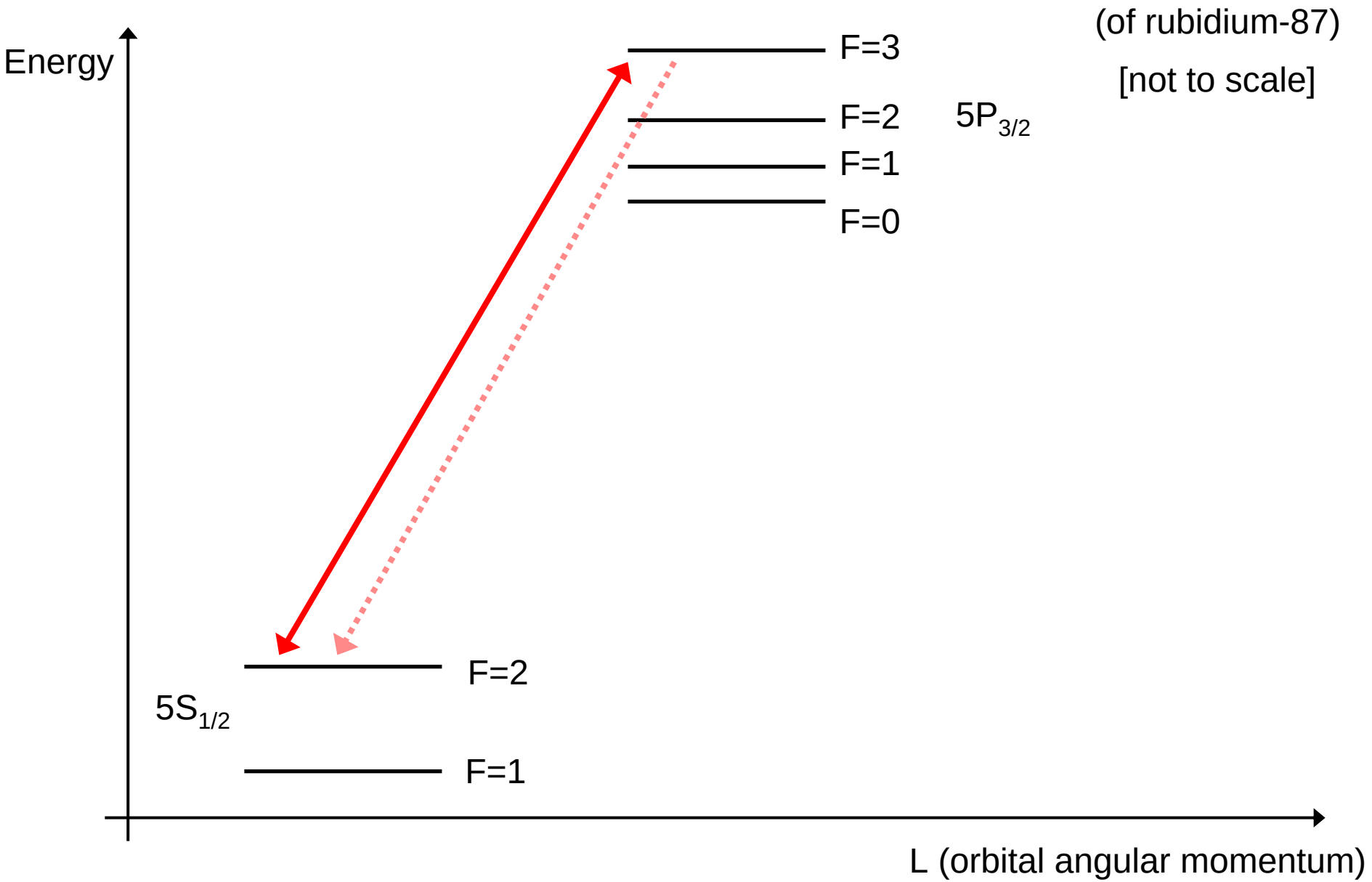
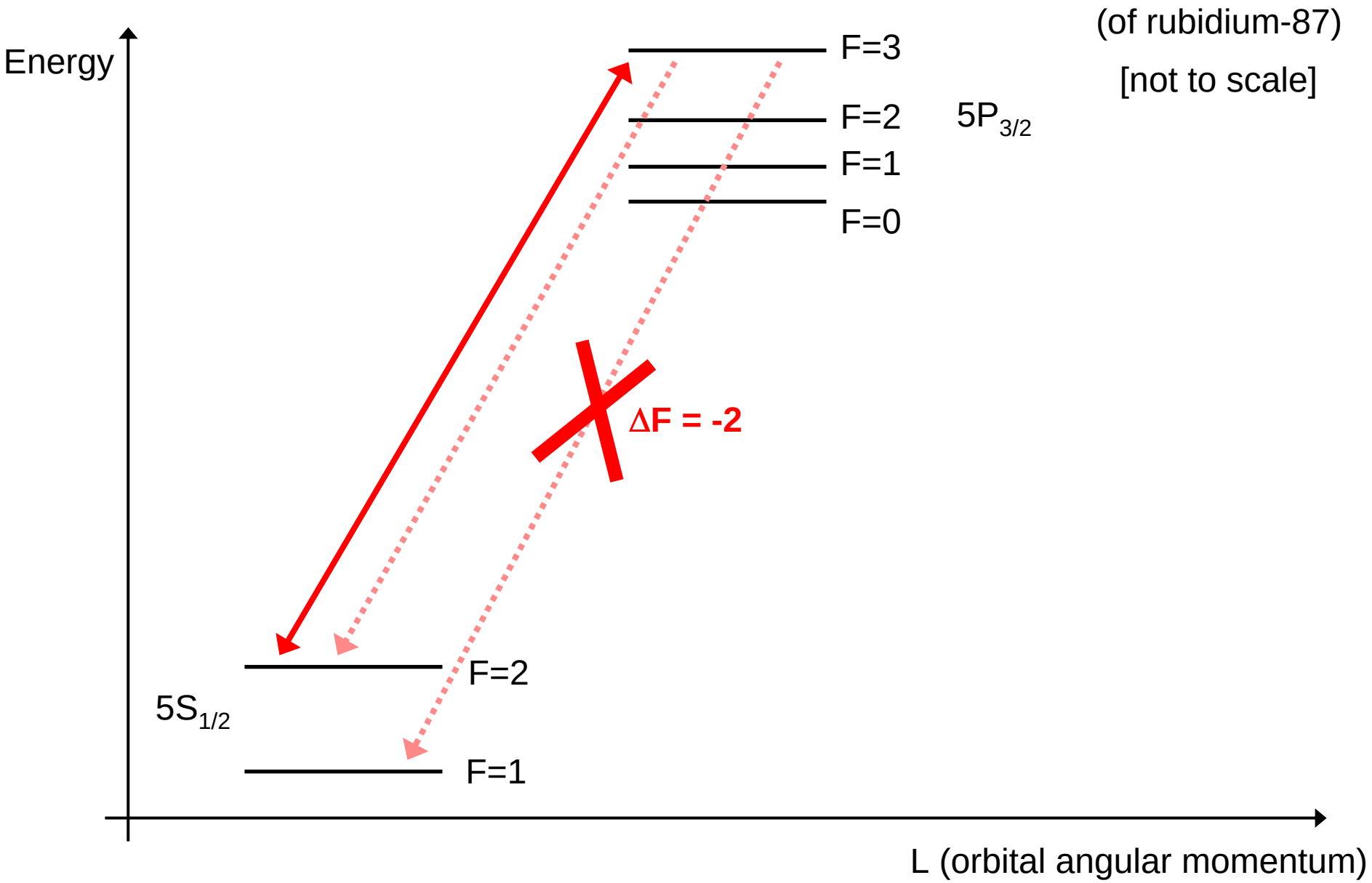
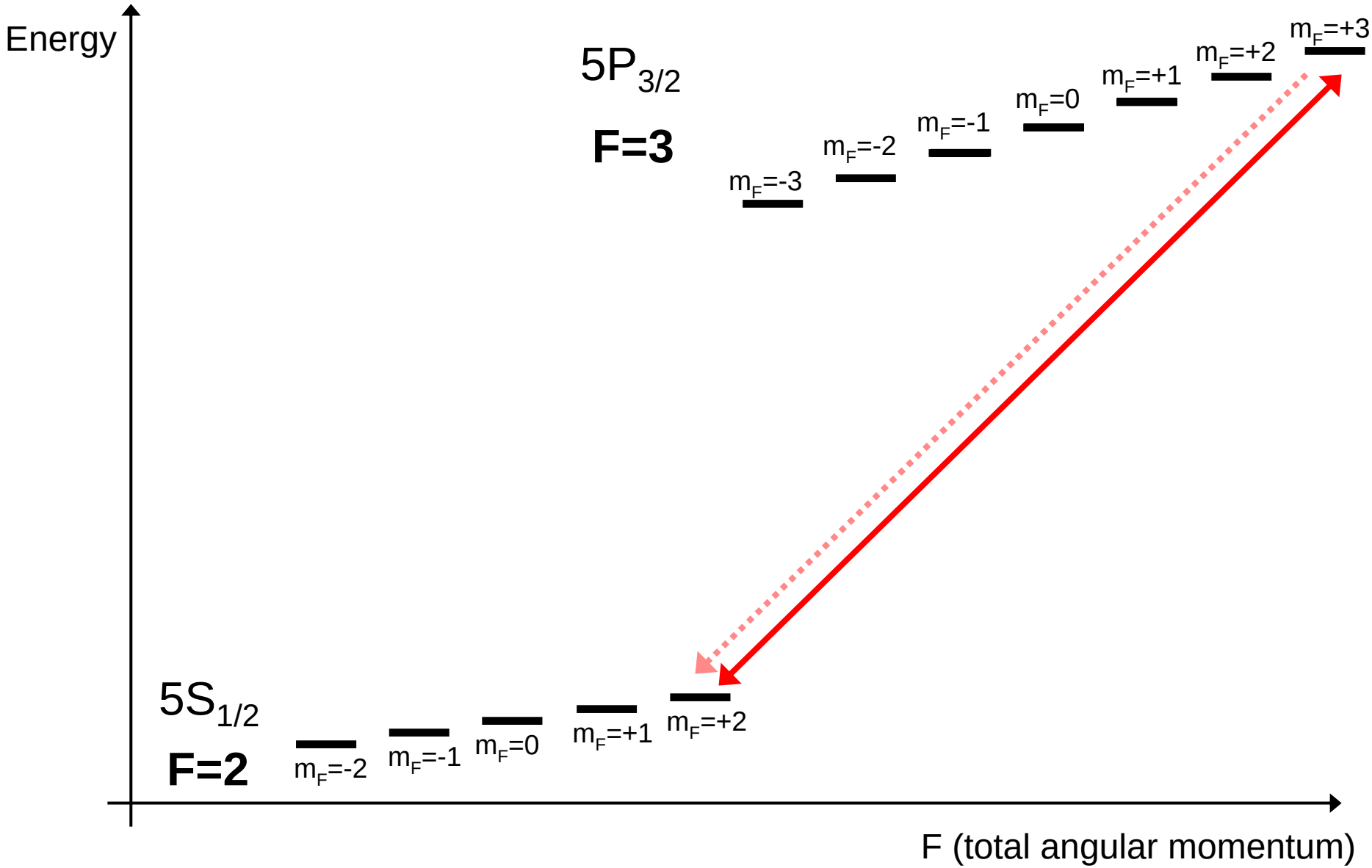
Why are Alkalis “2-level atoms” ?



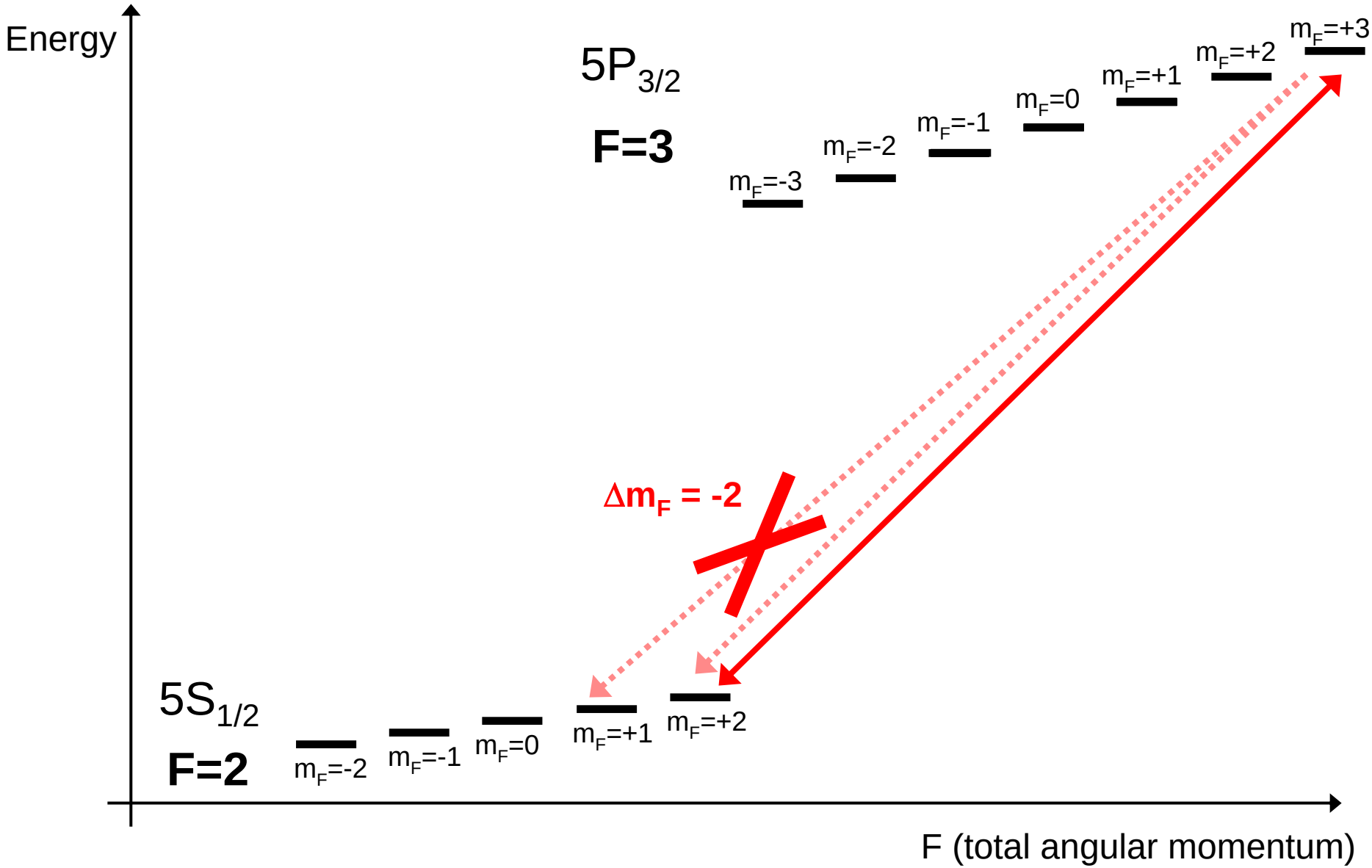
Why are Alkalis “2-level atoms” ?



The D2 line Cycling Transition



The D2 line Cycling Transition



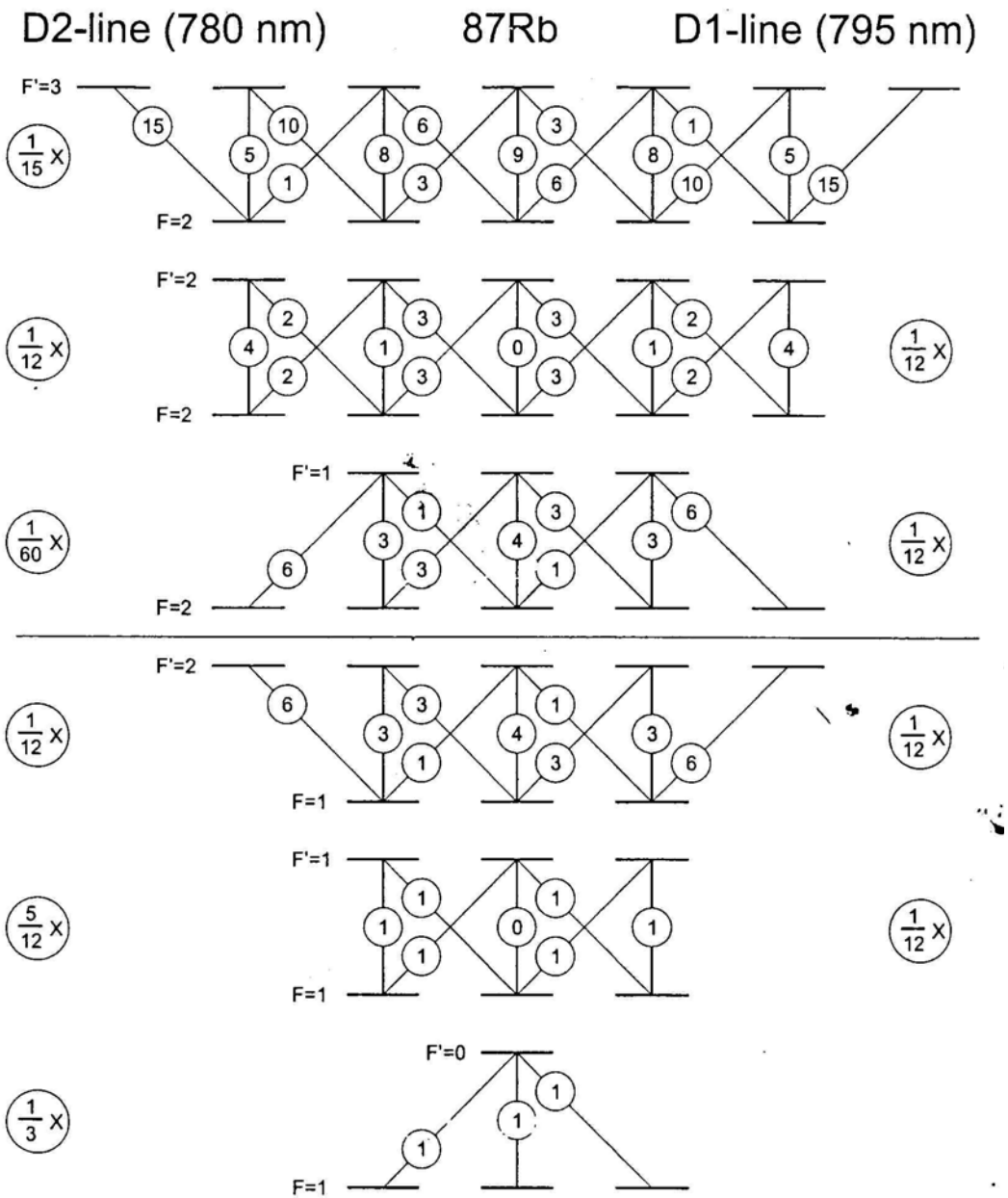


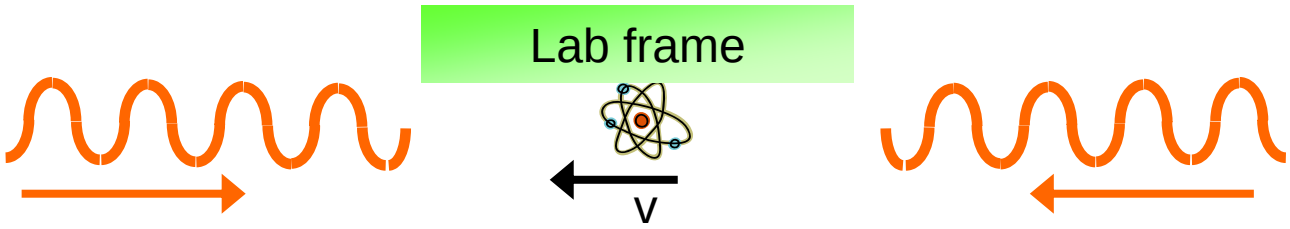
Figure A.2: Branching ratios for ^{87}Rb. Multiply by the circled number in the left(right) column to get the branching ration for the D2(D1) line.

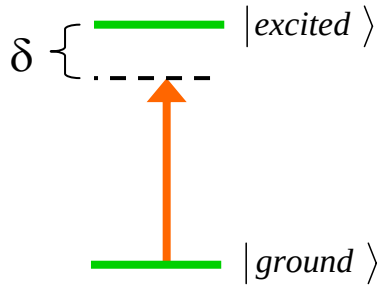
[source: unknown PhD Thesis]

Laser Cooling

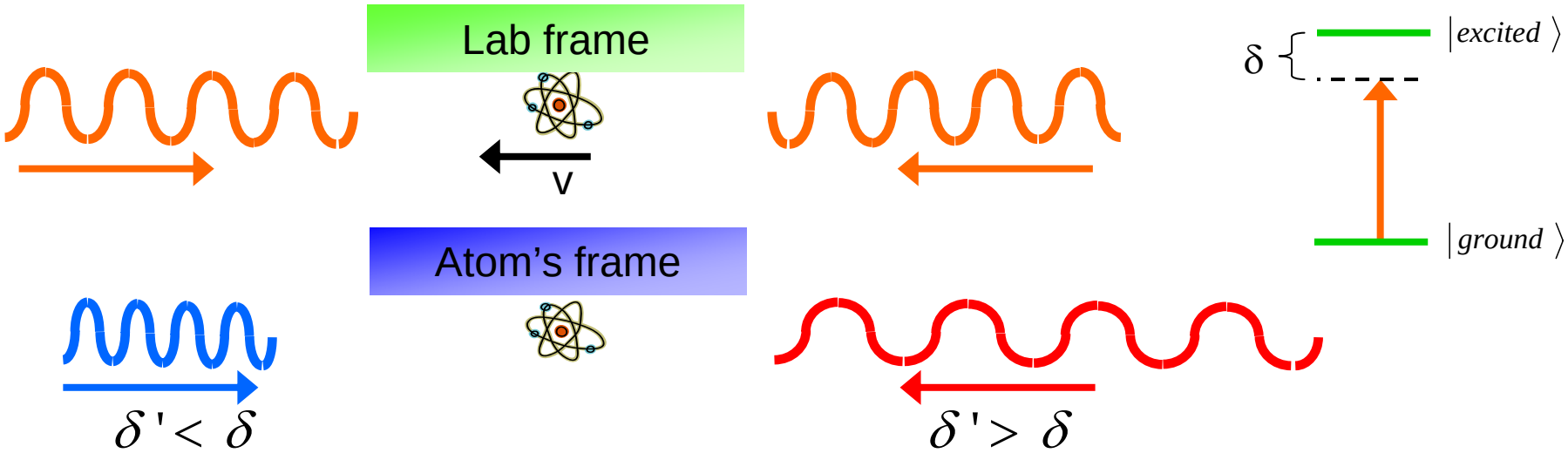
1. Doppler Cooling – optical molasses.
2. Doppler temperature.
3. Magneto-optical trap.

Doppler Cooling: How can a laser cool?

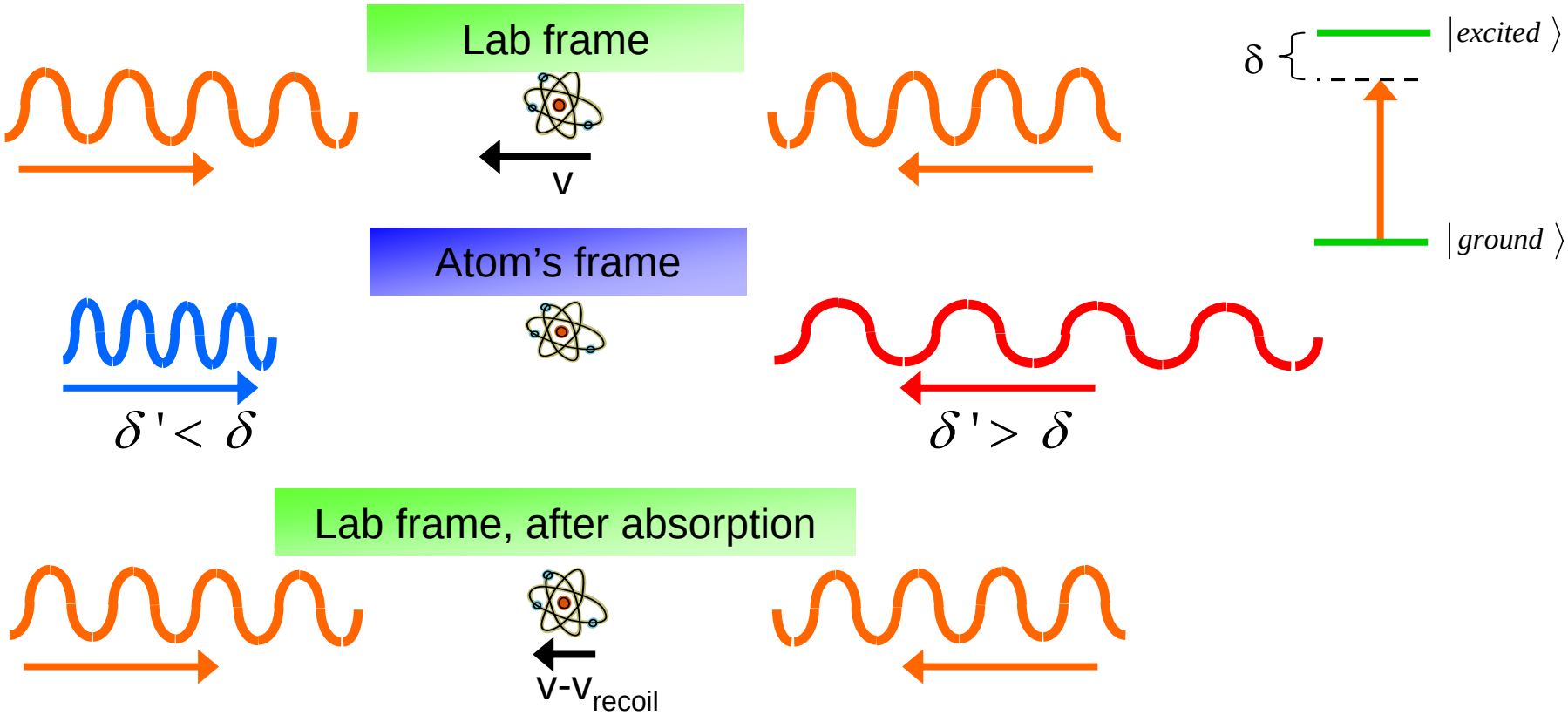




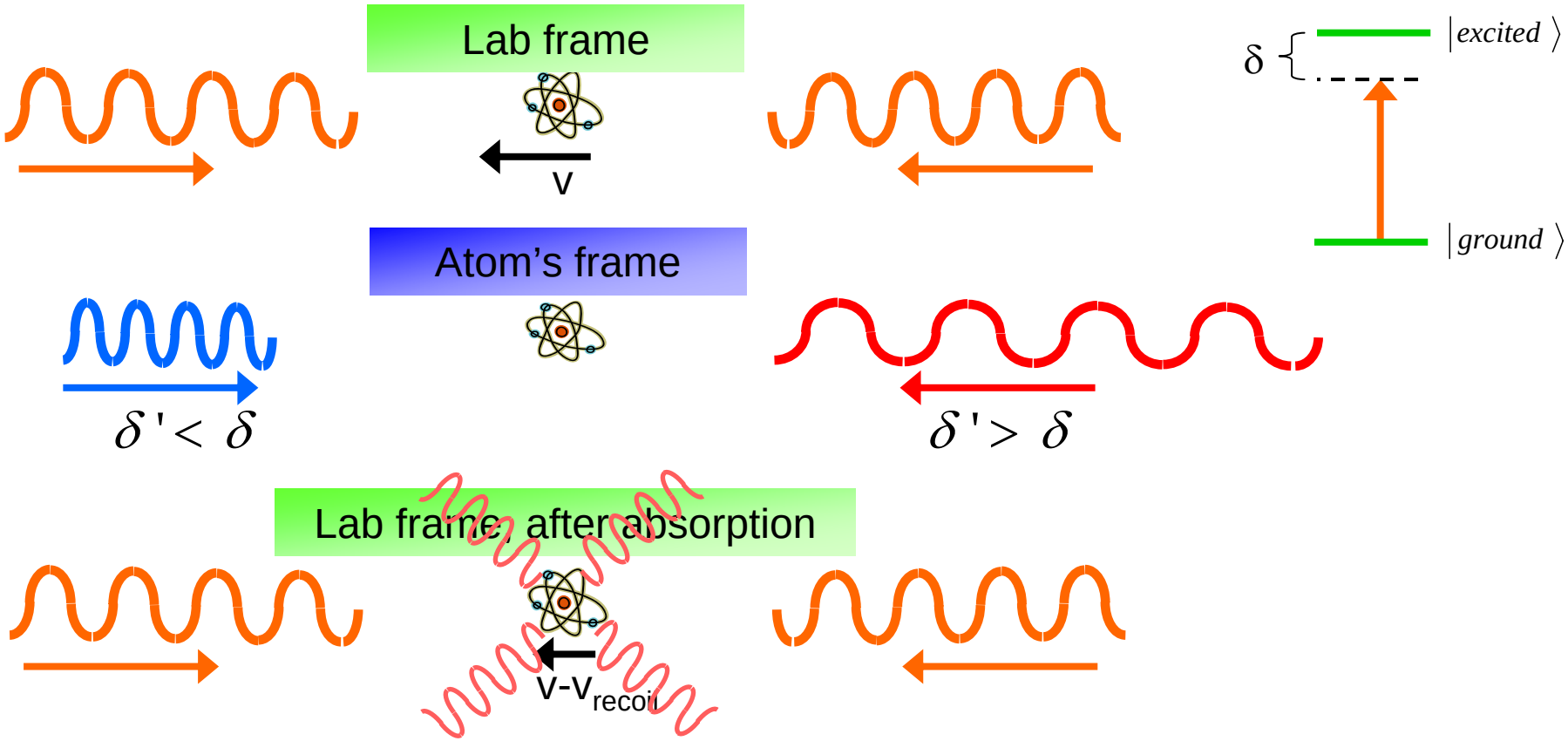
Doppler Cooling: How can a laser cool?



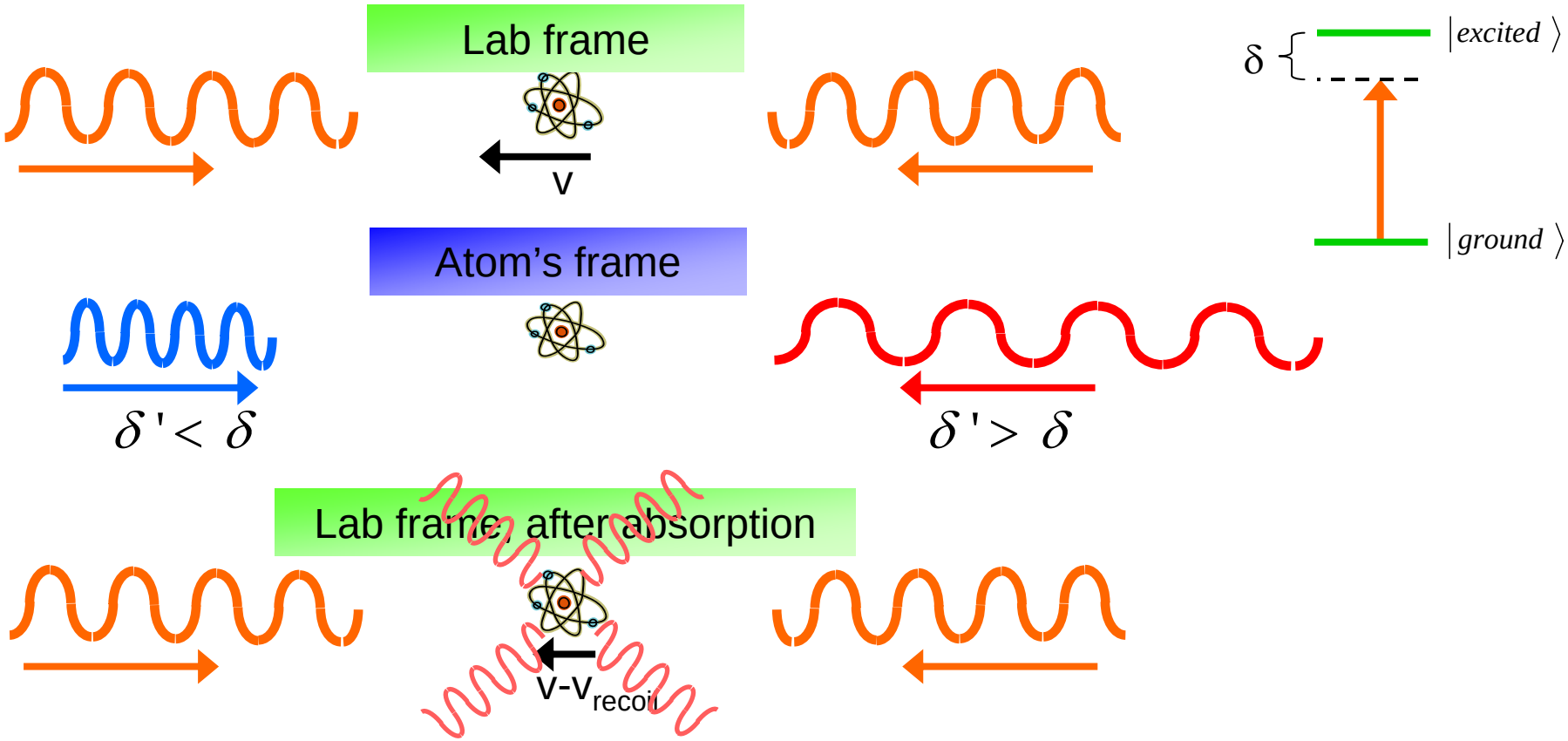
Doppler Cooling: How can a laser cool?



Doppler Cooling: How can a laser cool?

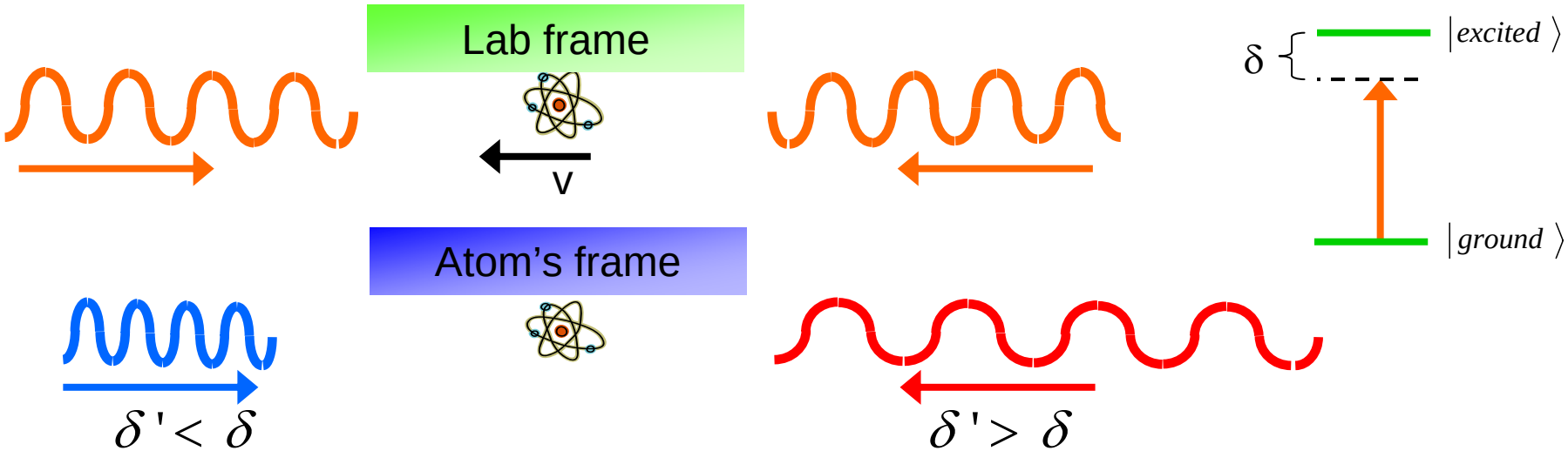


Doppler Cooling: How can a laser cool?

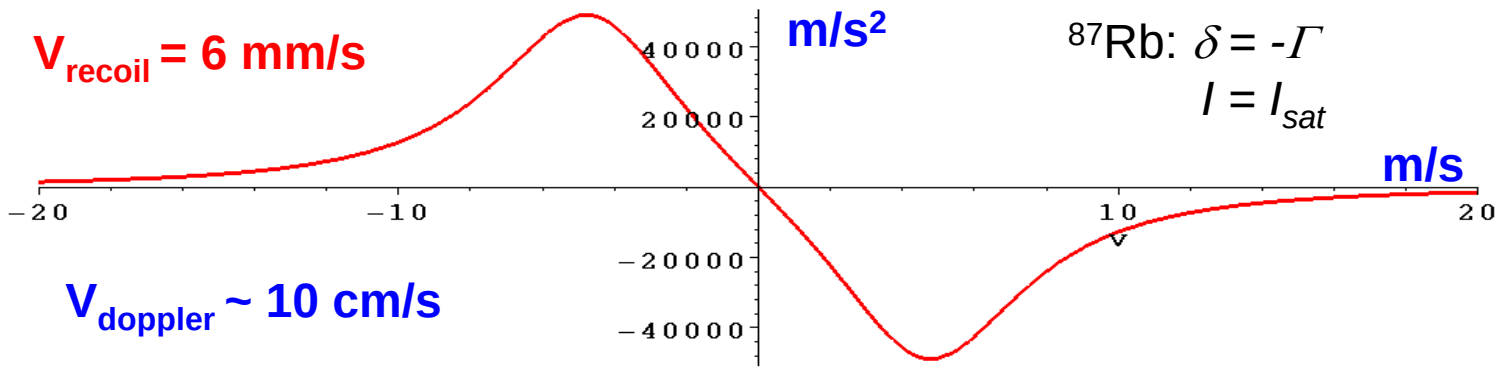


- Absorb a photon → atom gets $\hbar\vec{k}$ momentum kick.
- Repeat process at 10^7 kicks/s → large deceleration.
- Emitted photons are radiated symmetrically
  → do not affect motion on average

Doppler Cooling: How can a laser cool?



V_{recoil} = 6 mm/s



^{87}Rb: $\delta = -\Gamma$

$I = I_{sat}$

$V_{doppler}$ ~ 10 cm/s

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.

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.

Solution:

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