**Why is the sky blue?**

**Lord Rayleigh’s dimensional argument for the λ4 dependence on scattering**

For a particle much smaller than the wavelength of light, the induced dipole is proportional to volume of the particle since all mass elements are oscillating with the same phase. Therefore the scattered field can be written as



where *k* is a constant of proportionality. To conserve energy, the scattered intensity must fall off as where *r* is the distance from the particle. Putting this together gives



where is a different constant of proportionality. Now consider the units of both sides of the equation where the notation will denote the units of *a*. The left side is dimensionless so we can write



which is so say that



Now is an unknown constant of proportionality, but we know that it must be some function of the wavelength since it is the only other parameter that has units of length. That means we can write . If you consider a series expansion of this function, the first term must be

.

Putting this all together we have



In words this means that the scattered intensity of a small particle is proportional to the incident intensity, the square of the particle volume, and inversely proportional to the wavelength to the fourth power, and the square of the distance to the scatterer.

*Reference: The Physics Teacher, May 1985, 267-272*

**Converting the Light Scattering Equation:**

**Zimm’s equation:**

Start with:

Rearrange such that:

Since the term is small compared to one, one can make use of the Taylor expansion and truncate after the linear term:

Then the LS equation becomes:

which is Zimm’s equation in the Debye Plot: