Some Questions of Units
and Connections to the Electromagnetic Spectrum

Physics 214 2011, Electricity and Magnetism

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January 2011

Two fundamental constants:

1. $c = 3 \times 10^{10}$ cm/sec: relates length to time. Natural to set $c = 1$ and use same units for both. Similarly energy and momentum.

2. $\hbar = 6.58211899 \pm 10^{-22}$ MeV s. Related energy to time. Natural to set $\hbar = 1$. Then energy, mass, momentum have same units. Similarly time, length have (inverse) units.

Examples:

1. Microwaves: wavelengths mm, cm; frequencies $10^{13} - 10^9 sec^{-1}$;

2. Visible light: $eV^{-1} \sim 10^{-15}$ sec, $10^{-6} cm$.

3. X-rays: $KeV^{-1} \sim 10^{-18}$ sec.

4. γ-rays: $MeV - GeV^{-1} \sim 10^{-21} - 10^{-24}$ sec.

5. 1 fm = size of nucleus = 3×10^{-24} sec.

Conductivities, resistivities, skin depth:
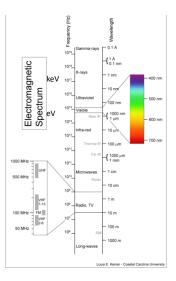Conductivity is usually quoted in SI units (siemens). In these units, skin depth is:

$$\delta = \frac{1}{\sqrt{\pi \mu_0}} \sqrt{\frac{1}{\sigma \nu}} \tag{1}$$

$$= 503 \text{ mm} \sqrt{\frac{1}{\sigma \nu}}$$

(ν is frequency in Hz) So, for Al, $\sigma = 3.5 \times 10^7$, so for ν in the Gigahertz range, δ is in the μ-m range.

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