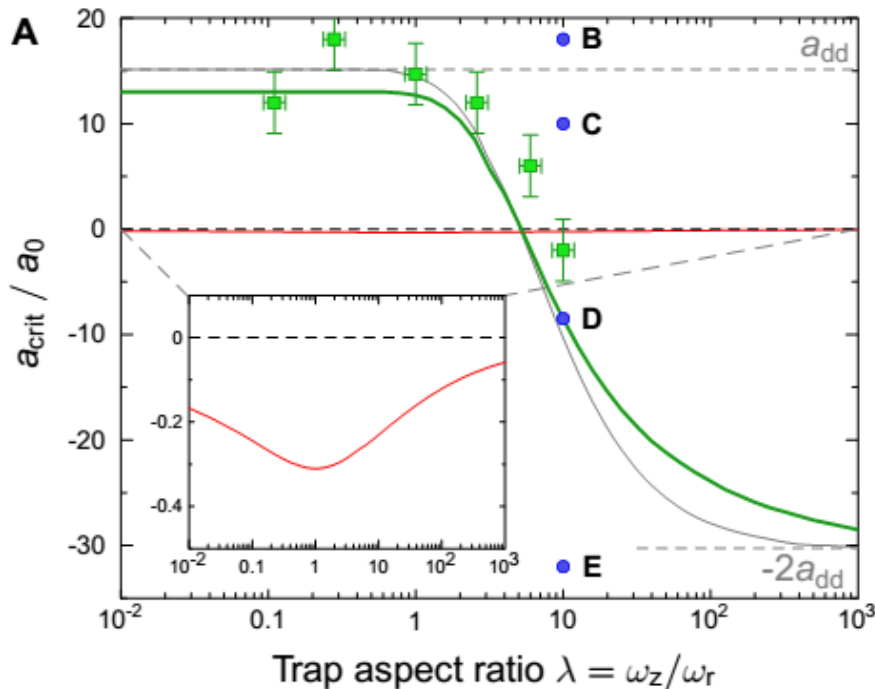
**B**



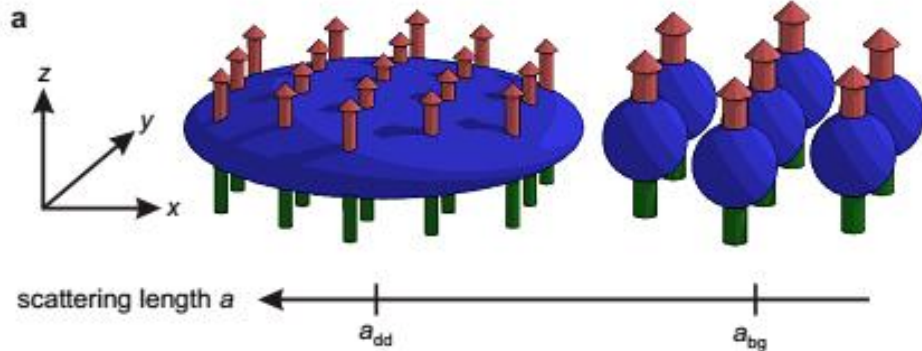
Prolate trap ( $\lambda < 1$ )

Theoretical curve from Ansatz

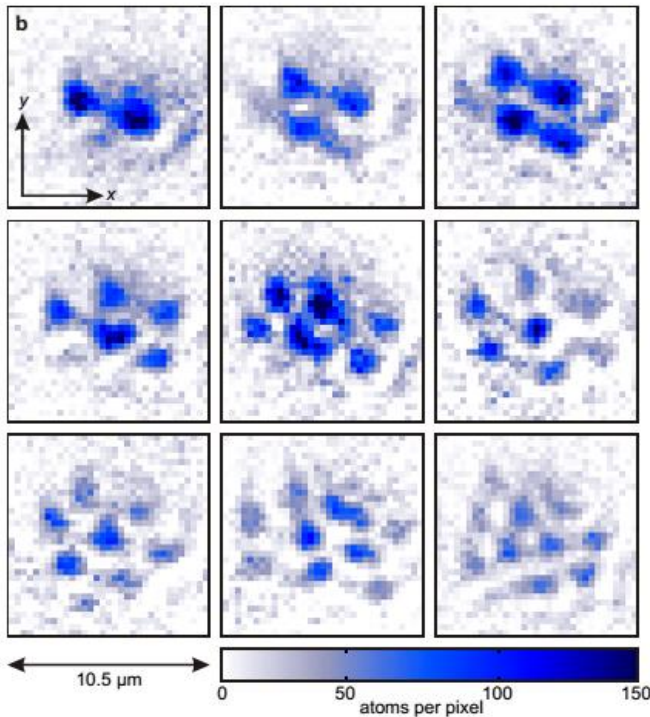
$$\Phi(r, z) = \left( \frac{N}{\pi^{3/2} \sigma_r^2 \sigma_z a_{\text{ho}}^3} \right)^{1/2} \exp \left( -\frac{1}{2a_{\text{ho}}^2} \left( \frac{r^2}{\sigma_r^2} + \frac{z^2}{\sigma_z^2} \right) \right)$$



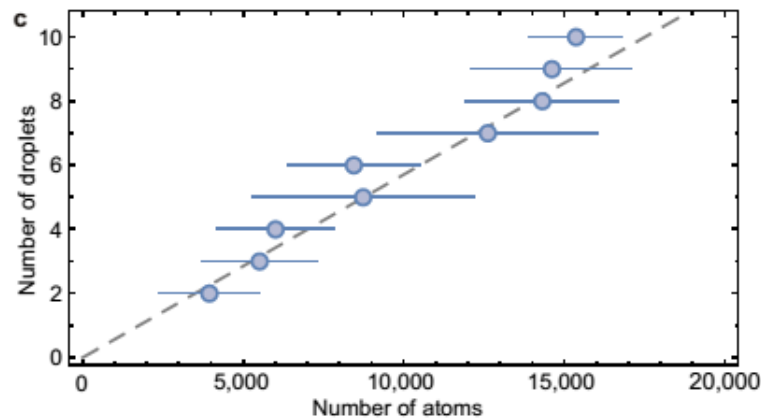
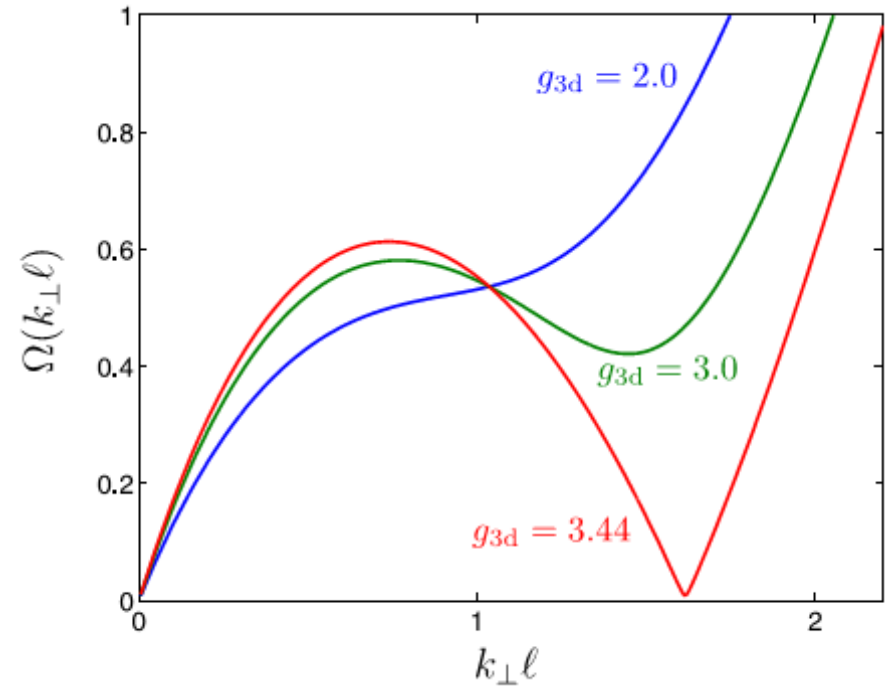
# Roton-maxon instability



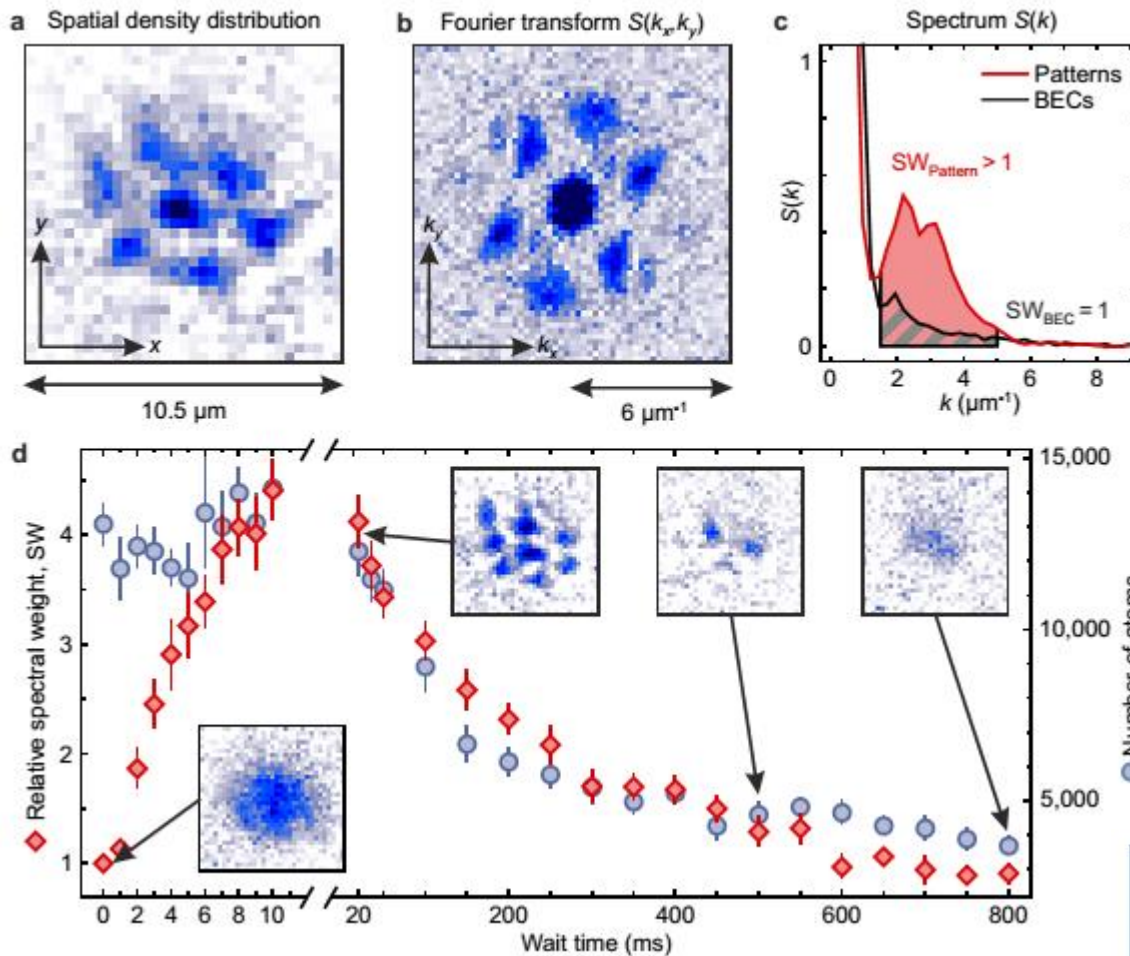
droplet formation  $^{164}\text{Dy}$



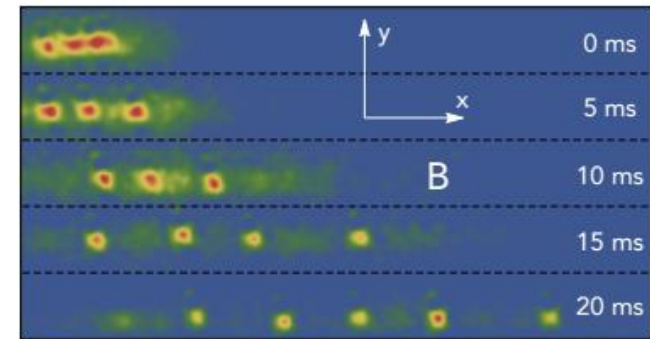
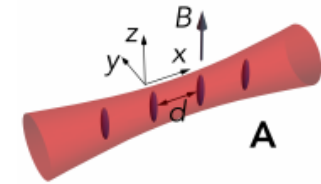
Spectrum in pancake trap



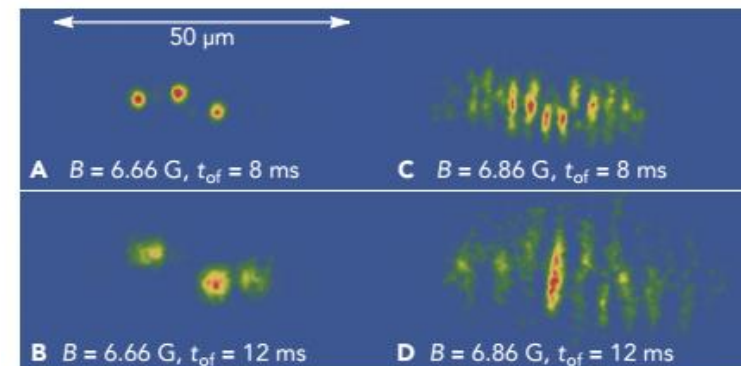
# Droplet formation, lifetime



## Droplets in wave guide



## Droplet interference



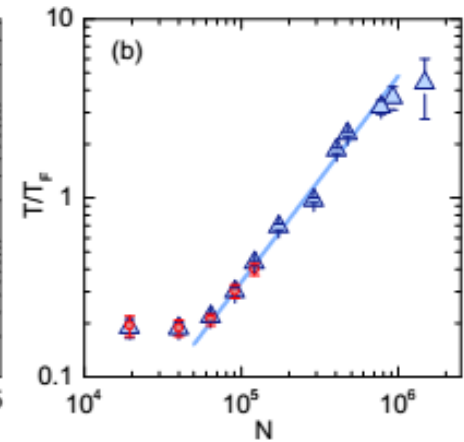
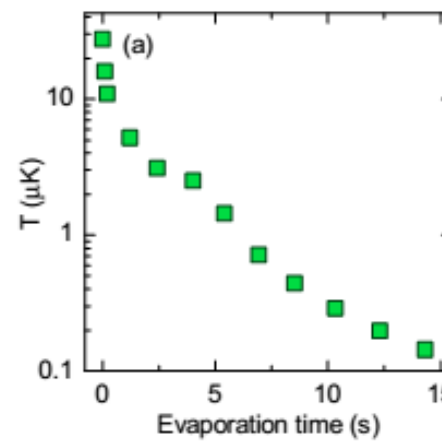
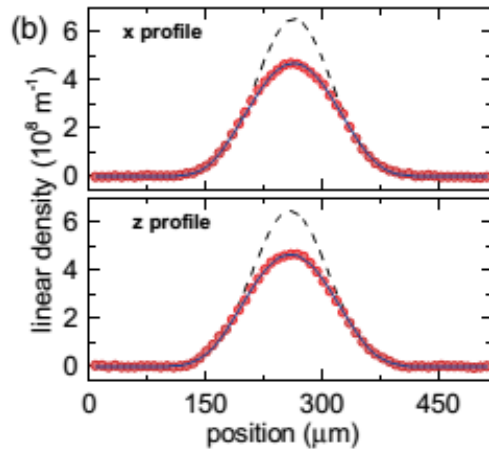
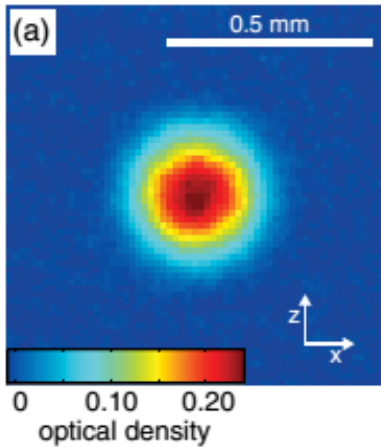
Droplets stabilized by correction to mean field E

$$\left. \frac{\partial \mu}{\partial n} \right|_{r=0} = g \left( 1 - \epsilon_{dd} f_{\text{dip}}(\kappa) + 16 \sqrt{n_0 a^3 / \pi} \left( 1 + \frac{3}{2} \epsilon_{dd}^2 \right) \right)$$



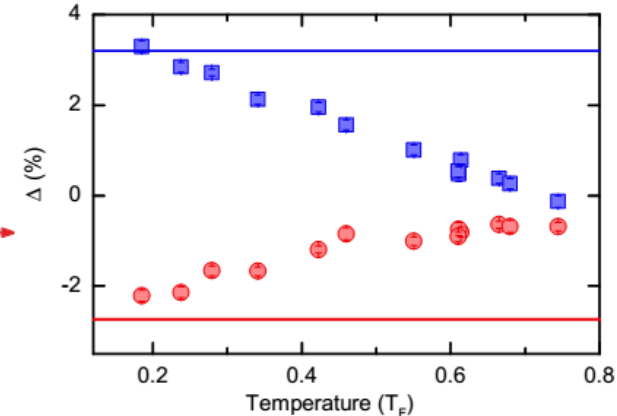
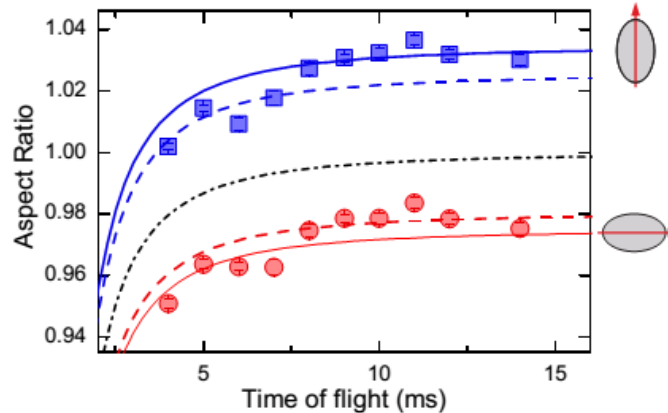
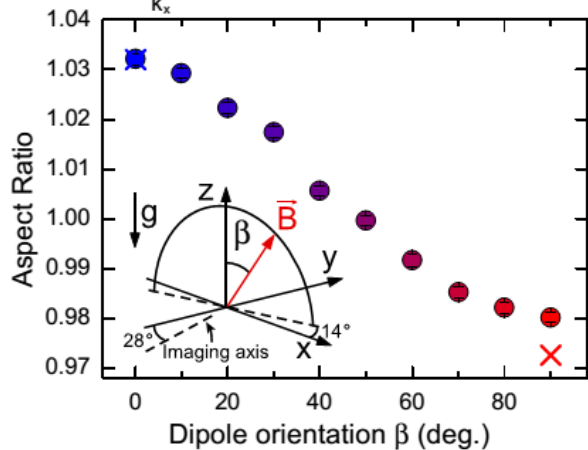
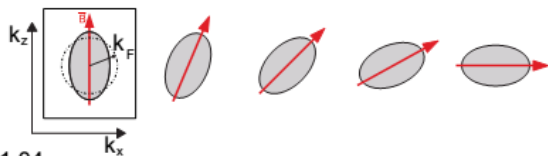
# Degenerate Fermi gas

$^{167}\text{Er}$



Efficient evaporative cooling even for spin polarized samples.

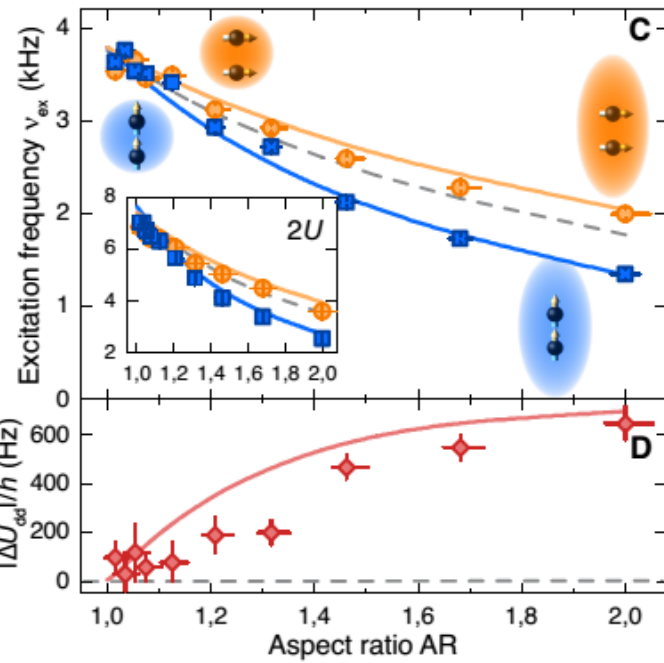
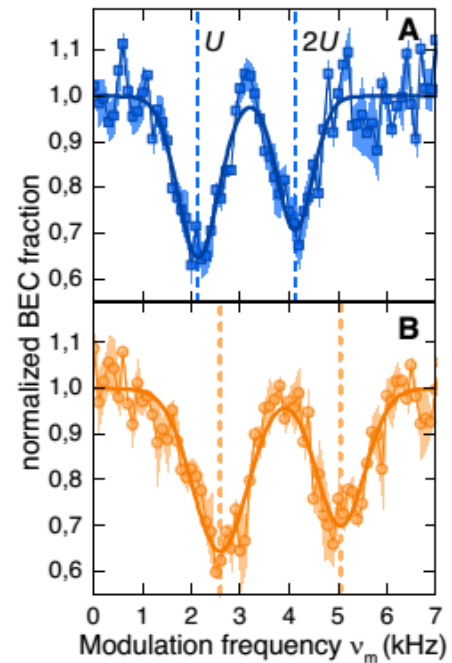
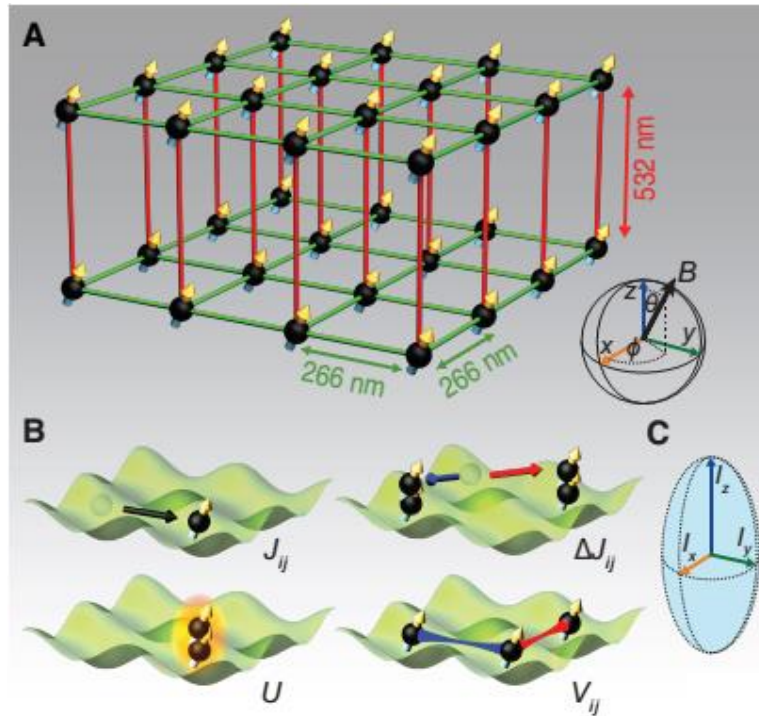
## Fermi surface deformation



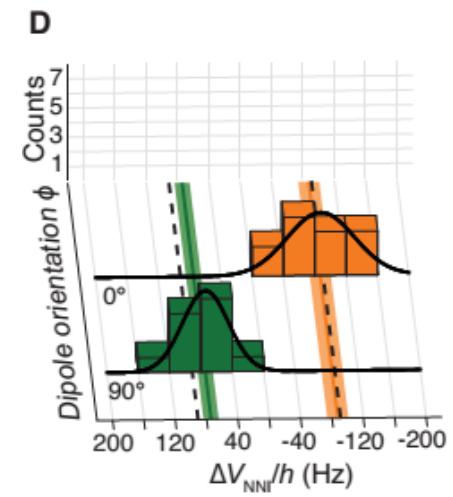
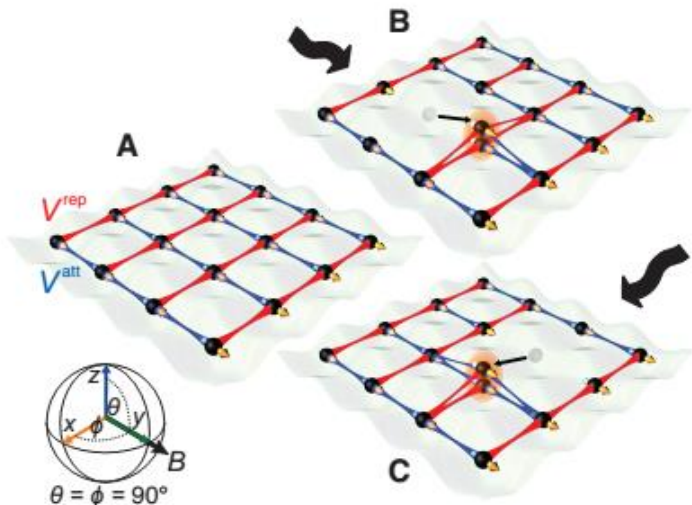
# Bose-Hubbard model

$^{168}\text{Er}$

onsite interaction

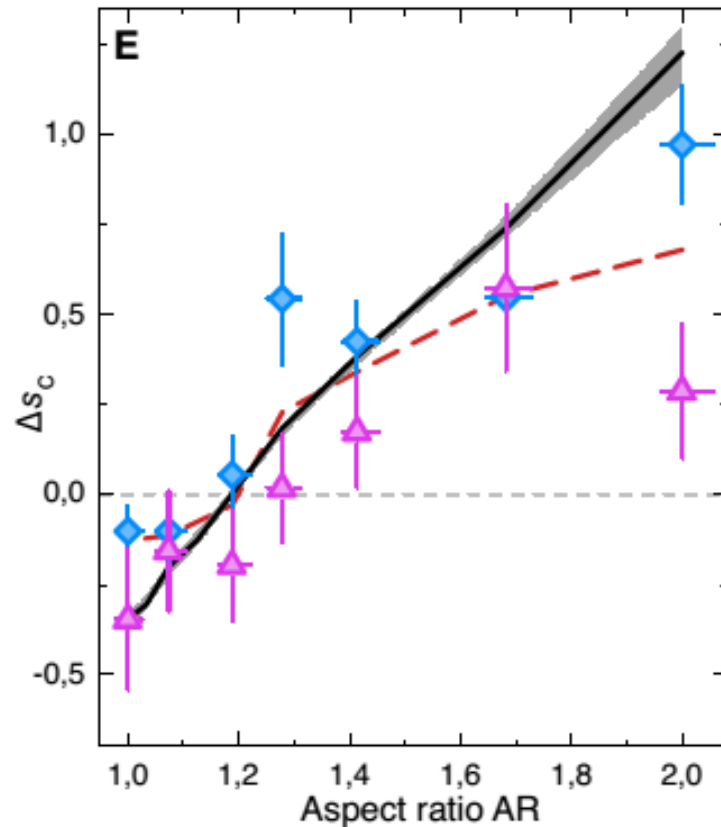
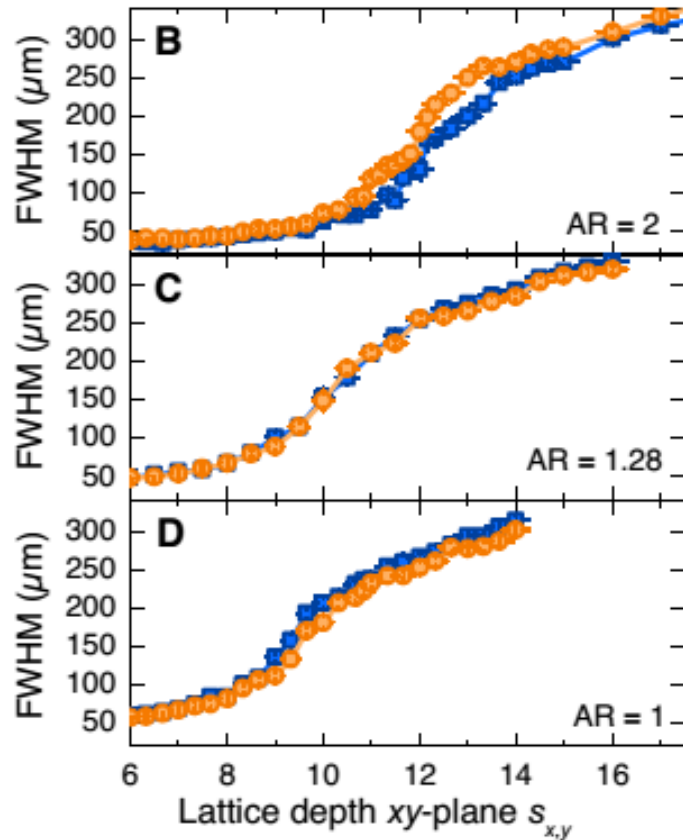
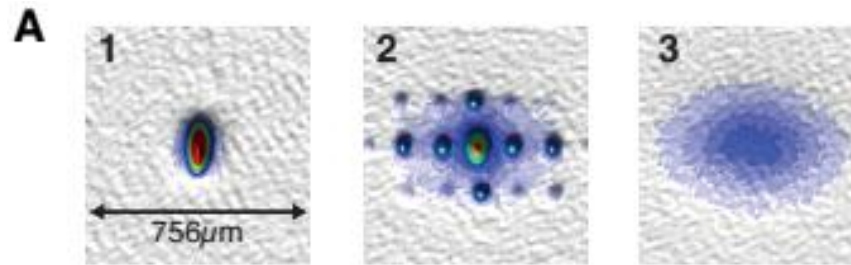


next nearest neighbor interaction





# Superfluid-Mott insulator transition



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