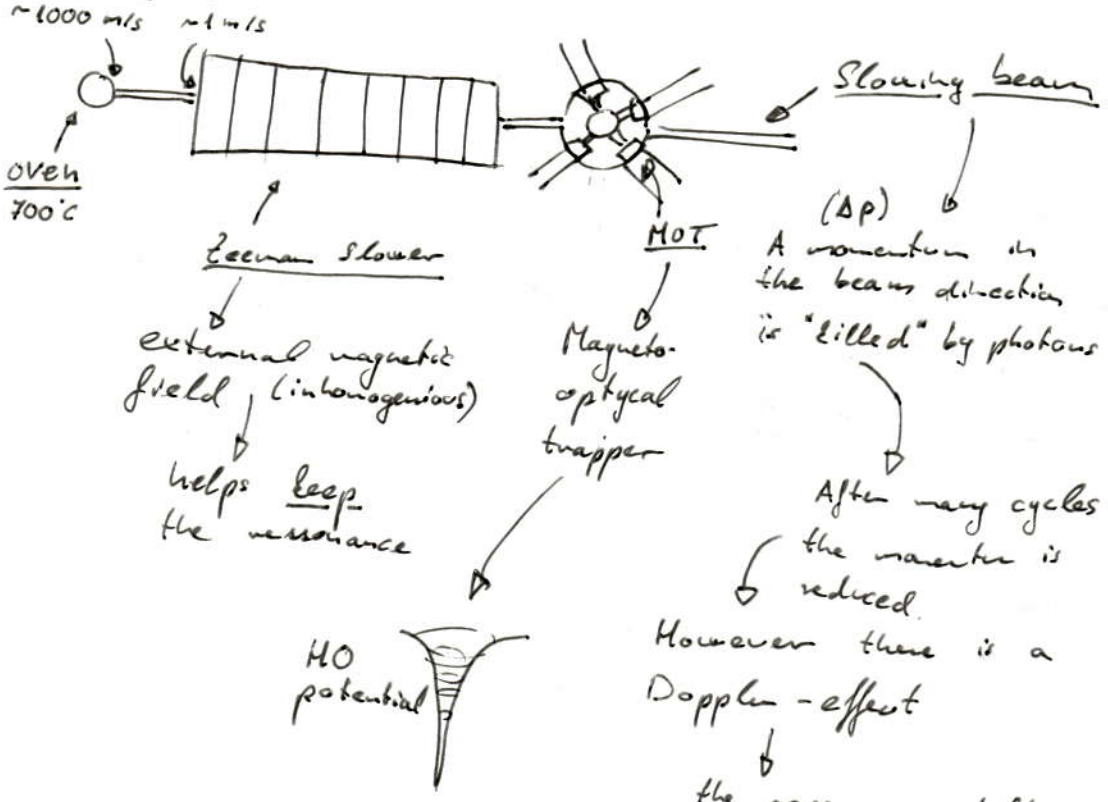
$$\frac{\delta T_0}{T} = -\frac{\gamma_1}{3}\left(\frac{\hbar\bar{\omega}}{k_B T_0}\right)\frac{\zeta(2)}{\zeta(3)} = -\frac{\gamma_1}{3}\frac{\zeta(2)}{\zeta^{2/3}(3)}\,N^{1/3}$$

this answes that δT is smaller than T_0 and can be cosidered as a correction

it lowers the critical Temp.

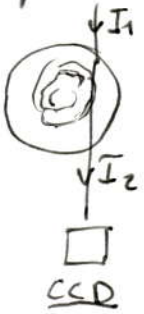
2019.02.25.

- Cooling gases in Optical traps



- Atoms are trapped in a soft potential:

idea: absorption measurment



$I_1 > I_2$

- absorption $\sim \int_{\text{path}} n\, ds$
- this way the projection of the density can be measured
- problem: "10^5 atoms are close together"
  → potential can be switched off
  → "sample starts to grow" → it is no longer density distribution
  ↓ velocity dist.
  + we know distance
  + we know TOF
  ⇒ density can be calculated.

- above T_c:

$$S(\vec{p},\vec{r}) = \frac{1}{e^{-\beta\left(\frac{p^2}{2m}+V(\vec{r})-\mu\right)} - 1} \rightarrow S(\vec{p}) = \int d^3r\, S(\vec{p},\vec{r})$$

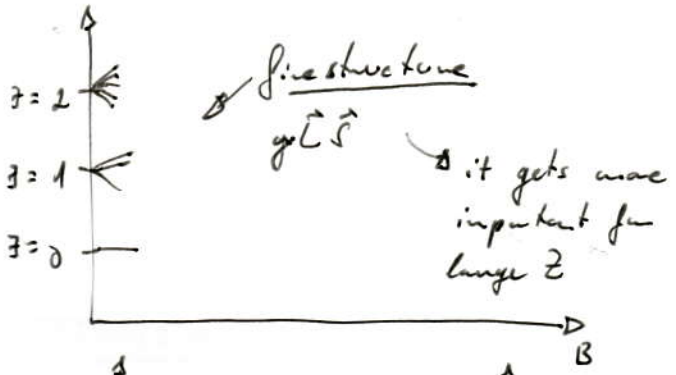
→ isotropic in $\vec{p}$ ($p^2\ldots$)
→ projection is concentric circles.

- approaching T_c:
  - 2 components → normal atoms → isotropic...
    → BEC
    ↓
    $S = |\Psi_0(\vec{r})|^2 \sim \varphi(\vec{r})$ ← 1 part. state
    ↓
    momentum dist is FT of this
    → $|\Psi_0(\vec{p})|^2$

- condensing atoms in anisotropic HO-potential
  → Ψ will be anisotropic → FT is <u>anisotropic...</u>
  ↓
  have to know below T_c

- Hyperfine states

$\vec{L} = 1, \ \vec{S} = 1, \ \vec{J} = 0, 1, 2$

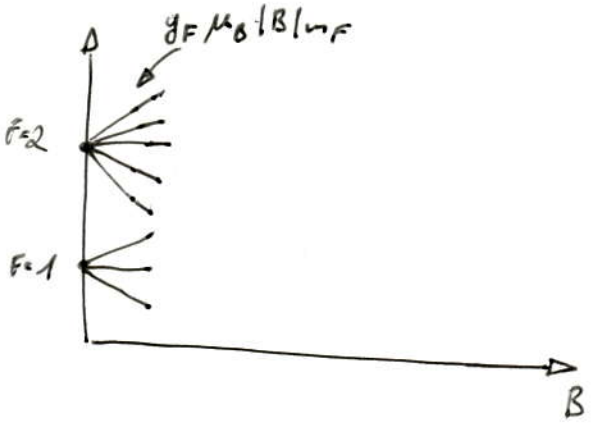


fine structure
$g_J \vec{L} \vec{S}$

it gets more important for large L

at small B
anomalious
Zeeman-effect
$g_J \mu_B |B| m_J$
if $\mu_B |B| < \Delta E$

high B:
$\mu |B| (m_L + 2 m_S)$
if $\mu_B |B| > \Delta E$



- Hyperfine coupling:

$a \vec{i} \vec{J}$ — $\vec{L} + \vec{S}$

↑ Spin of the nucleus

$\frac{a}{g} \sim 10^{-4}$ → smaller effect than $\vec{L}\vec{S}$ coupling

$^{23}Na, \ ^{85}Rb$

in grund state only 1 electron above the closed shell

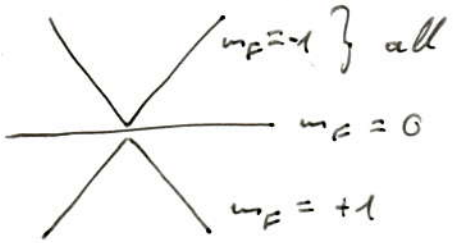
$\boxed{L = 0}$ $S = \frac{1}{2}$, $J = \frac{1}{2}$

but $i = \frac{3}{2}$ → total angl. mom.:

$\vec{F} = 1, 2$

$(\vec{F} = \vec{L} + \vec{S} + \vec{i})$

- trapping potential:



} all atoms will be in $m_F = -1$

↓

Spin-polarized sample

you can only trap atoms that: $m_F g_F > 0$

for $F = 2 \rightarrow m_F = 1, 2$ can be trapped.

generally only 1 branch is cooled

↳ most energetic ones can be removed

} "it gets taken away"

↳ "evaporation"

- modulus potential : spontaneous majorana flip : $m_f = -1 \to m_f = 0$

→ problem...

→ using HO potential

→ apply rotating pot. on the modulus

} solution

⇨ the effective pot will be H.O.
