1.5. 以磁力线为边界 $\longrightarrow H_n=0$

$$H_n = \vec{H}\cdot\hat{n} = \frac{1}{\mu}\vec{B}\cdot\hat{n} = \frac{1}{\mu}(\nabla\times\vec{A})\cdot\hat{n} = -\frac{1}{\mu}\nabla A_z\cdot\hat{t} = -\frac{1}{\mu}\frac{\partial A_z}{\partial t} = 0$$

为第一类.

补3:

$$\nabla\times\vec{E} = -\frac{\partial\vec{B}}{\partial t} = -\frac{\partial(\nabla\times\vec{A})}{\partial t} = -\nabla\times\frac{\partial\vec{A}}{\partial t} \longrightarrow \nabla\times\left(\vec{E}+\frac{\partial\vec{A}}{\partial t}\right)=0$$

令 $\vec{E}+\frac{\partial\vec{A}}{\partial t} = -\nabla\varphi$. 则 $\vec{E} = -\frac{\partial\vec{A}}{\partial t}-\nabla\varphi$

$$\rightarrow \nabla\cdot\vec{E} = -\frac{\partial}{\partial t}\nabla\cdot\vec{A} - \nabla^2\varphi = \frac{\rho}{\varepsilon}. \quad ①$$

$$\nabla\times\vec{H} = \vec{J}+\frac{\partial\vec{D}}{\partial t} = \vec{J}+\varepsilon\frac{\partial\vec{E}}{\partial t} = \vec{J}-\varepsilon\left(\frac{\partial^2\vec{A}}{\partial t^2}+\frac{\partial}{\partial t}\nabla\varphi\right).$$

由于 $\vec{H}=\frac{1}{\mu}\vec{B}$, $\nabla\times(\nabla\times\vec{A}) = \nabla(\nabla\cdot\vec{A})-\nabla^2\vec{A}$.

则 $\nabla\times\vec{H} = \frac{1}{\mu}\nabla\times(\nabla\times\vec{A}) = \frac{1}{\mu}\left(\nabla(\nabla\cdot\vec{A})-\nabla^2\vec{A}\right)$

$$\rightarrow \nabla(\nabla\cdot\vec{A})-\nabla^2\vec{A} = \mu\vec{J}-\varepsilon\mu\left(\frac{\partial\vec{A}}{\partial t}+\nabla\frac{\partial\varphi}{\partial t}\right). \quad ②$$

洛伦兹规范: $\nabla\cdot\vec{A}+\varepsilon\mu\frac{\partial\varphi}{\partial t}=0.$

则: ①: $\nabla^2\varphi - \varepsilon\mu\frac{\partial^2\varphi}{\partial t} = -\frac{\rho}{\varepsilon}.$

②: $\nabla^2\vec{A} - \varepsilon\mu\frac{\partial^2\vec{A}}{\partial t} = -\mu\vec{J}.$