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Electrodynamics Continuity Equation

The electric charge density (charge per unit volume) is give by $\rho(\boldsymbol{r}, t)$ and the volume current density (current per unit area) is given by $\boldsymbol{J}(\boldsymbol{r}, t)$. Local conservation of charge states that the time rate of change of the total charge within a volume is equal to the negative of the charge flowing out of that volume, resulting in the equation

$$\frac{d}{dt}\int_V \rho(\boldsymbol{r}, t)\, dV = -\oint_S \boldsymbol{J} \cdot d\boldsymbol{S}.$$

From this law of charge conservation, derive the electrodynamics continuity equation.

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