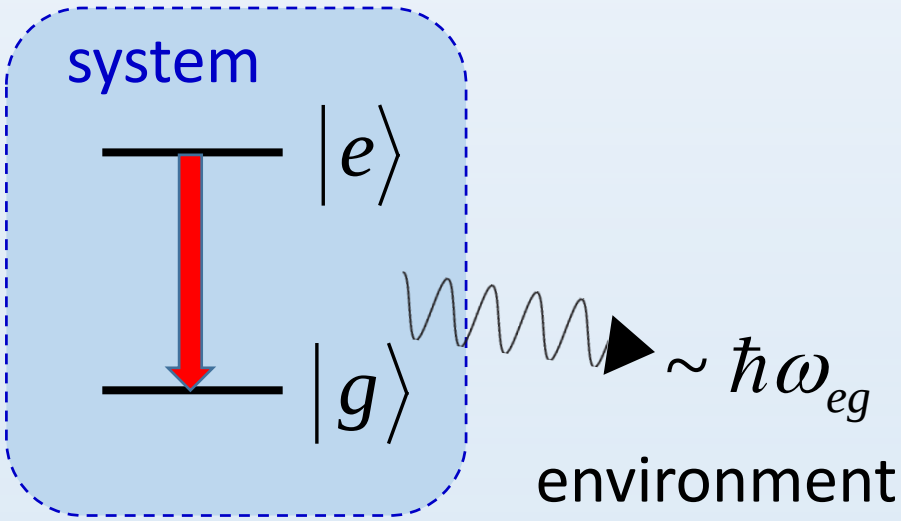
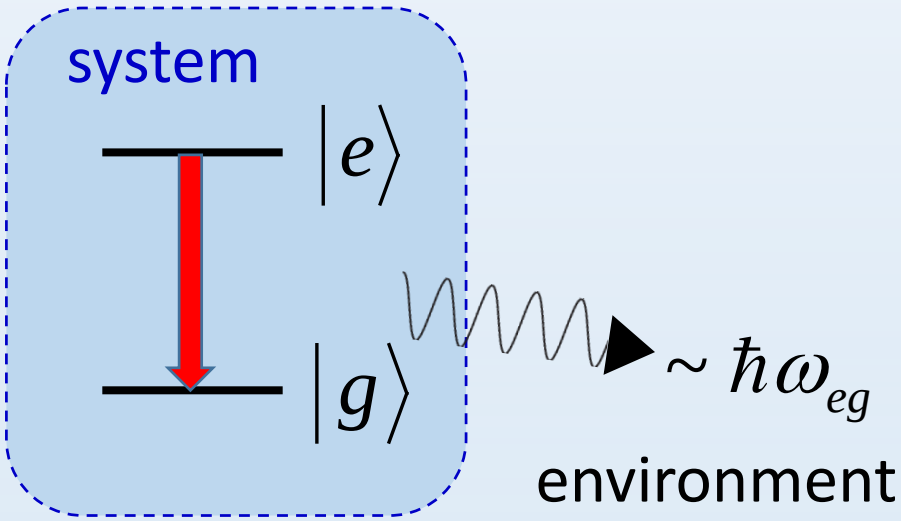
Spontaneous emission

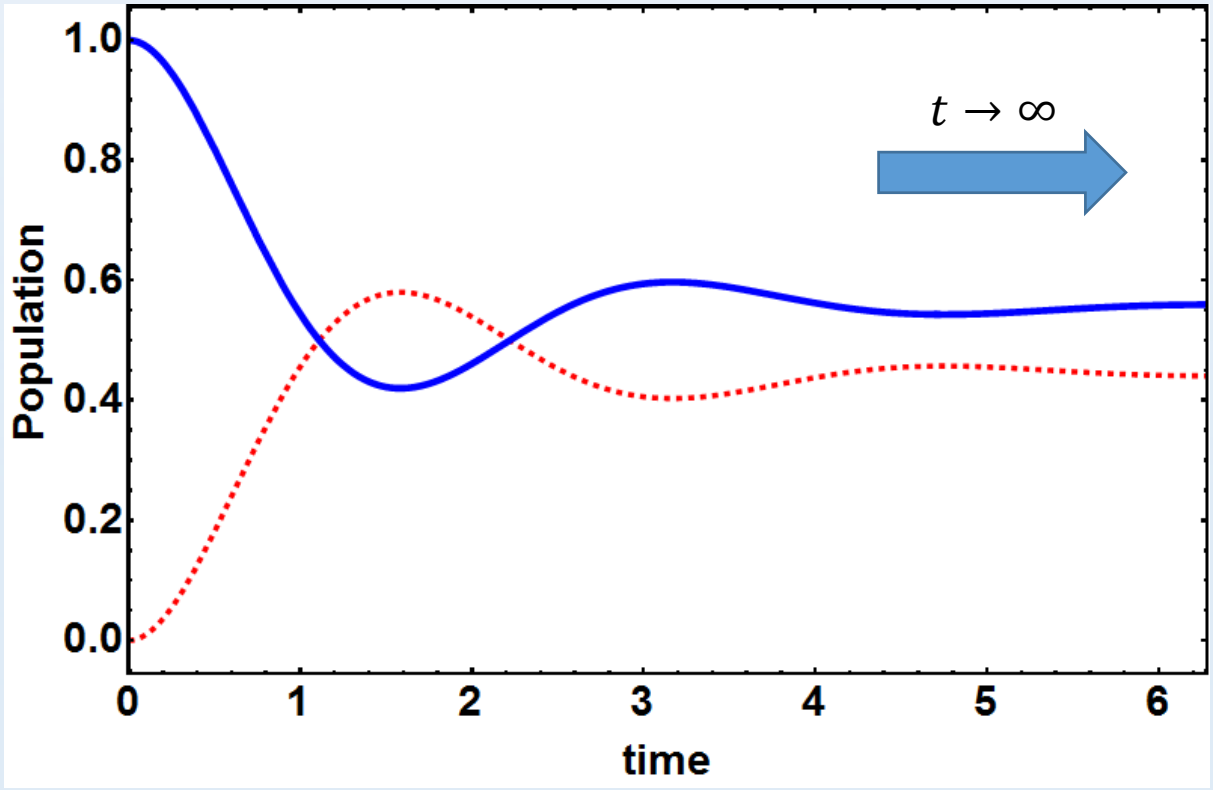


Spontaneous emission



$$|\psi\rangle = \sum_{\alpha,\beta} c_{\alpha\beta} |\alpha\rangle_{system} |\beta\rangle_{environment}$$

Optical Bloch equations – steady state solutions



$\Omega = 1$

$\Gamma = 1$

Dipole Matrix Elements – charts, tables, etc.

Table 10: ^{87}Rb D_2 ($5^2S_{1/2} \longrightarrow 5^2P_{3/2}$) Dipole Matrix Elements for π transitions ($F = 2, m_F \longrightarrow F', m'_F = m_F$), expressed as multiples of $\langle J = 1/2||er||J' = 3/2\rangle$.

	$m_F = -2$	$m_F = -1$	$m_F = 0$	$m_F = 1$	$m_F = 2$
$F' = 3$	$-\sqrt{\frac{1}{6}}$	$-\sqrt{\frac{4}{15}}$	$-\sqrt{\frac{3}{10}}$	$-\sqrt{\frac{4}{15}}$	$-\sqrt{\frac{1}{6}}$
$F' = 2$	$-\sqrt{\frac{1}{6}}$	$-\sqrt{\frac{1}{24}}$	0	$\sqrt{\frac{1}{24}}$	$\sqrt{\frac{1}{6}}$
$F' = 1$		$\sqrt{\frac{1}{40}}$	$\sqrt{\frac{1}{30}}$	$\sqrt{\frac{1}{40}}$	

$$\Delta F = 0$$
$$\Delta m_F = 0$$

Table 11: ^{87}Rb D_2 ($5^2S_{1/2} \longrightarrow 5^2P_{3/2}$) Dipole Matrix Elements for σ^- transitions ($F = 2, m_F \longrightarrow F', m'_F = m_F - 1$), expressed as multiples of $\langle J = 1/2||er||J' = 3/2\rangle$.

	$m_F = -2$	$m_F = -1$	$m_F = 0$	$m_F = 1$	$m_F = 2$
$F' = 3$	$\sqrt{\frac{1}{2}}$	$\sqrt{\frac{1}{3}}$	$\sqrt{\frac{1}{5}}$	$\sqrt{\frac{1}{10}}$	$\sqrt{\frac{1}{30}}$
$F' = 2$		$-\sqrt{\frac{1}{12}}$	$-\sqrt{\frac{1}{8}}$	$-\sqrt{\frac{1}{8}}$	$-\sqrt{\frac{1}{12}}$
$F' = 1$			$\sqrt{\frac{1}{120}}$	$\sqrt{\frac{1}{40}}$	$\sqrt{\frac{1}{20}}$

Dipole Matrix Elements – charts, tables, etc.

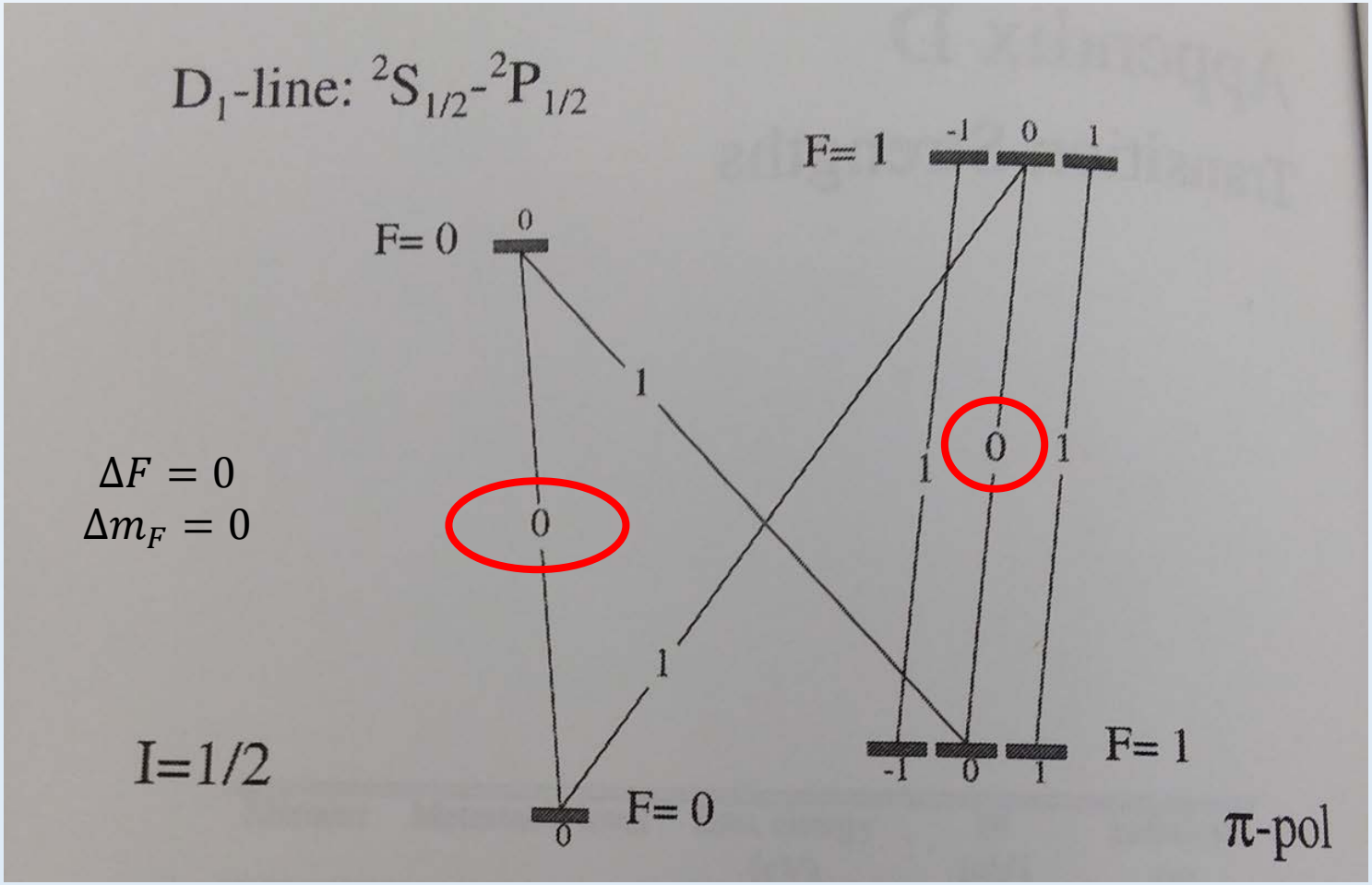
Table 7: ^{87}Rb Dipole Matrix Elements, Saturation Intensities, and Resonant Scattering Cross Sections.

$D_2(5^2S_{1/2} \longrightarrow 5^2P_{3/2})$ Transition Dipole Matrix Element	$\langle J = 1/2 \| er \| J' = 3/2 \rangle$	$4.227(5)\ ea_0$ $3.584(4) \times 10^{-29}$ C·m
Effective Dipole Moment, Saturation Intensity, and Resonant Cross Section ($F = 2 \rightarrow F' = 3$) (isotropic light polarization)	$d_{\mathrm{iso,eff}}(F = 2 \rightarrow F' = 3)$	$2.042(2)\ ea_0$ $1.731(2) \times 10^{-29}$ C·m
	$I_{\mathrm{sat(iso,eff)}}(F = 2 \rightarrow F' = 3)$	$3.576(4)$ mW/cm^2
	$\sigma_{0\mathrm{(iso,eff)}}(F = 2 \rightarrow F' = 3)$	1.356×10^{-9} cm^2
Effective Far-Detuned Dipole Moment, Saturation Intensity, and Resonant Cross Section (D_2 line, π-polarized light)	$d_{\mathrm{det,eff,D_2}}$	$2.441(3)\ ea_0$ $2.069(2) \times 10^{-29}$ C·m
	$I_{\mathrm{sat(det,eff,D_2)}}$	$2.503(3)$ mW/cm^2
	$\sigma_{0\mathrm{(det,eff,D_2)}}$	1.938×10^{-9} cm^2
Dipole Moment, Saturation Intensity, and Resonant Cross Section $\lvert F = 2, m_F = \pm 2 \rangle \rightarrow \lvert F' = 3, m'_F = \pm 3 \rangle$ cycling transition ($\sigma^{\pm}$-polarized light)	$d_{(m_F = \pm 2 \rightarrow m'_F = \pm 3)}$	$2.989(3)\ ea_0$ $2.534(3) \times 10^{-29}$ C·m
	$I_{\mathrm{sat}(m_F = \pm 2 \rightarrow m'_F = \pm 3)}$	$1.669(2)$ mW/cm^2
	$\sigma_{0(m_F = \pm 2 \rightarrow m'_F = \pm 3)}$	2.907×10^{-9} cm^2
$D_1(5^2S_{1/2} \longrightarrow 5^2P_{1/2})$ Transition Dipole Matrix Element	$\langle J = 1/2 \| er \| J' = 1/2 \rangle$	$2.992(3)\ ea_0$ $2.537(3) \times 10^{-29}$ C·m
Effective Far-Detuned Dipole Moment, Saturation Intensity, and Resonant Cross Section (D_1 line, π-polarized light)	$d_{\mathrm{det,eff,D_1}}$	$1.727(2)\ ea_0$ $1.4646(15) \times 10^{-29}$ C·m
	$I_{\mathrm{sat(det,eff,D_1)}}$	$4.484(5)$ mW/cm^2
	$\sigma_{0\mathrm{(det,eff,D_1)}}$	1.082×10^{-9} cm^2

$\times \sqrt{2}$

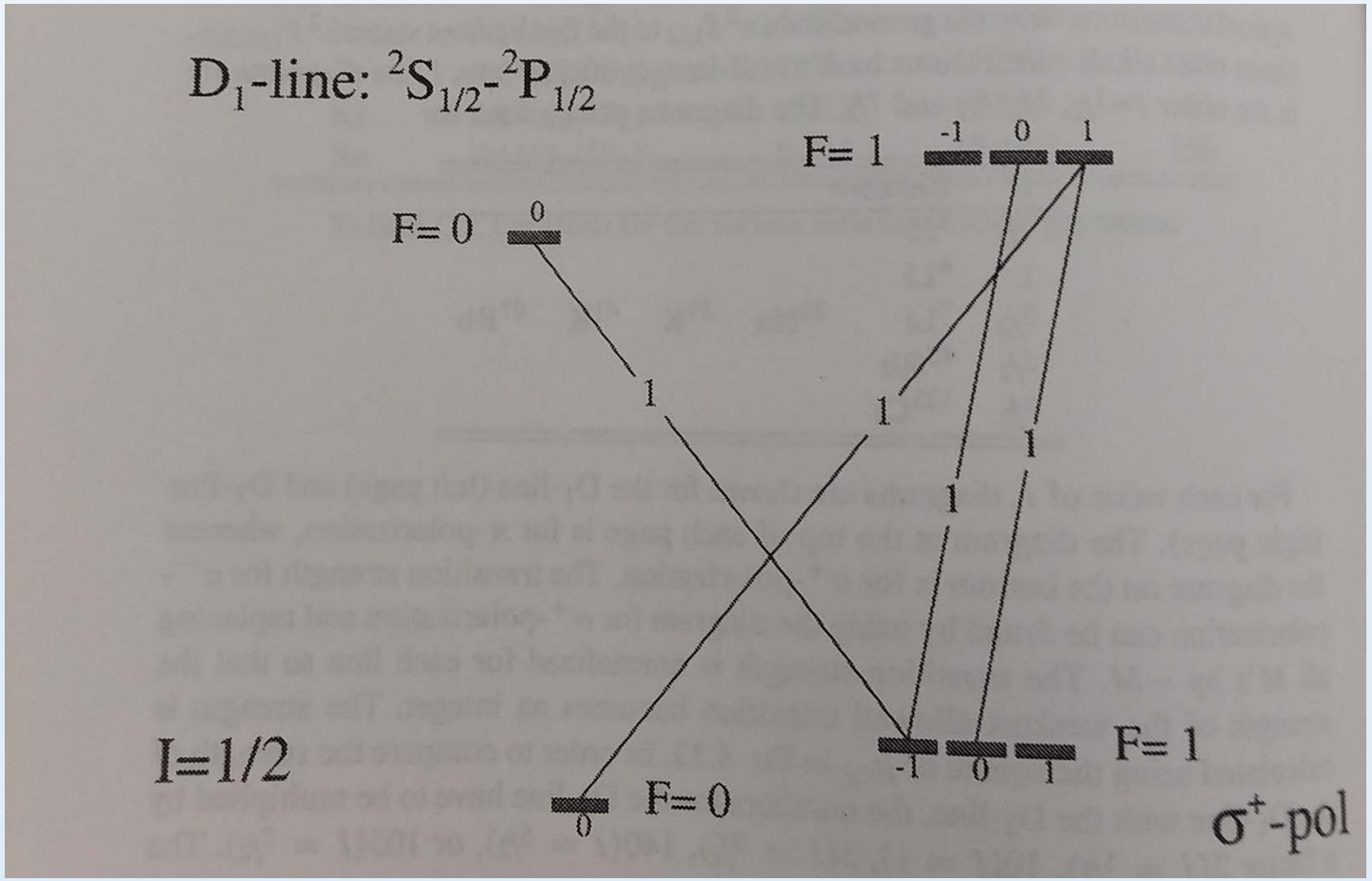
$\times 1$

Dipole Matrix Elements – charts, tables, etc.



Metcalf & van der Straten, Laser Cooling and Trapping

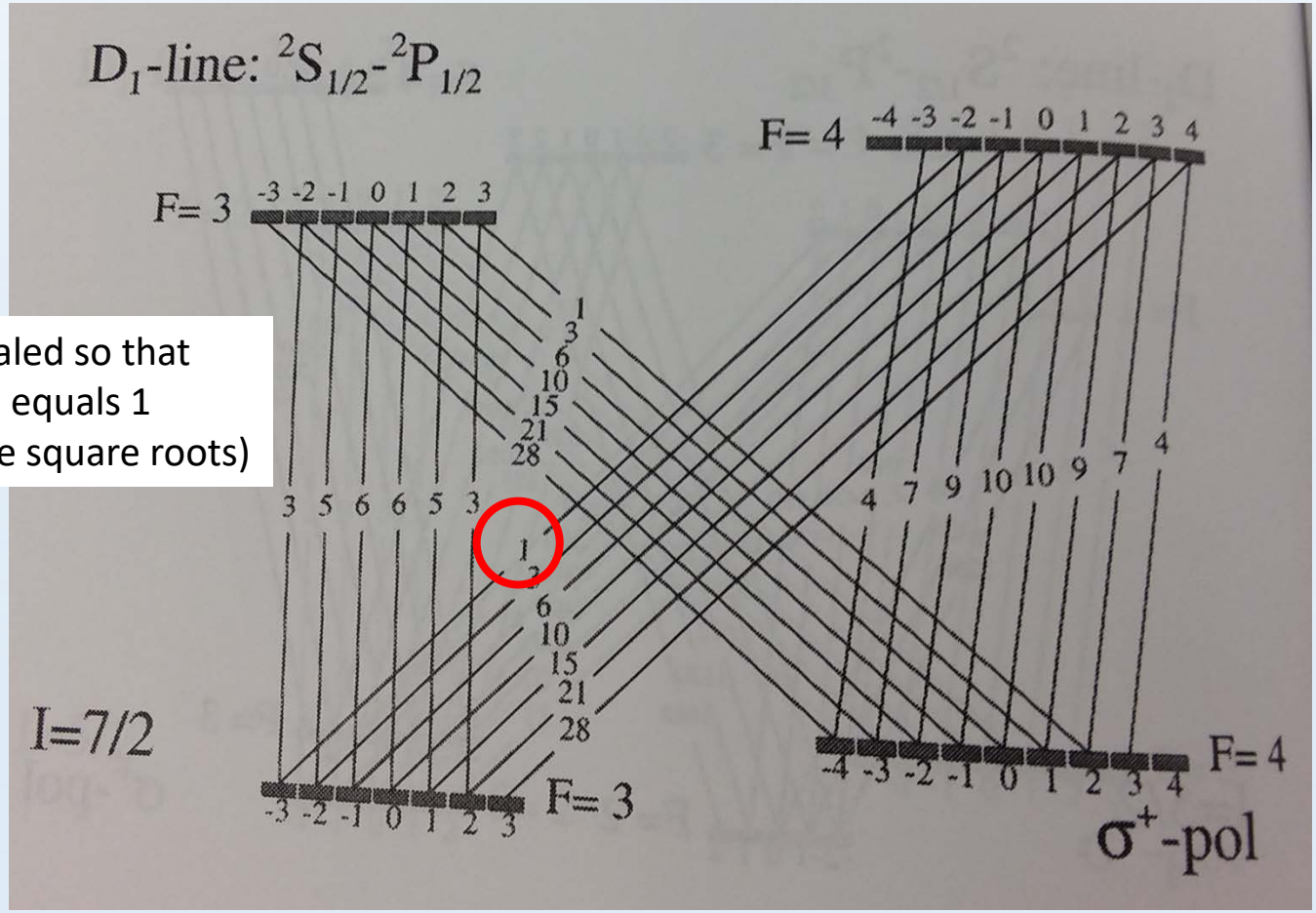
Dipole Matrix Elements – charts, tables, etc.



Metcalf & van der Straten, Laser Cooling and Trapping

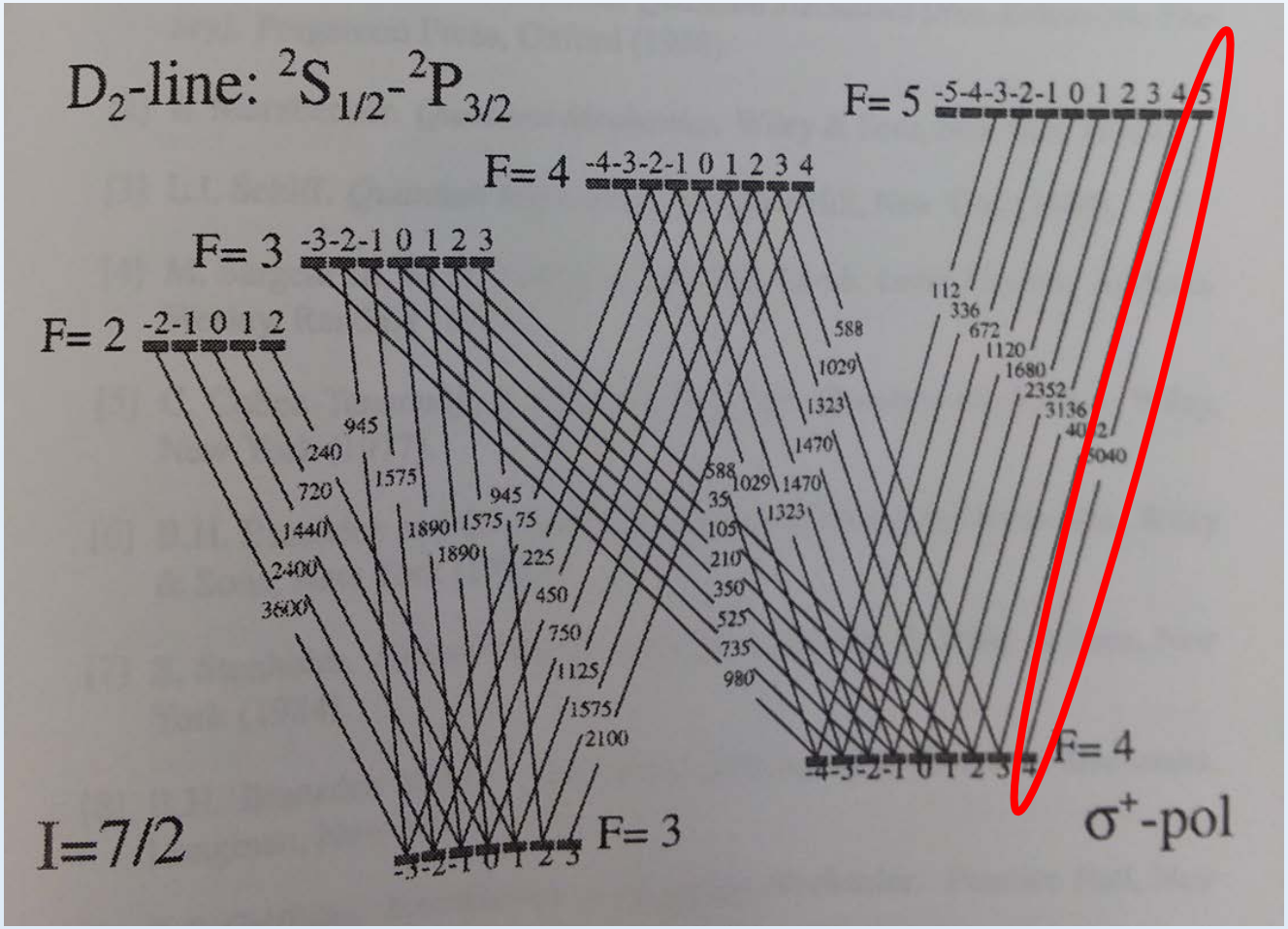
Dipole Matrix Elements – charts, tables, etc.

strengths scaled so that weakest line equals 1 (need to take square roots)



Metcalf & van der Straten, Laser Cooling and Trapping

Dipole Matrix Elements – charts, tables, etc.



Effective
"2-level atom"

Metcalf & van der Straten, Laser Cooling and Trapping