2.5: A Conducting Body

The electrostatic field must be zero inside a conducting body. A non-zero field would act on mobile charges in the body and so produce currents that would cause the charge distribution to change with time. Any time variation of the field sources must generate time-varying fields in contradiction with the assumption of the electrostatic limit in which nothing changes with time. Since the electrostatic field is zero everywhere inside a conducting body, it follows from Equation (2.4.1) that the electric field just outside a conducting body can have no components parallel with the surface. The electric field just outside a conducting body must be **normal** to the surface of that body. Finally, it follows from an application of Gauss' Theorem to a pill-box spanning the surface of the conducting body that the electric field just outside that conducting body is given by

$$E_n = |\overrightarrow{\mathrm{E}}| = \frac{\sigma_t}{\epsilon_0} = \frac{1}{\epsilon_0}(\sigma_f + \sigma_b)\,, \tag{2.5.1}$$

where σ_f is a **free surface charge density** on the conducting body, and $\sigma_b = -P_n$ is a bound surface charge density due to a discontinuity in the normal component of $\vec{P}$ if the conductor is in contact with a dielectric material.