1. $B_{2x}^{\parallel} = B_{1x}^{\parallel}$

$\Rightarrow B_{2x}^{\parallel} - B_{1x}^{\parallel} = 0$

$\Rightarrow$ Tangential component of magnetic field parallel to sheet current ($\vec{K} = K\hat{x}$) is continuous.

2. $B_{2y}^{\parallel} - \frac{1}{2}\mu_0 K = B_{1y}^{\parallel} + \frac{1}{2}\mu_0 K$

$\Rightarrow B_{2y}^{\parallel} - B_{1y}^{\parallel} = \mu_0 K$

$\Rightarrow$ Tangential component of magnetic field perpendicular to sheet current is discontinuous by an amount $\mu_0 K$.

3. $B_{2z}^{\perp} = B_{1z}^{\perp}$

$\Rightarrow B_{2z}^{\perp} - B_{1z}^{\perp} = 0$

$\Rightarrow$ Normal component of magnetic field is continuous across sheet/surface current.

As, $\vec{\nabla} \cdot \vec{A}(\vec{r}) = 0$

$$\underbrace{\int_V \vec{\nabla} \cdot \vec{A}(\vec{r})\, d\tau}_{\text{Applying Divergence theorem.}} = 0$$

$$\oint_S \vec{A}(\vec{r}) \cdot d\vec{a} = 0$$

$\Rightarrow A_2^{\perp} - A_1^{\perp} = 0$

$\Rightarrow$ Normal component of magnetic vector potential is continuous while crossing the surface current.

$\oint_C \vec{A}(\vec{r}) \cdot d\vec{l} = \int_S \vec{B}(\vec{r}) \cdot d\vec{a} = 0$ (Magnetic flux through the shrinking surface, S of the Amperian loop, C is zero $\Leftarrow$ assumption)

assumption.

$A_2^{\parallel} - A_1^{\parallel} = 0 \Rightarrow$ Tangential component of $\vec{A}(\vec{r})$ is continuous as well.

can easily be calculated.

Magnetization:

conventional current → charge transport ; Free current , current
Atomic current → no charge transport ; circulatory/magnetization/bound –

All matter consists ultimately of atoms, and each atom consists of electrons in motion. These electrons constitute the current, called 'atomic current'. It thus appears that we have two kinds of currents :

1_ Conventional Current, which consists of charge transport, i.e, the motion of free electrons or charged ions.

2_ Atomic Current, which is pure circulatory current and give rise to no charge transport.

However, both kinds of current may produce magnetic fields.

Eeach atomic current is a tiny closed circuit of atomic dimensions, and it may therefore be appropriately described as a magnetic dipole. In fact, the magnetic dipole moment is the quantity of interest here, since the distant magnetic field due to a single atom is completely determined by specifying its magnetic dipole moment, $\vec{m}$.

Let the magnetic moment of the ith atom be $\vec{m}_i$. We sum up vectorially all of the dipole moments in a small volume element ΔV, and then divide the result by ΔV ; the resulting quantity,

$$\vec{M} = \lim_{\Delta V \to 0} \frac{1}{\Delta V} \sum_i \vec{m}_i ,$$

is called Magnetization. SI Unit: A/m

$$\vec{P} = \lim_{\Delta V \to 0} \frac{1}{\Delta V} \sum_i \vec{p}_i$$

↓

polarization SI Unit: C/m^2

$\vec{M}$ ≡ magnetic dipole moment per unit volume.

In the unmagnetized state,

$$\underbrace{\sum_i \vec{m}_i}_{\vec{B}_{ext}=0} = 0 ,$$ as a result of random orientation of the $\vec{m}_i$.

In the presence of an external magnetic field, the various dipole moments allign themselves in the direction of the external magnetic field, and

$$\underbrace{\sum_i \vec{m}_i}_{\vec{B}_{ext} \neq 0} \neq 0.$$