From Bohren and Hufmanf, p. 121,

$$S_2(180^\circ) = -S_1(180^\circ) = \frac{1}{2}\sum_n (-1)^n(2n+1)(a_{n1} - a_{n2})$$

$$Q_b = \frac{\sigma_b}{\pi a^2} = \frac{1}{x^2}\left|\sum_n (-1)^n(2n+1)(a_{n1} - a_{n2})\right|^2$$

Exercises

(1) For a sphere of radius 5 μm and real refractive index 1.59, use your code to provide graphs of Q_e, Q_s, Q_a, and Q_b as a function of size parameter for $\Im\,\mathsf{m} = 10^{-6}$, .001 and .1 over ka=[.01, 100].

(2) Produce graphs of Q_e, Q_s, Q_a, and Q_b for a 5 μm silicon sphere over λ =[280, 2500] μm.

(3) Compare Q_b with normal incidence reflectance from the bulk material.

(4) The absorption cross section of a sphere may be written as (ReadMie.pdf)

$$\sigma_a = \frac{2\pi}{|\mathsf{m}|^2 k^2}\sum_{n=1}^{\infty}(2n+1)\,\Re\; i\psi'_n(\eta)\,\psi_n^*(\eta)\left(\mathsf{m}\,|c_{n1}|^2 + \mathsf{m}^*\,|c_{n2}|^2\right),$$

where $\eta = \mathsf{m}kr\big|_{r=a}$. Rather than just looking at η, graph Q'_a as a function of kr for $kr = [0, ka+1]$. Use the 5 μm Si sphere of Ex. (2) and $\lambda = 350, 400$ and 600 nm. In other words plot the function

$$\sigma'_a = \frac{2\pi}{|\mathsf{m}|^2 k^2}\sum_{n=1}^{\infty}(2n+1)\,\Re\; i\psi'_n(kr)\,\psi_n^*(kr)\left(\mathsf{m}\,|c_{n1}|^2 + \mathsf{m}^*\,|c_{n2}|^2\right).$$

Discuss your results.