9.9: Summary of Relations Between f, A and S

In this section I use ϖf to mean either $\varpi_1 f_{12}$ or $\varpi_2 f_{21}$, since these are equal; likewise I use ϖB to mean either $\varpi_1 B_{12}$ or $\varpi_2 B_{21}$. The Einstein A coefficient is used exclusively in connection with emission spectroscopy. The B coefficient is defined here in terms of radiation energy density per unit wavelength interval; that is, it is the B^a of section 9.4. The relations between the possible definitions of B are given in equations 9.4.1-4.

The following relations for electric dipole radiation may be useful. In these, ε_0 is the "rationalized" definition of free space permittivity, and the formulas are suitable for use with SI units.

$$\varpi_2 A_{21} = \frac{8\pi hc}{\lambda^5}\varpi B = \frac{2\pi e^2}{\varepsilon_0 mc\lambda^2}\varpi f = \frac{16\pi^3}{3h\varepsilon_0\lambda^3}S; \tag{9.9.1}$$

$$\varpi B = \frac{e^2\lambda^3}{4h\varepsilon_0 mc^2}\varpi f = \frac{2\pi^2\lambda^2}{3h^2\varepsilon_0 c}S = \frac{\lambda^5}{8\pi hc}\varpi_2 A_{21}; \tag{9.9.2}$$

$$\varpi f = \frac{8\pi^2 mc}{3he^2\lambda}S = \frac{\varepsilon_0 mc\lambda^2}{2\pi e^2}\varpi_2 A_{21} = \frac{4h\varepsilon_0 mc^2}{e^2\lambda^3}\varpi B; \tag{9.9.3}$$

$$S = \frac{3h\varepsilon_0\lambda^3}{16\pi^3}\varpi_2 A_{21} = \frac{3h^2\varepsilon_0 c}{2\pi^2\lambda^2}\varpi B = \frac{3he^2\lambda}{8\pi^2 mc}\varpi f. \tag{9.9.4}$$

For electric quadrupole radiation:

$$\varpi_2 A_{21} = \frac{8\pi^5}{5\varepsilon_0 h\lambda^5}S. \tag{9.9.5}$$

For magnetic dipole radiation:

$$\varpi_2 A_{21} = \frac{16\pi^3\mu_0}{3h\lambda^3}S, \tag{9.9.6}$$

in which μ_0 is the free space permeability.