Lecture 13) The 4-Potential and the Wave Equation in Lorentz-Covariant Form

4-potential: $A^\mu = \left(\frac{V}{c}, \underline{A}\right)$

Wave equation: $\Box^2 A^\mu = \mu_0 \underline{j}^\mu$, where $\Box^2 = \partial_\nu \partial^\nu = \frac{1}{c^2}\frac{\partial^2}{\partial t^2} - \nabla^2$

when we choose the Lorenz gauge $\partial_\mu A^\mu = 0$

Gauge Transformation can be written as $A^\mu \Rightarrow A^\mu - \partial^\mu \chi$

E and B fields from A^μ – the Electromagnetic Field Tensor

$$F^{\mu\nu} = \partial^\mu A^\nu - \partial^\nu A^\mu = \begin{matrix} \\ \downarrow \mu \end{matrix} \begin{matrix} \longrightarrow \nu \end{matrix} \begin{bmatrix} 0 & -\frac{E_1}{c} & -\frac{E_2}{c} & -\frac{E_3}{c} \\ \frac{E_1}{c} & 0 & -B_3 & B_2 \\ \frac{E_2}{c} & B_3 & 0 & -B_1 \\ \frac{E_3}{c} & -B_2 & B_1 & 0 \end{bmatrix} = -F^{\nu\mu}$$

↑ antisymmetric