Computational light scattering, fall 2022 (PAP315, 5 cr), Exercise 1

The answers are due on **September 14, 2022**. Please return them to Anne Virkki via e-mail (anne.virkki@helsinki.fi).

1-2. Derive expressions for the electric and magnetic fields **E** and **B** in the electric dipole approximation. The vector potential is

$$\mathbf{A}(\mathbf{r}) \quad = \quad \frac{-ikc\mu_0}{4\pi}\,\mathbf{p}\,\frac{e^{ikr}}{r},$$

where **p** is the electric dipole moment. (Jackson 9.2; 12 points)

3-4. Using a Mie scattering computer code, consider the formation of the rainbow and glory phenomena in the angular scattering by water droplets. For the droplets, the refractive index is $m = 1.33$ and the size parameter is $x = ka$, where a is the radius of the spherical particle, $k = 2\pi/\lambda$ is the wave number, and λ is the wavelength. Increase x gradually starting from the Rayleigh regime. At what values of x do the phenomena start to show up? Where do the interference patterns in the angular dependencies derive from? Typically, how does the number of interference features within the scattering angle range $0-180^\circ$ relate to x? In the nature, water droplets follow a size distribution. Carry out size averaging for the angular patterns and show that the rainbow and glory features are enhanced. Explain the rainbow features qualitatively using geometric optics. The glory phenomenon cannot be explained using geometric optics. How would you explain it? Provide one explanation based on the literature.

(12 points)