

BOUNDARY BETWEEN MAGNETIC MATERIALS

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References: Griffiths, David J. (2007) Introduction to Electrodynamics, 3rd Edition; Prentice Hall - Problem 6.26.

Just as electric field lines bend when crossing a boundary between two different dielectrics, so magnetic field lines bend when crossing a boundary between different permeabilities.

From the boundary conditions on the field \mathbf{B} and on the auxiliary field \mathbf{H} we have

$$B_{\perp}^{above} = B_{\perp}^{below} \quad (1)$$

$$\mathbf{H}_{\parallel}^{above} - \mathbf{H}_{\parallel}^{below} = \mathbf{K}_f \times \hat{\mathbf{n}} \quad (2)$$

If there is no free current at the boundary, then $\mathbf{K}_f = 0$ and $\mathbf{H}_{\parallel}^{above} = \mathbf{H}_{\parallel}^{below}$. From the definition of permeability, we also have, for linear materials:

$$\mathbf{B} = \mu \mathbf{H} \quad (3)$$

If θ_i is the angle between the normal to the boundary and the field lines \mathbf{B}_i in material i , then the conditions above come out to

$$B_1 \cos \theta_1 = B_2 \cos \theta_2 \quad (4)$$

$$\frac{B_1 \sin \theta_1}{\mu_1} = \frac{B_2 \sin \theta_2}{\mu_2} \quad (5)$$

Dividing these two equations, we get

$$\frac{\tan \theta_1}{\tan \theta_2} = \frac{\mu_1}{\mu_2} \quad (6)$$

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