Central equations in the tissue optics course

The Henyey-Greenstein phase function:

\[ p(\Omega') = p(\cos \theta) = \frac{1}{4\pi} \frac{1-g^2}{(1+g^2-2g\cos\theta)^{3/2}} \]

The tissue optical properties:

\[ \mu_t = \mu_a + \mu_s \quad \text{total attenuation coefficient} \]

\[ a = \frac{\mu_s}{\mu_t} \quad \text{albedo} \]

\[ \mu'_s = \mu_s (1-g) \quad \text{reduced scattering coefficient} \]

\[ \mu_{\text{eff}} = \sqrt{\frac{\mu_s}{D}} \quad \text{effective attenuation coefficient} \]

\[ D = \frac{1}{3\mu_r} = \frac{1}{3(\mu_a + (1-g)\mu_s)} \quad \text{diffusion coefficient} \]

Ficks law:

\[ J = -c D \nabla \rho \quad \text{photon current density} \]

\[ \phi(r,t) = c h v \rho(r,t) \quad \text{fluence rate expressed as photon density} \]

The time-dependent diffusion equation:

\[ \frac{1}{c} \frac{\partial}{\partial t} \phi(r,t) - D \nabla^2 \phi(r,t) + \mu_t \phi(r,t) = S(r,t) \]

The Greens function of the above equation in a semi-infinite medium:

\[ \phi(\rho,z,t) = c(4\pi D c t)^{3/2} \exp(-\mu_a c t) \left\{ \exp \left[ -\frac{(z-z_0)^2 + \rho^2}{4Dc t} \right] - \exp \left[ -\frac{(z+z_0)^2 + \rho^2}{4Dc t} \right] \right\} \]

The steady state diffusion equation:

\[ \nabla^2 \phi(r) - \mu_{\text{eff}}^2 \phi(r) = S(r) \]

Fluence rate for a point source in an infinite medium:

\[ \phi(r) = \phi(r = 0) \frac{1}{|r|} \exp(-\mu_{\text{eff}} \cdot |r|) = \frac{P \mu_{\text{eff}}^2}{4\pi \mu_a} \frac{1}{|r|} \exp(-\mu_{\text{eff}} \cdot |r|) \]

\[ \rho c \frac{\partial T}{\partial t} = \nabla (k \nabla T) + q_s + q_p + q_m \]

The Bioheat equation:

\[ \Delta T = \frac{Q}{4\pi \alpha a} e^{-\frac{r^2}{4\alpha a}} \]

The perfusion term:

\[ q_p = -\omega \rho_h c_h \rho (T - T_a) \]