

The Nobel Prize in Physics 1997

"for development of methods to cool and trap atoms with laser light"



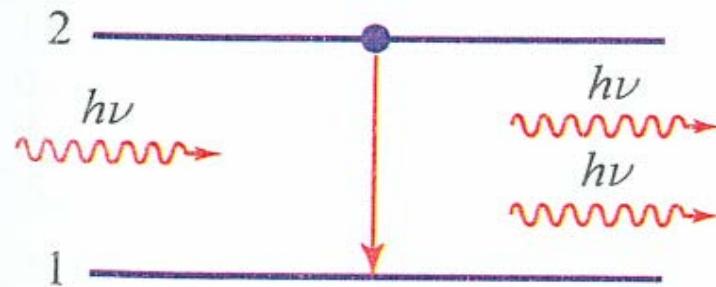
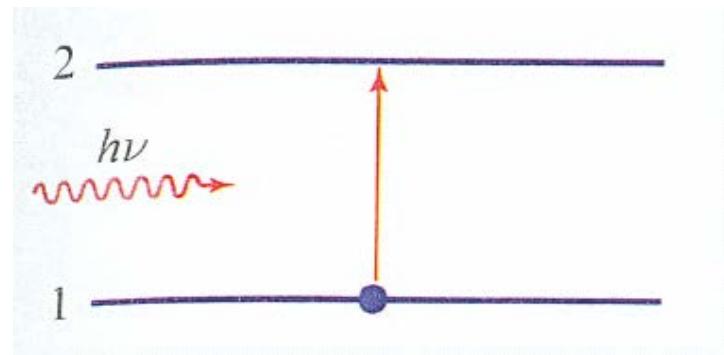
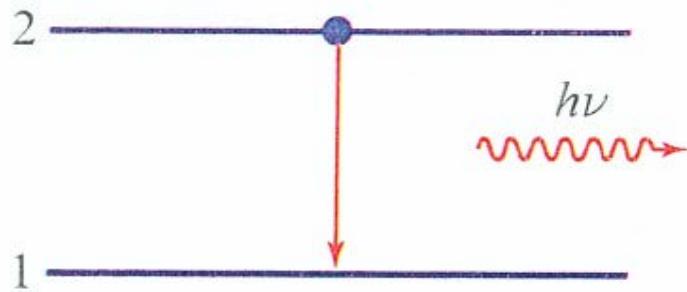
Steven Chu

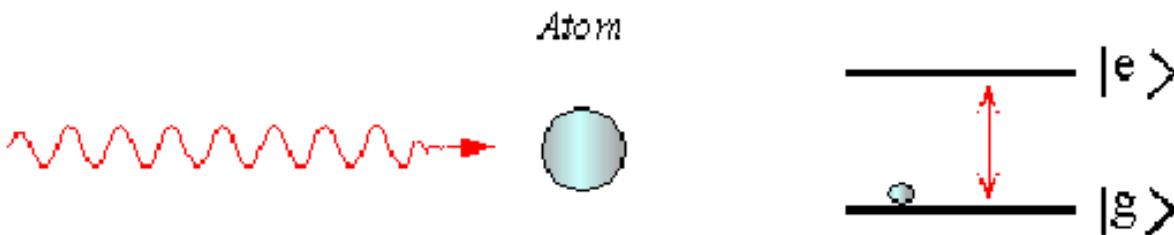


Claude Cohen-Tannoudji



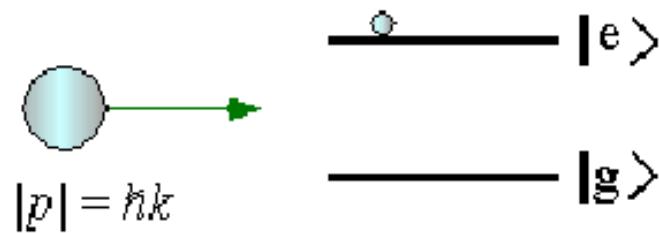
William D. Phillips





$$\vec{F}_{scatt} = \hbar \vec{k} \Gamma \rho_2$$

$$= \hbar \vec{k} \frac{\Gamma}{2} \frac{I / I_{sat}}{1 + I / I_{sat} + 4\delta^2 / \Gamma^2}$$



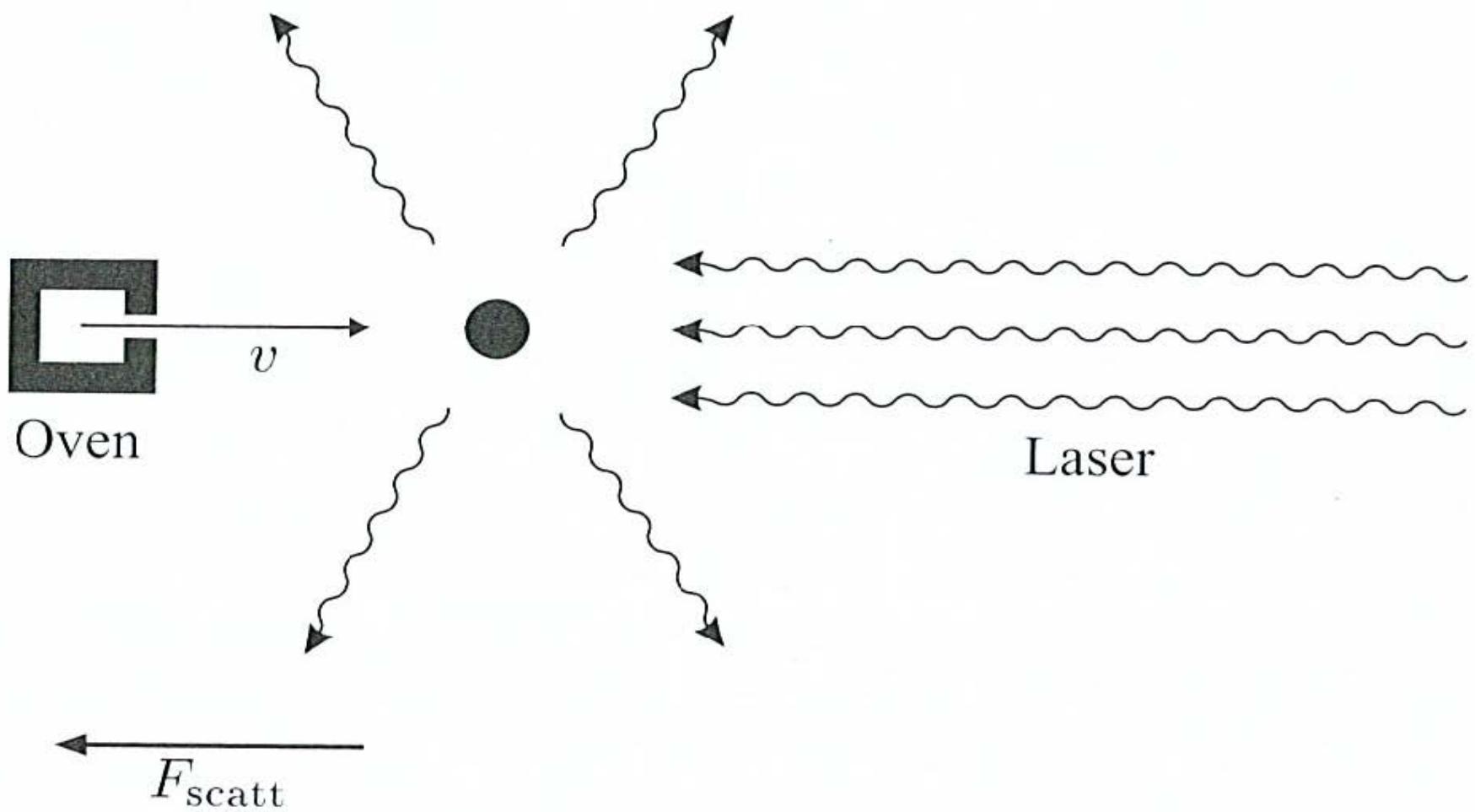
$$a_{\max} = \frac{h}{\lambda M 2\tau}$$

A light blue sphere representing an atom is shown with three green arrows pointing away from it in different directions, representing multiple scattering paths.

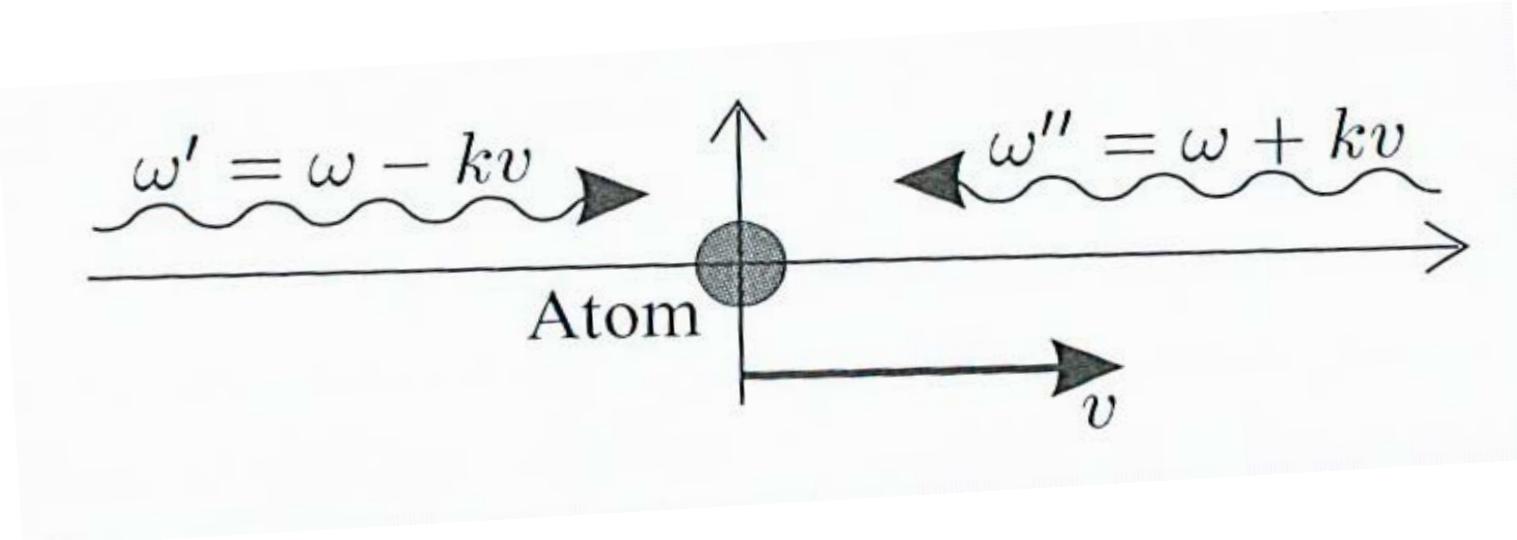
$|e\rangle$

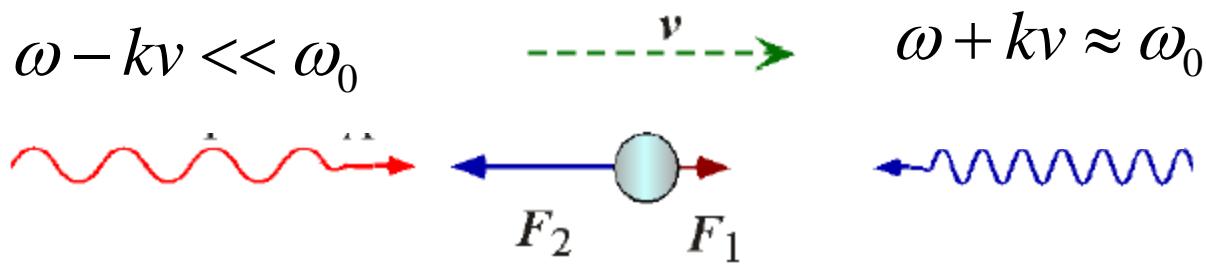
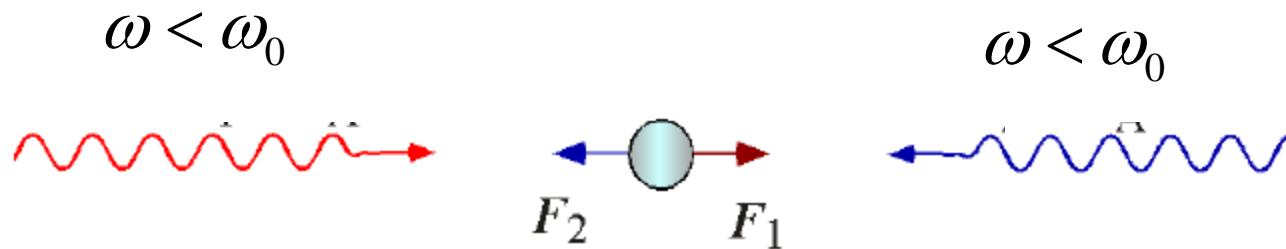
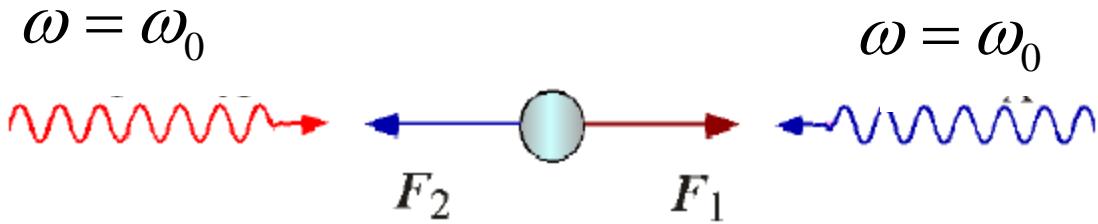
$|g\rangle$

A vertical energy level diagram showing two horizontal lines. The top line is labeled $|e\rangle$ and the bottom line is labeled $|g\rangle$.

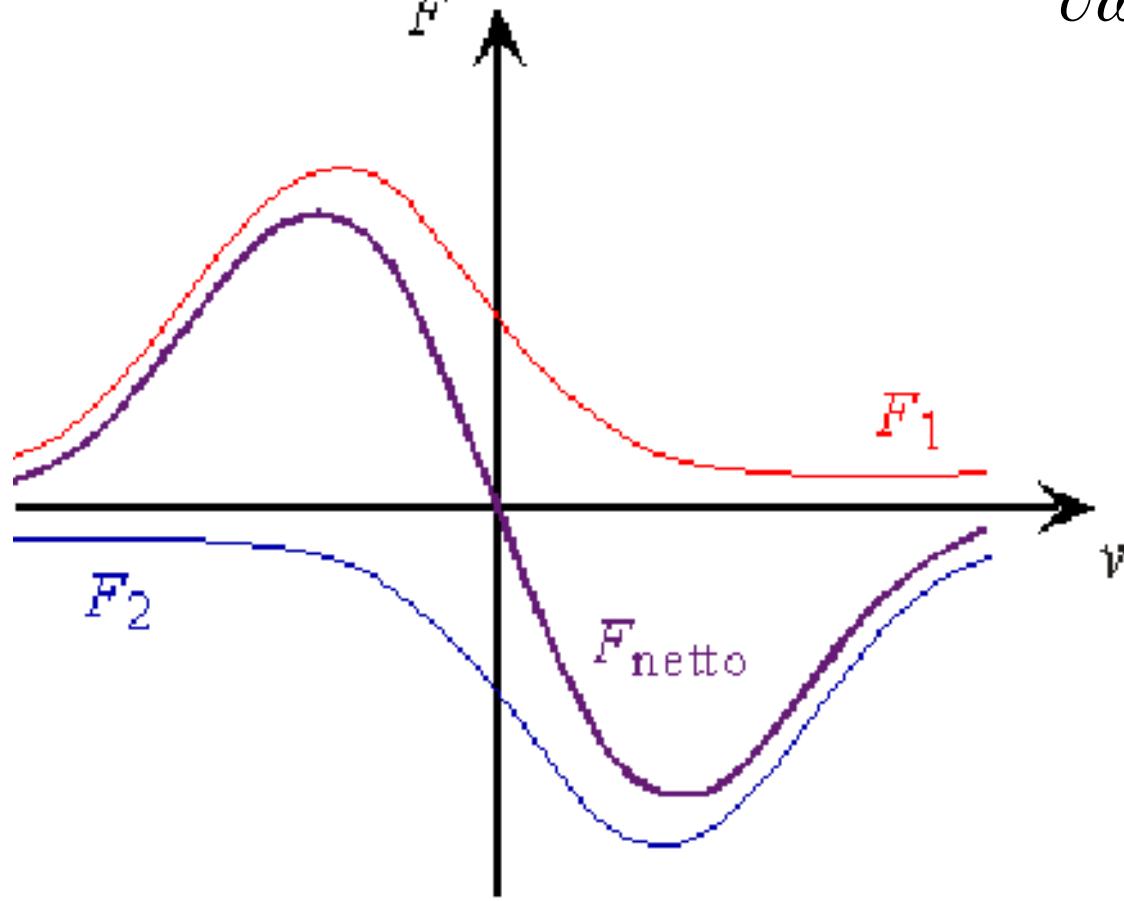


Doppler effect

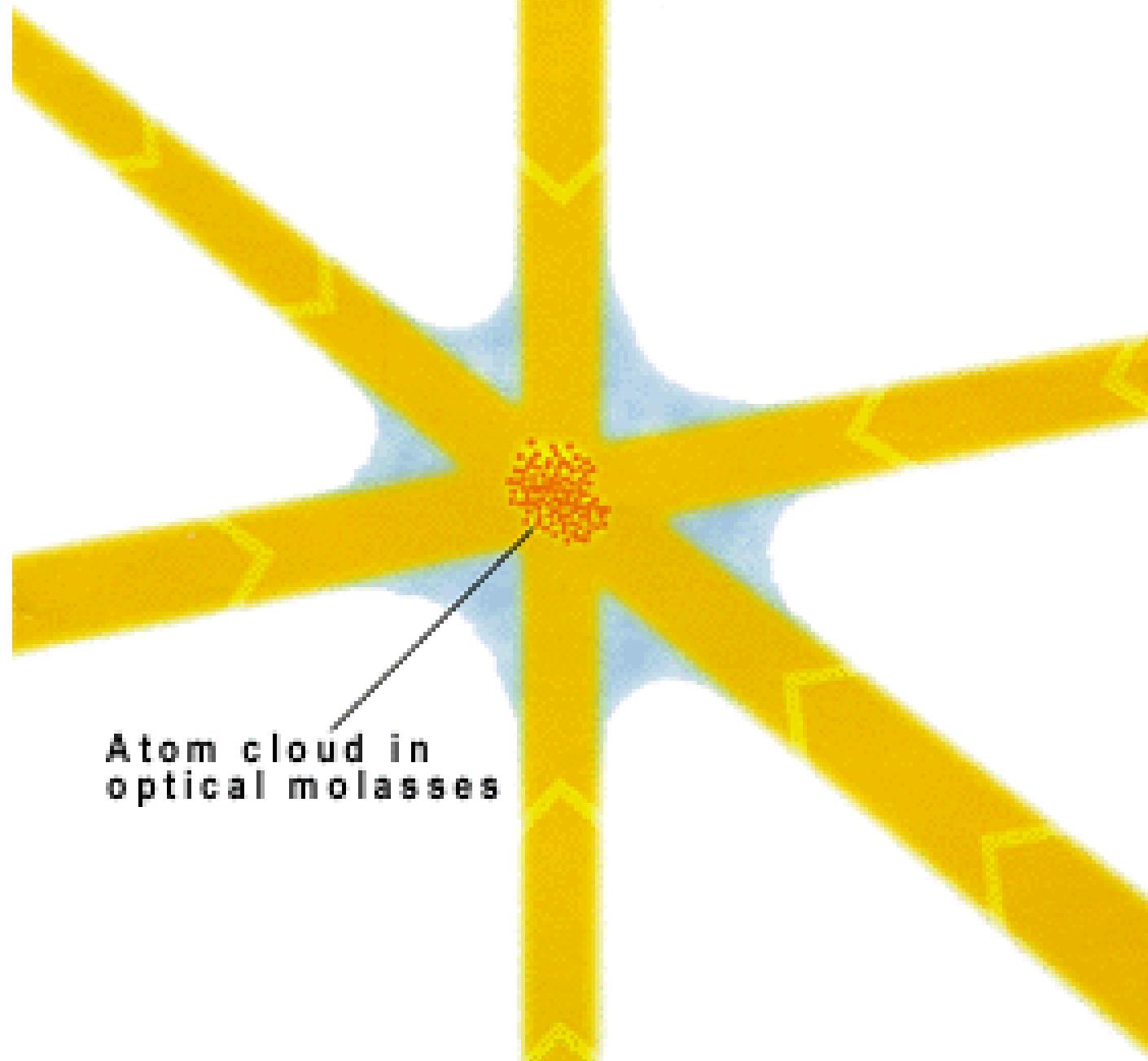




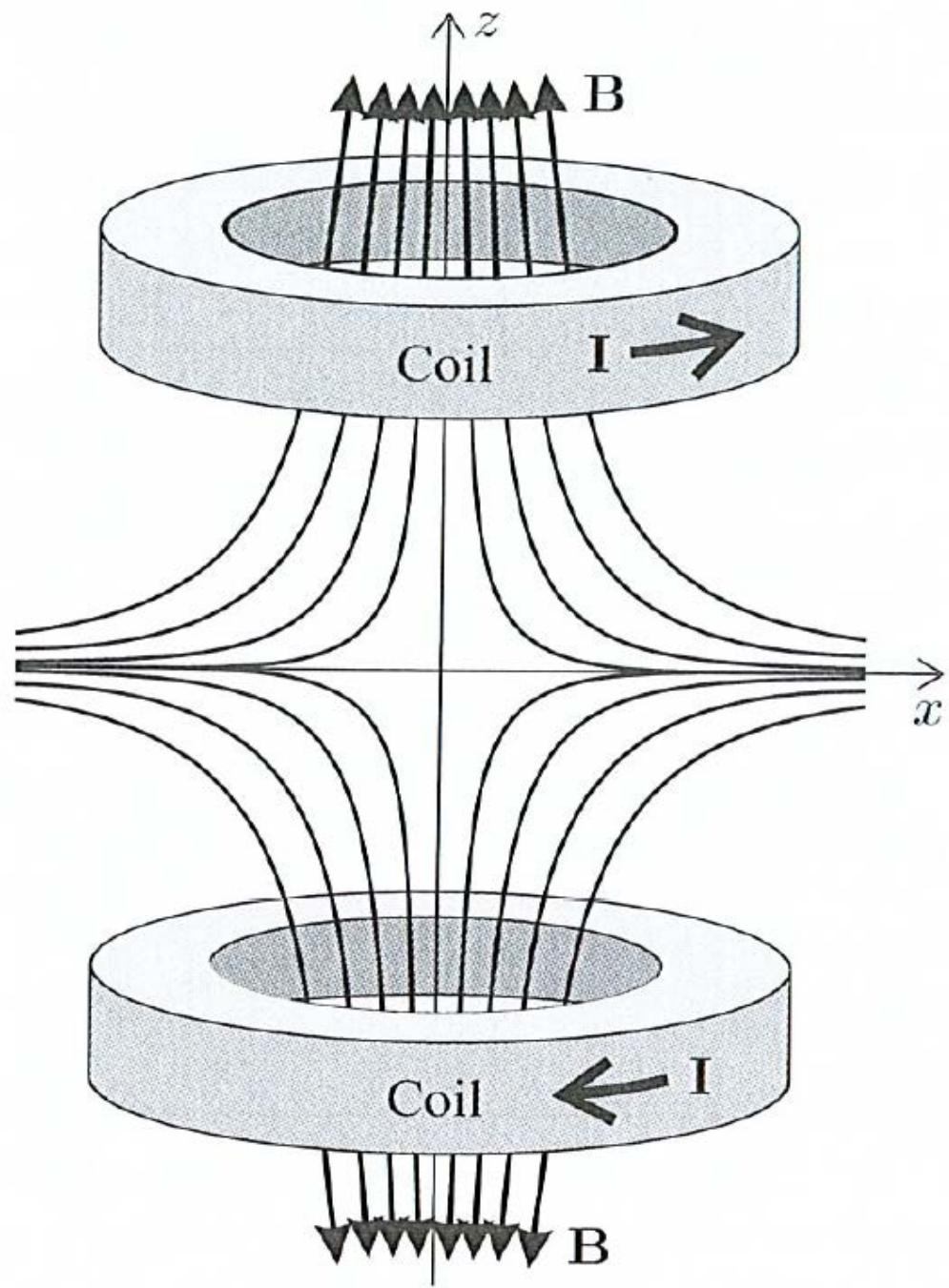
$$F_{molasses} = F_{scatt}(\omega - \omega_0 - kv) - F_{scatt}(\omega - \omega_0 + kv) \cong -2 \frac{\partial F_{scatt}}{\partial \omega} kv \cong -\alpha v$$



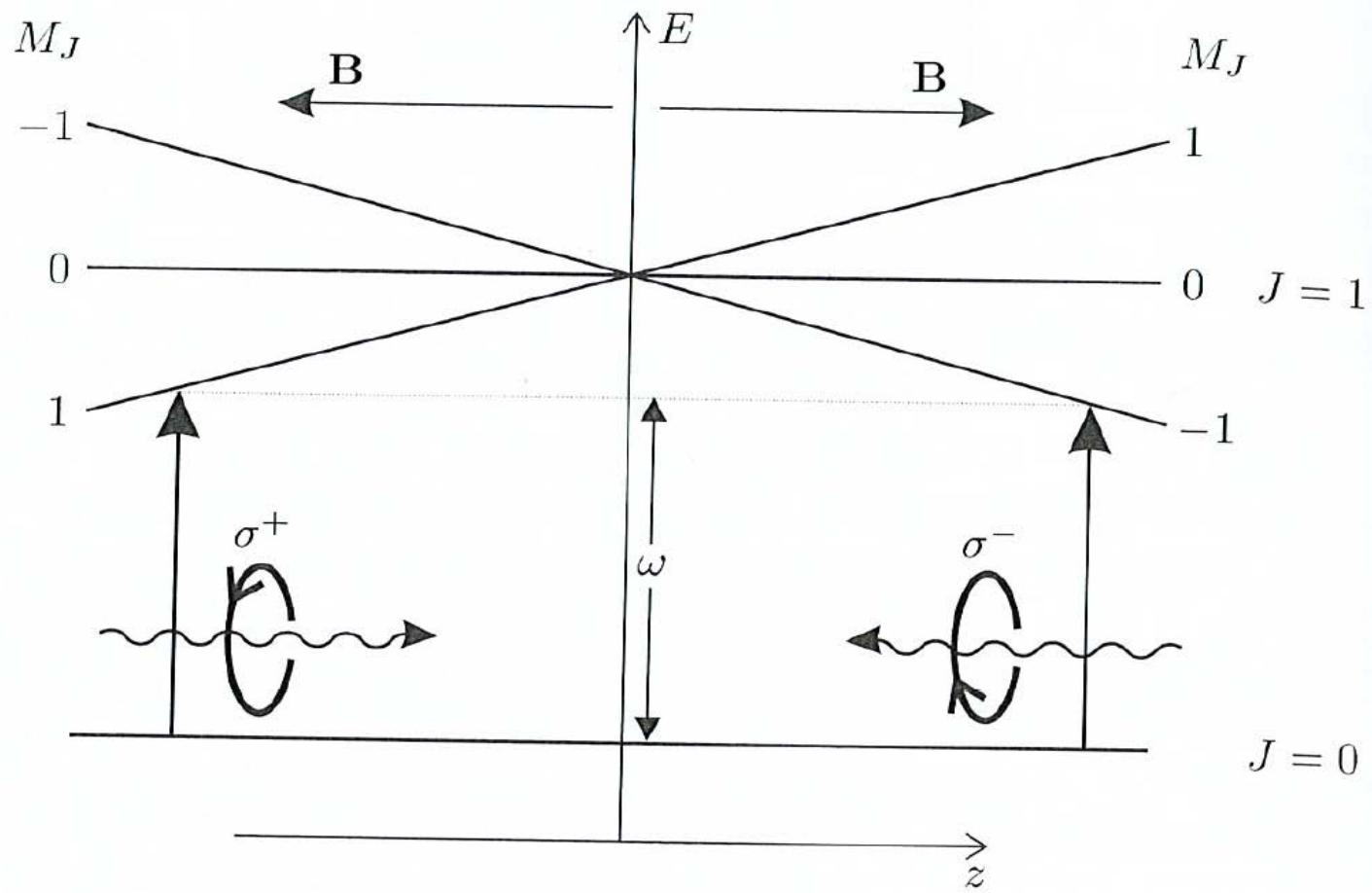
$$\alpha = 2k \frac{\partial F_{scatt}}{\partial \omega} = 4\hbar k^2 \frac{I}{I_{sat}} \frac{-2\delta/\Gamma}{[1 + 4\delta^2/\Gamma^2]^2}$$



Atom cloud in
optical molasses



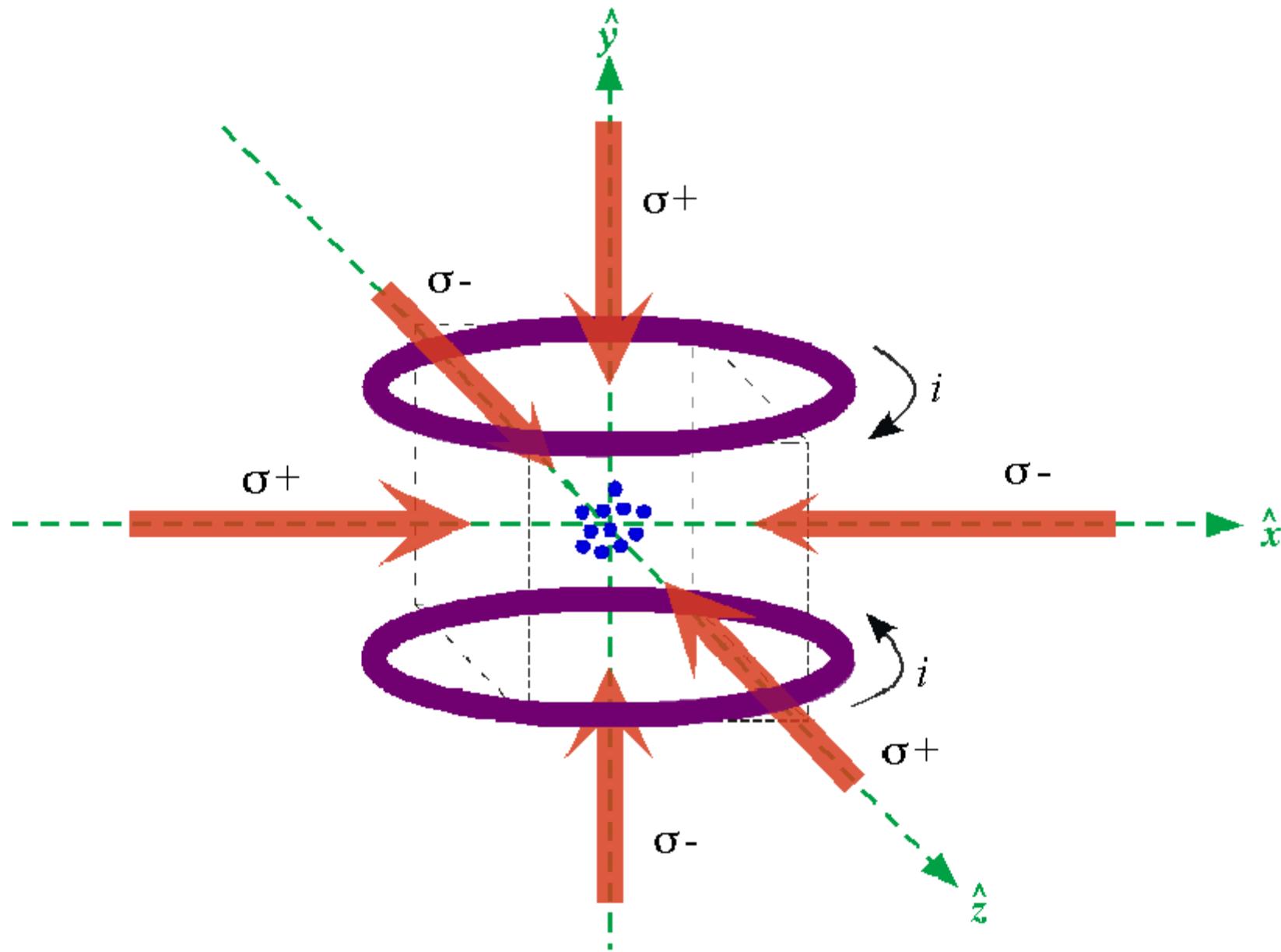
(a)



$$\beta = \frac{g_J \mu_B}{\hbar} \frac{dB}{dz}$$

$$F_{MOT} = F_{scatt}^{\sigma^+}(\omega - kv - (\omega_0 + \beta z)) - F_{scatt}^{\sigma^-}(\omega + kv - (\omega_0 - \beta z))$$

$$\cong -2(kv + \beta z) \frac{\partial F_{scatt}}{\partial \omega} \cong -\alpha v - \frac{\alpha \beta}{k} z$$



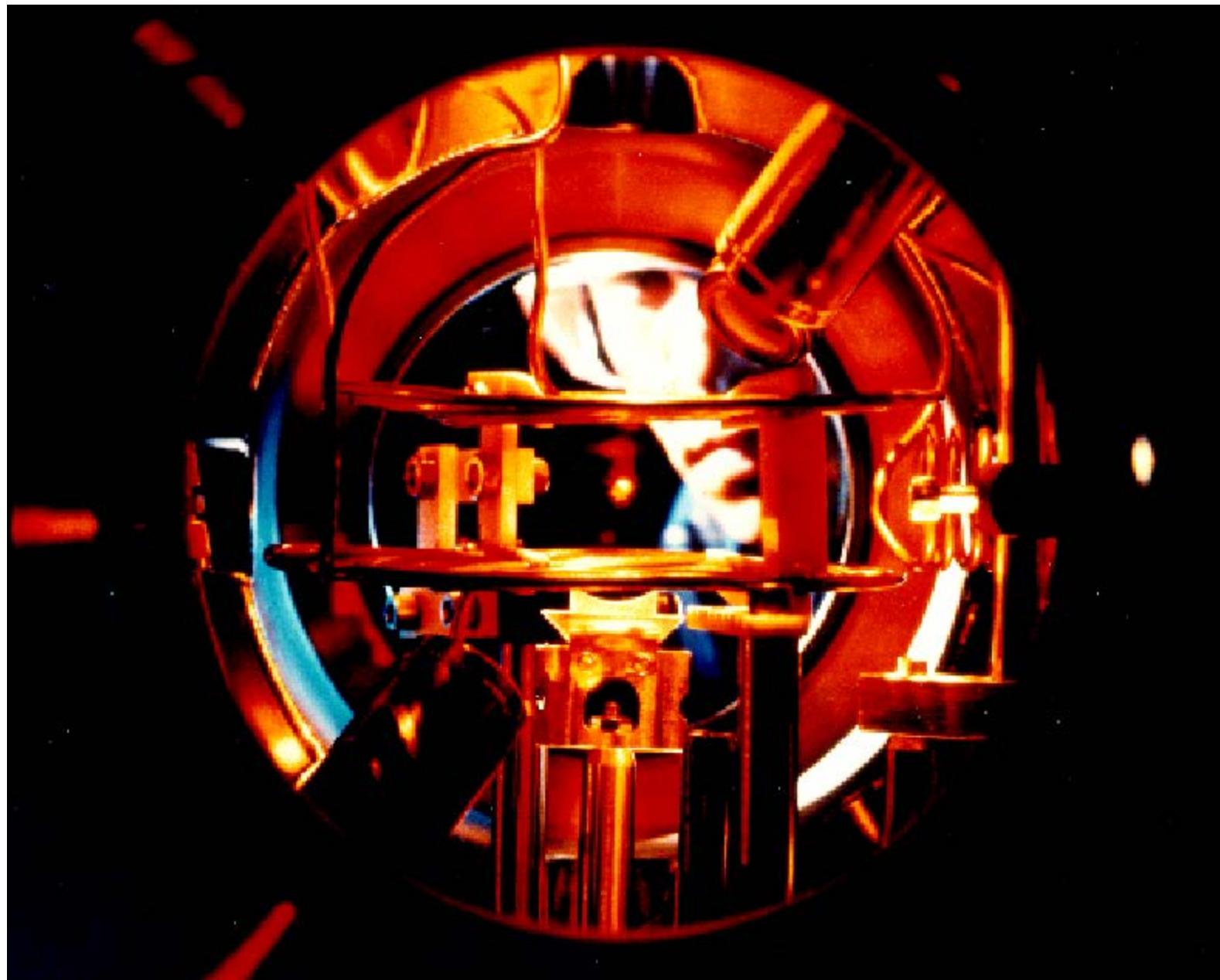


table 9.1 Properties of some elements used in laser cooling experiments.

Element	Atomic mass number	Wavelength of resonance (nm)	Lifetime of the excited state (ns)	Doppler temp. (μK)
H	1	121.6	1.5	2400
Li	7	671	27	140
Na	23	589	16	240
K	39	767	26	150
Rb	85, 87	780	27	140
Cs	133	852	31	123