Magneto-Optical Trap (MOT)

Problem:

Doppler cooling reduces momentum spread of atoms only.

→ Similar to a damping or friction force (optical molasses).

→ Does not reduce spatial spread.

→ Does not confine the atoms.

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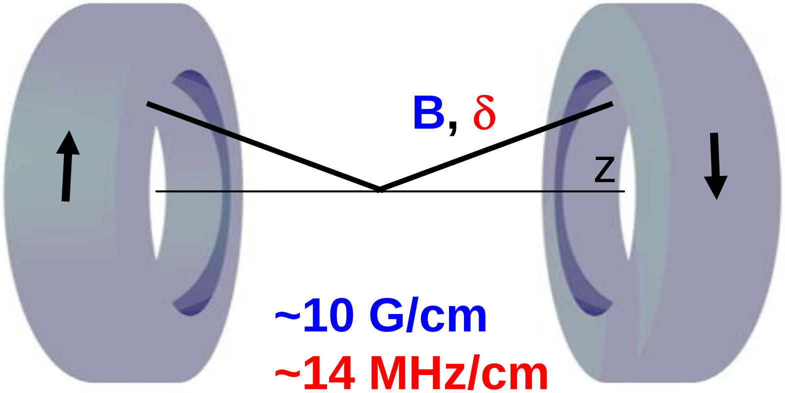
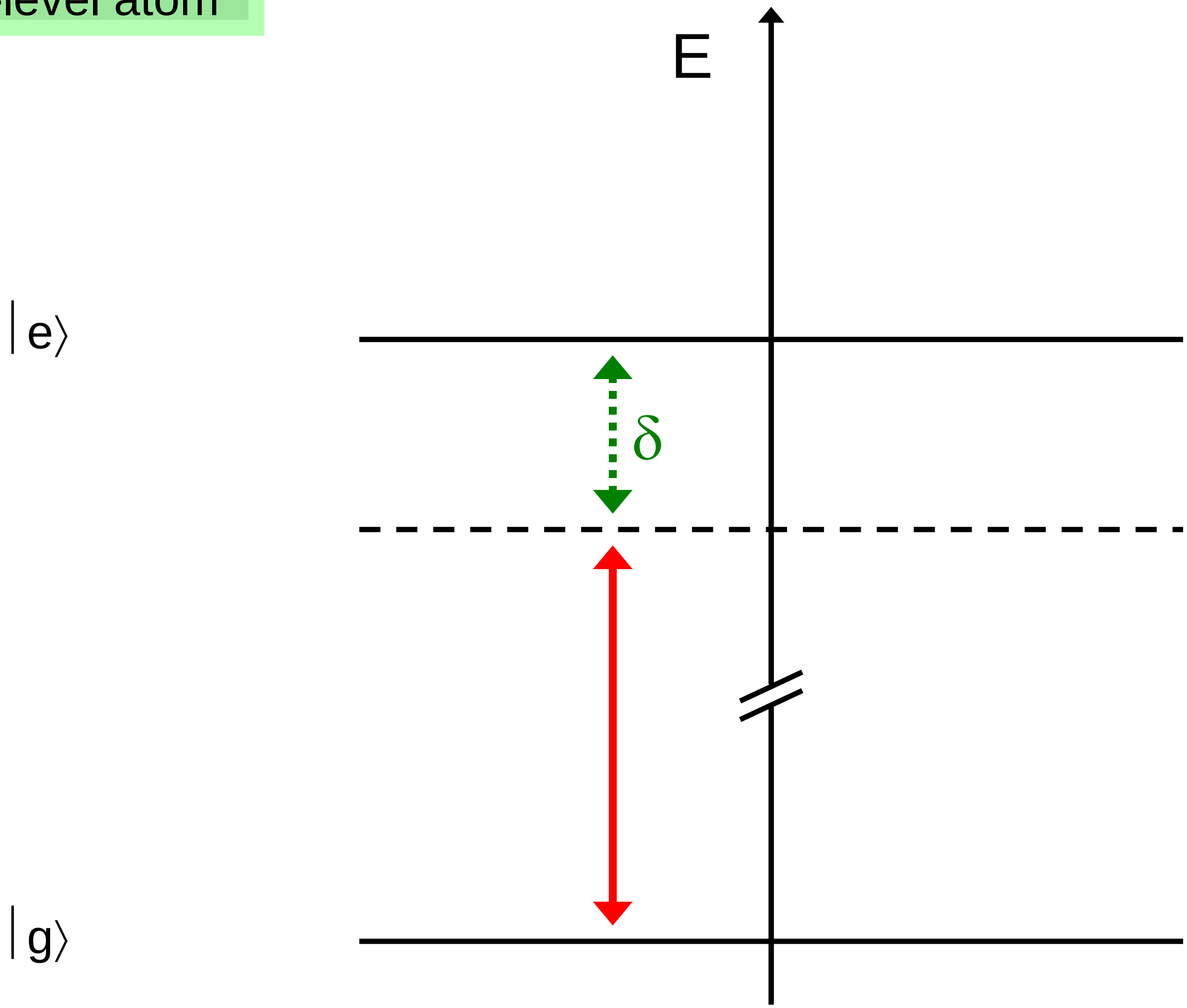
Solution:

Spatially tune the laser-atom detuning with the Zeeman shift from a spatially varying **magnetic field**.



Magneto-Optical Trap

2-level atom

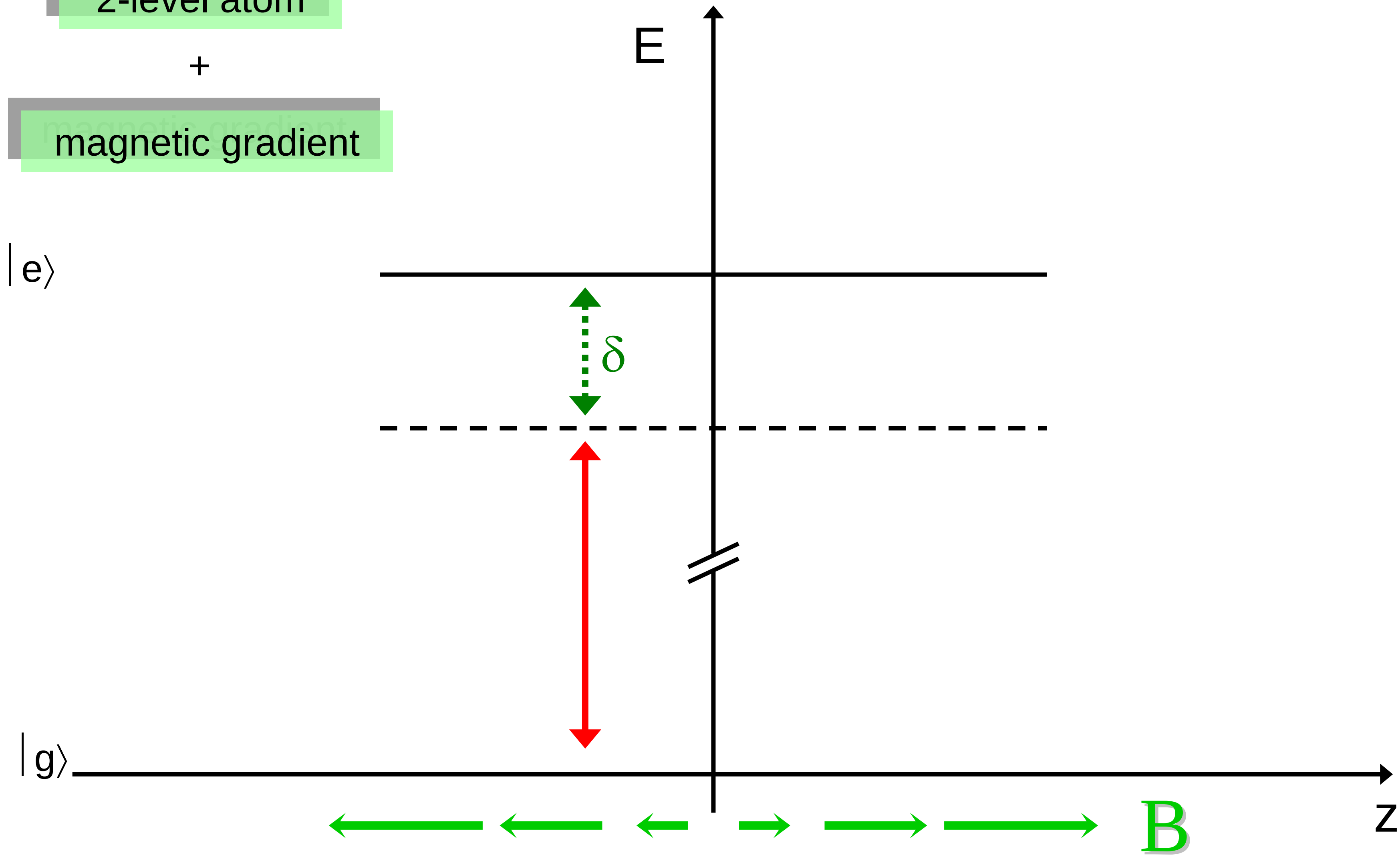


Magneto-Optical Trap

2-level atom

+

magnetic gradient



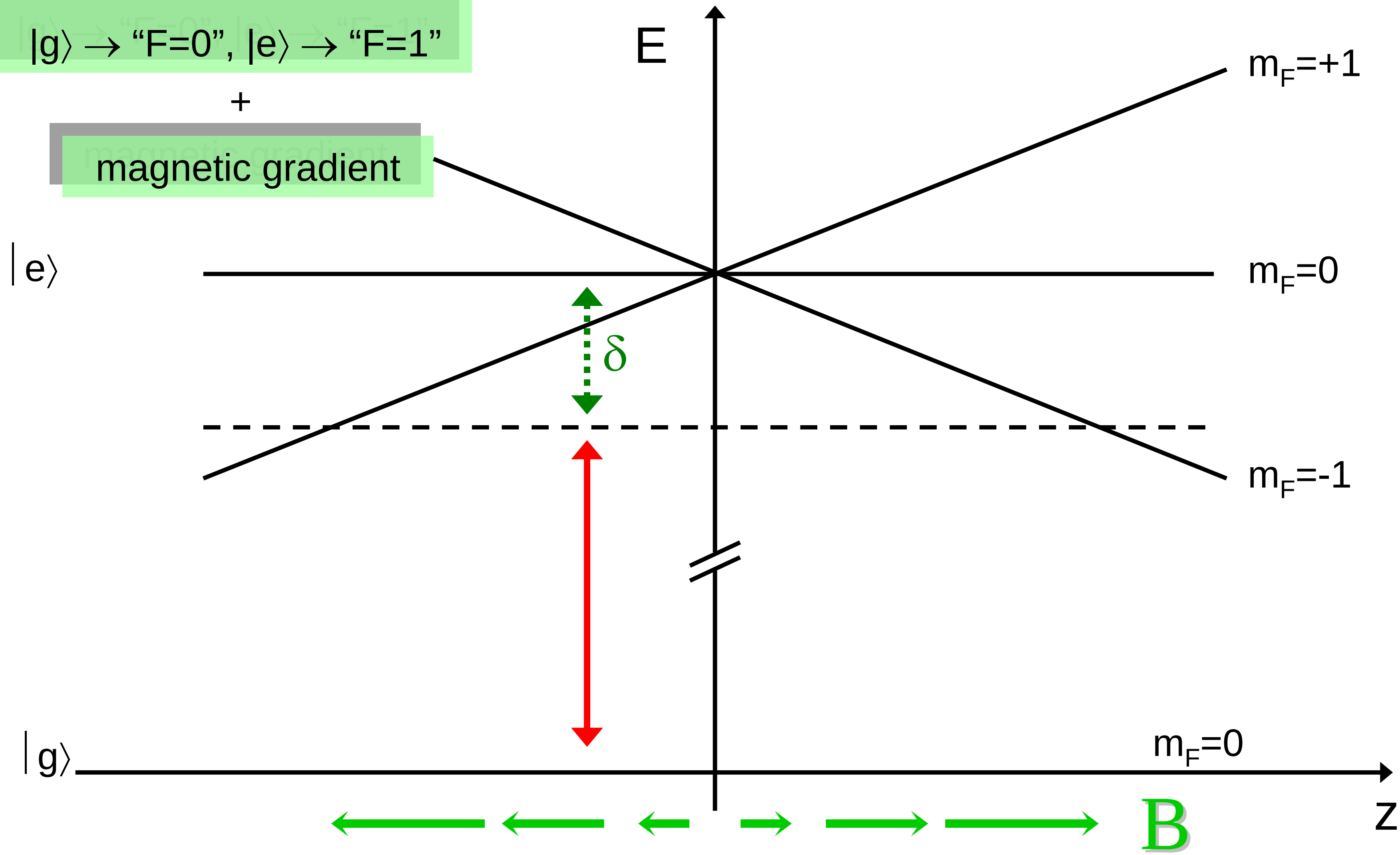
Magneto-Optical Trap

4-level atom

|g⟩ → “F=0”, |e⟩ → “F=1”

+

magnetic gradient



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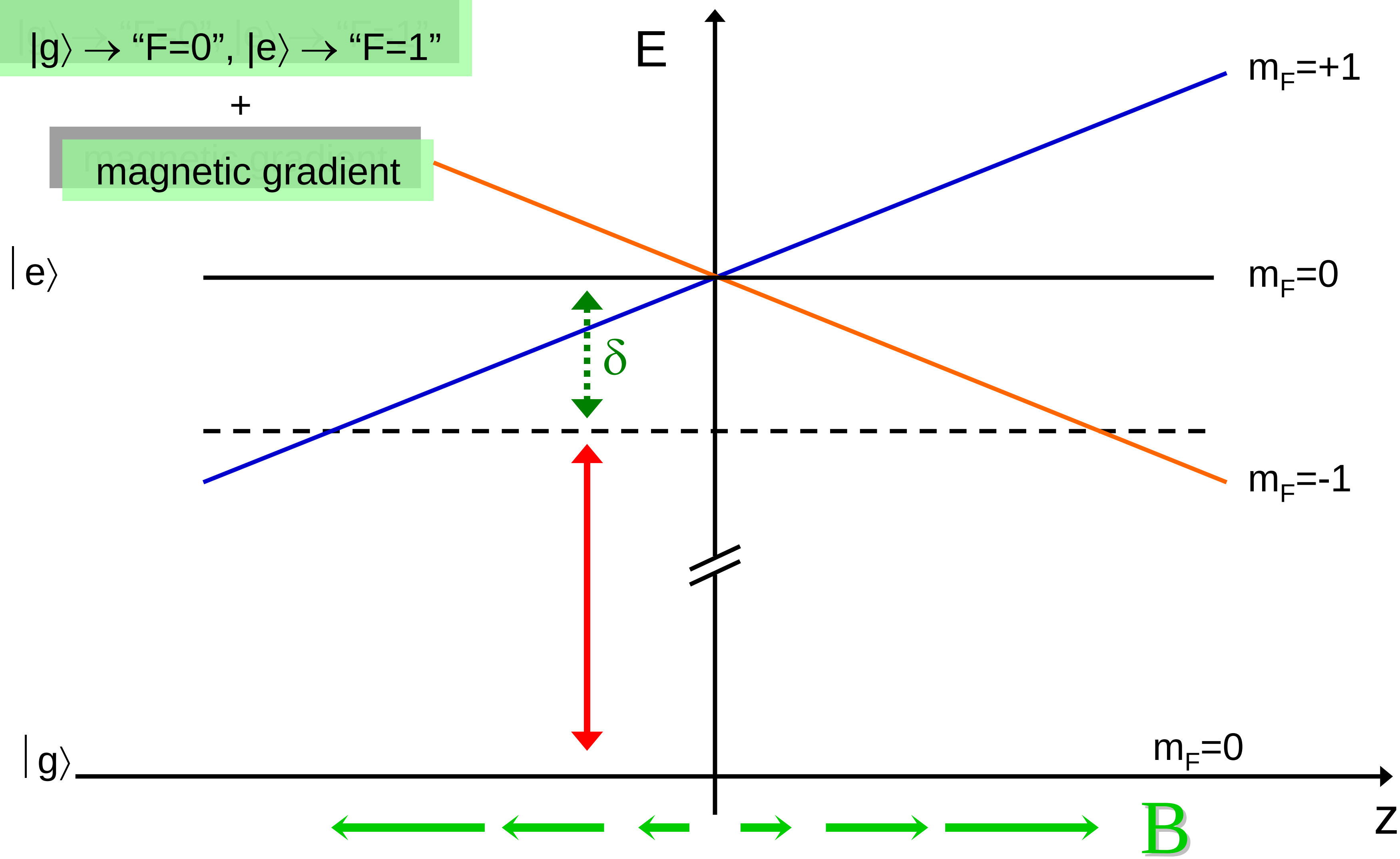

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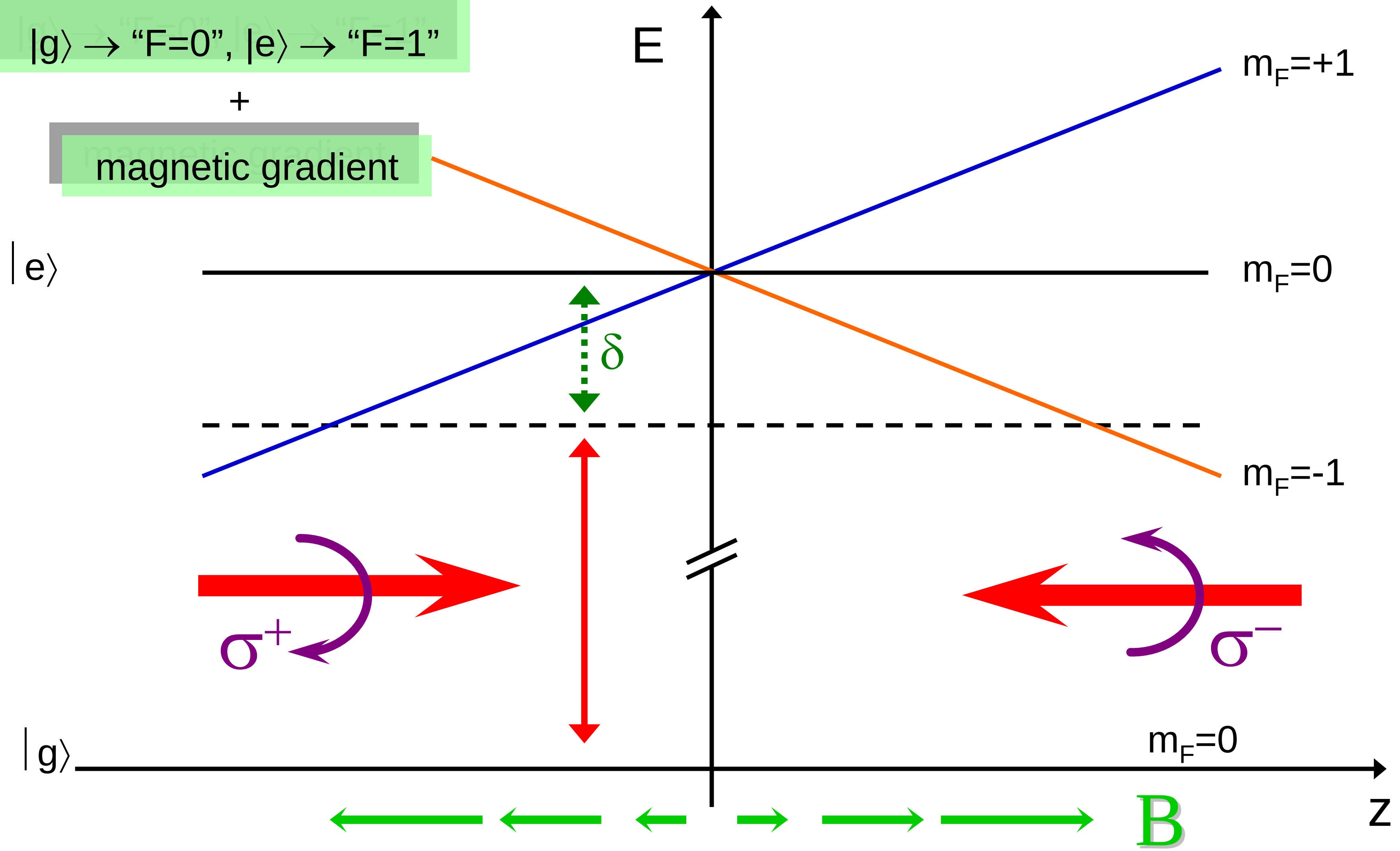

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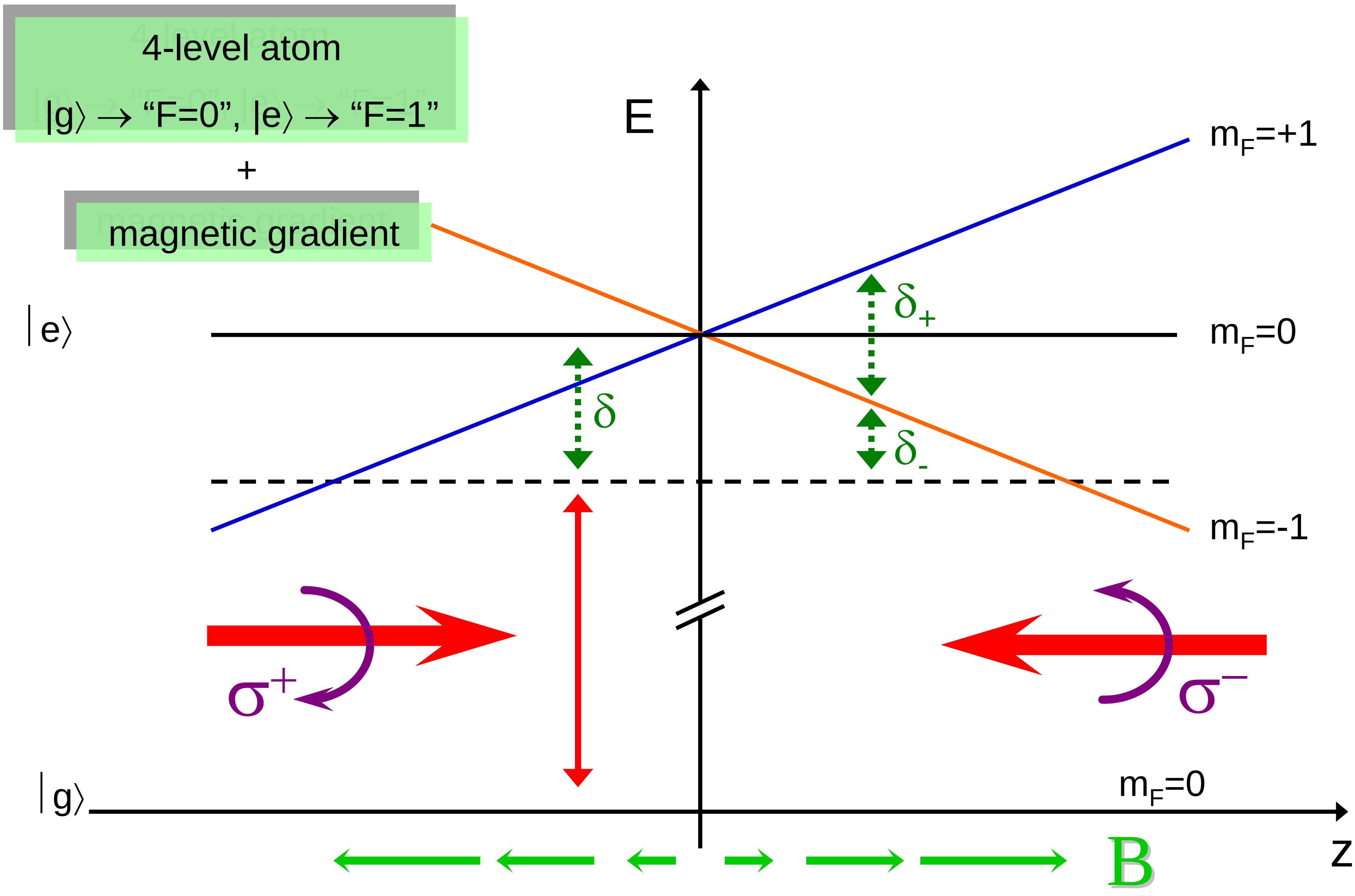

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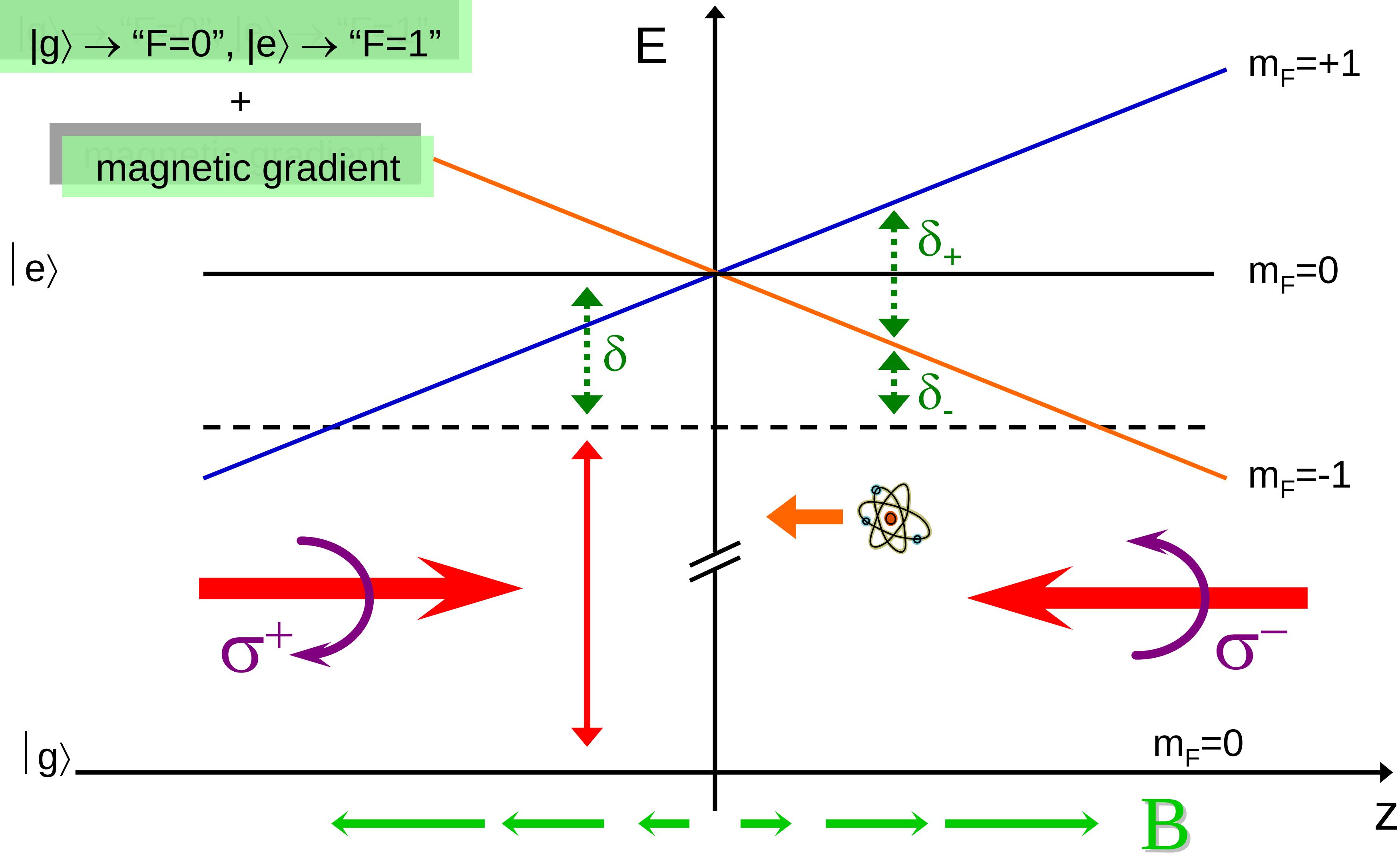

Magneto-Optical Trap (MOT)

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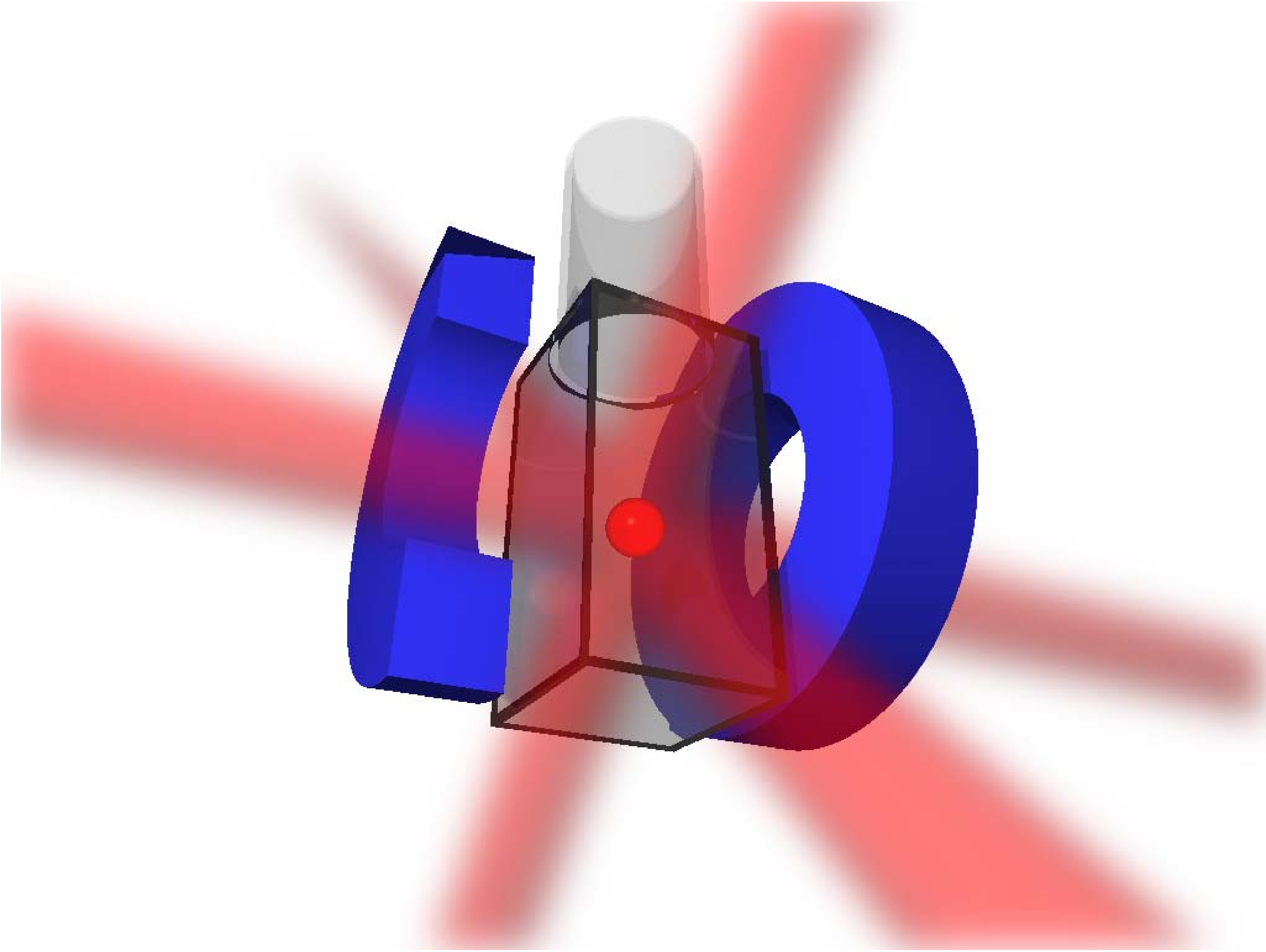

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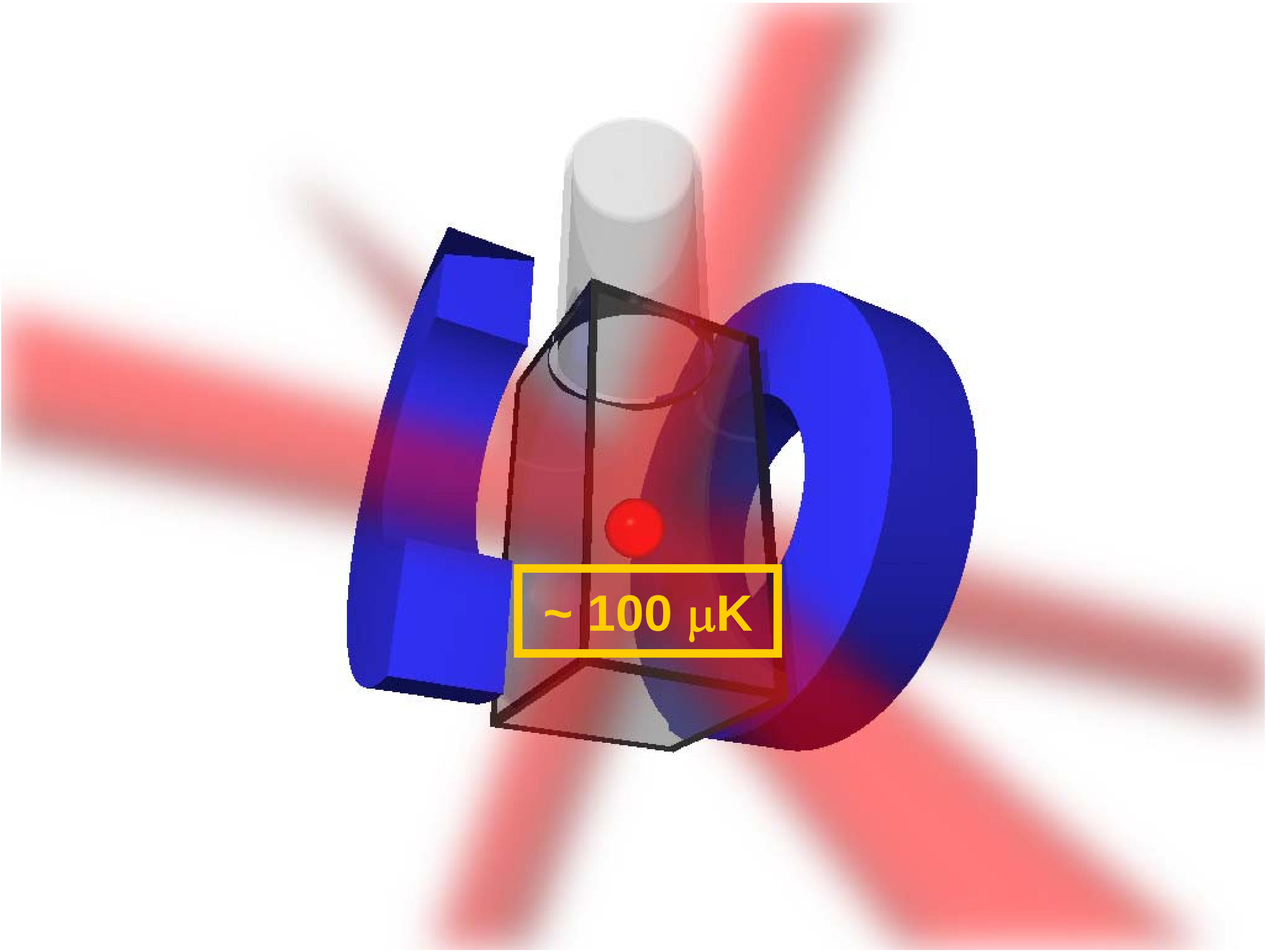
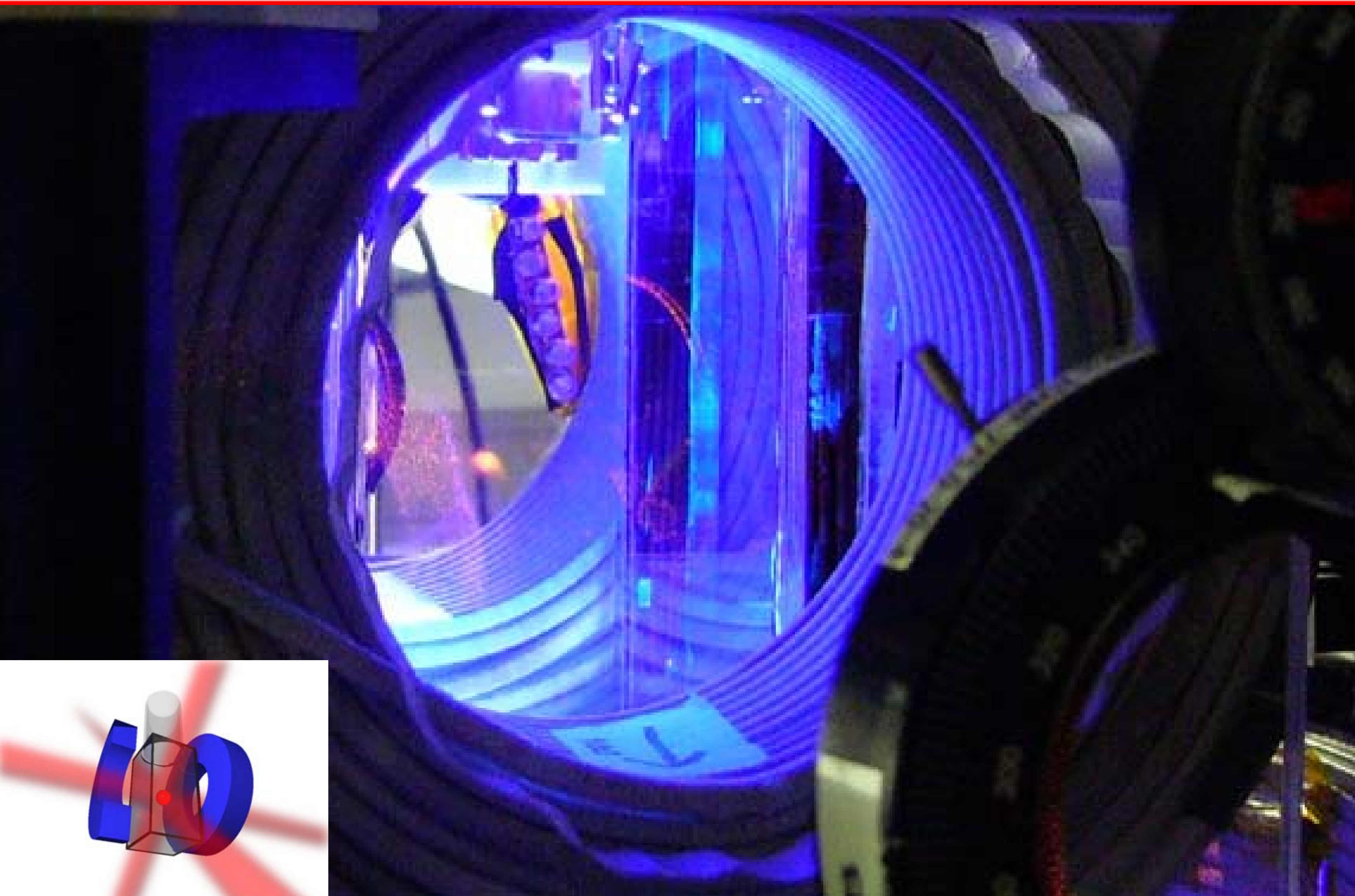
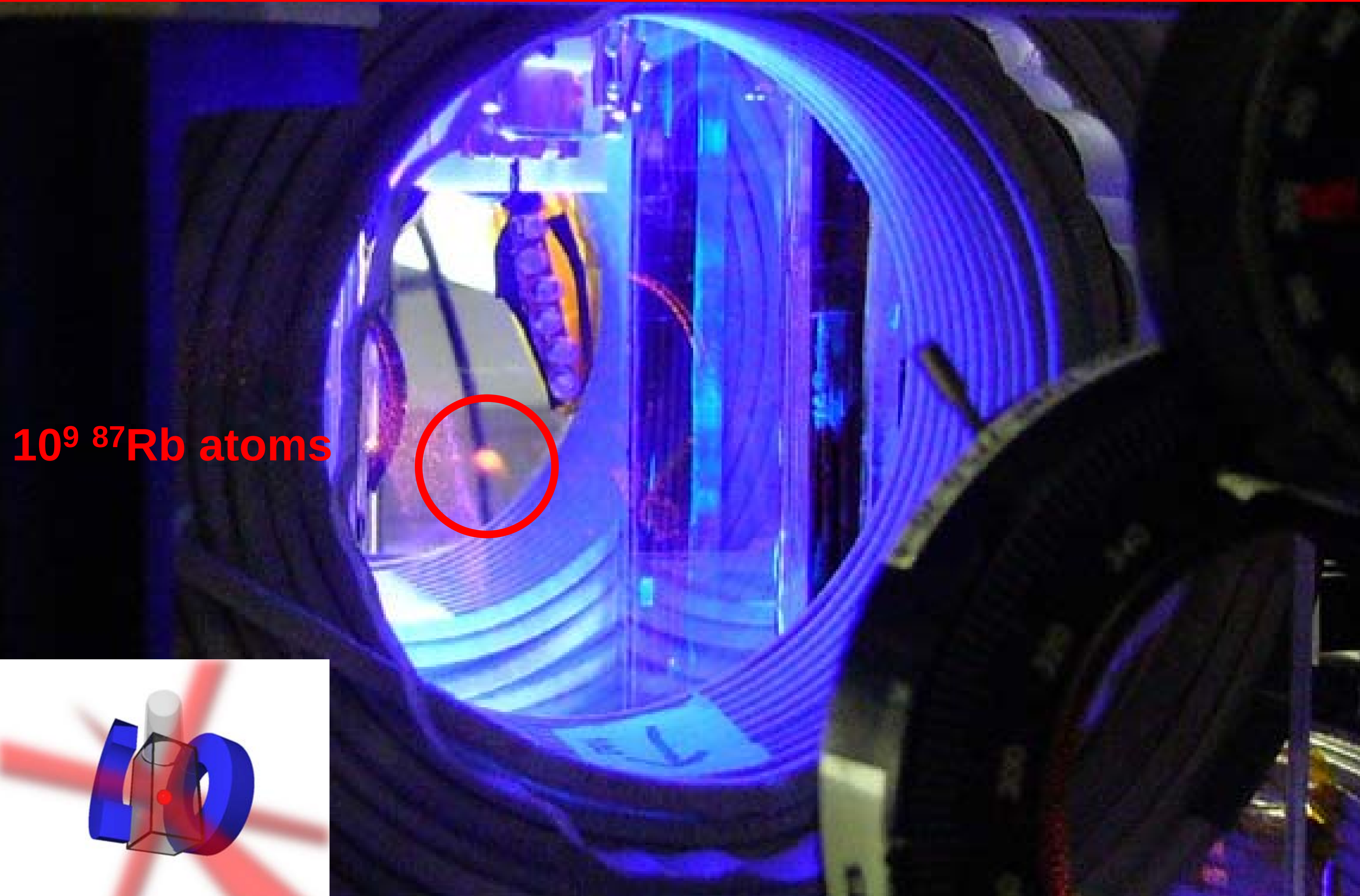


Magneto-Optical Trap (MOT)



Magneto-Optical Trap (MOT)



Francium MOT

PROBLEM: Accelerator produces only **10^6 Fr atoms/s**.

→ Very difficult to work with.

SOLUTION: **Attach a Francium Magneto-Optical Trap to the accelerator.**

→ Cold Francium is concentrated in **~1 mm^3** volume.

→ With **$T < 100\ \mu K$**, Doppler broadening is negligible.

→ Long integration times.

→ Minimally perturbative environment (substrate free).

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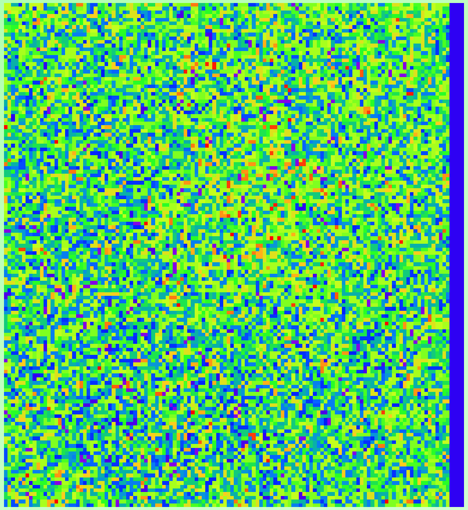

MOT collection efficiency ~ 1 %

MOT with ~10^5 ^{210}Fr atoms

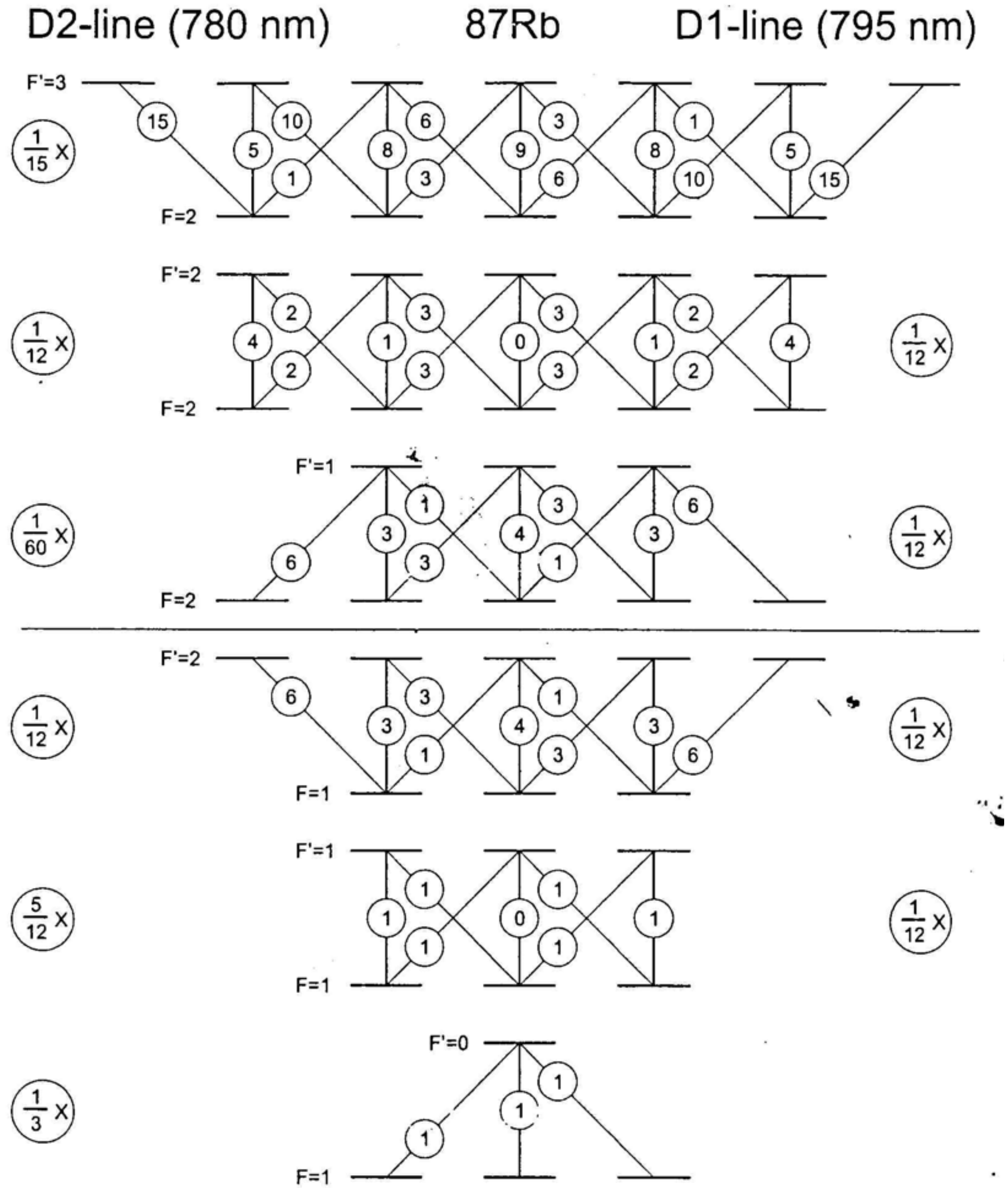

Figure A.2: Branching ratios for ^{87}Rb. Multiply by the circled number in the left(right) column to get the branching ration for the D2(D1) line.

[source: unknown PhD Thesis]