

7-45 誘電体の電場のエネルギー

$$D = \epsilon E$$

$$U = \frac{1}{2} \int \rho \phi \, dV$$

$$= \frac{1}{2} \int (\nabla \cdot D) \phi \, dV$$

$$= -\frac{1}{2} \int (\nabla \phi) \cdot D \, dV + \frac{1}{2} \int \nabla \cdot (\phi D) \, dV$$

$$\left[\nabla \cdot (\phi D) = (\nabla \phi) \cdot D + \phi \nabla \cdot D \right]$$

$$\text{第2項} = \frac{1}{2} \int \nabla \cdot (\phi D) \, d^3r$$

$$= \frac{1}{2} \int (\phi D)_n \, dS \rightarrow 0$$

$$\nabla \phi = -E \quad \text{よって}$$

$$\left(\phi \sim \frac{1}{r}, D_n \sim \frac{1}{r^2}, dS = 4\pi r^2 \right)$$

$$U = \frac{1}{2} \int D \cdot E \, dV$$

$$\therefore U = \frac{1}{2} \int \epsilon |E|^2 \, dV$$

$$\epsilon_0 \rightarrow \epsilon$$