# Single-Particle Transition (Weisskopf Estimate)

For an electric single-particle transition we assume excitation of only one proton in an average central potential that changes its orbit from $j_i$ to $j_f$. A magnetic transition takes place when the intrinsic spin is flipped, i.e., $j_i = \ell_i \pm 1/2 \rightarrow j_f = \ell_f \mp 1/2$, respectively. For a magnetic transition the multipolarity $\lambda$ is given by $|j_i - j_f| = \lambda$ and $|\ell_i - \ell_f| = \lambda - 1$.

A useful scale of $B(E\lambda)$- and $B(M\lambda)$-values are the Weisskopf units which allow a rough estimate of the number of nucleons contributing to radiation. For a transition from an excited state $I_i$ to the ground state $I_{gs}$ we find in the electric (E$\lambda$) and magnetic (M$\lambda$) case

$$B(E\lambda; I_i \rightarrow I_{gs}) = \frac{(1.2)^{2\lambda}}{4\pi}(\frac{3}{\lambda+3})^2 A^{2\lambda/3} \quad e^2(fm)^{2\lambda} \tag{1}$$

$$B(M\lambda; I_i \rightarrow I_{gs}) = \frac{10}{\pi}(1.2)^{2\lambda-2}(\frac{3}{\lambda+3})^2 A^{(2\lambda-2)/3} \quad \mu_N^2(fm)^{2\lambda-2} \tag{2}$$

For the first few values of $\lambda$, the Weisskopf estimates are

$$B(E1; I_i \rightarrow I_{gs}) = 6.446\ 10^{-4}\ A^{2/3} \quad e^2(barn) \tag{3}$$

$$B(E2; I_i \rightarrow I_{gs}) = 5.940\ 10^{-6}\ A^{4/3} \quad e^2(barn)^2 \tag{4}$$

$$B(E3; I_i \rightarrow I_{gs}) = 5.940\ 10^{-8}\ A^{2} \quad e^2(barn)^3 \tag{5}$$

$$B(E4; I_i \rightarrow I_{gs}) = 6.285\ 10^{-10}\ A^{8/3} \quad e^2(barn)^4 \tag{6}$$

$$B(M1; I_i \rightarrow I_{gs}) = 1.790 \quad (\frac{e\hbar}{2Mc})^2 \tag{7}$$