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 **B** and on the auxiliary field **H** we have

$$B_{\perp}^{above} = B_{\perp}^{below} \tag{1}$$

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

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:

$$\mathbf{B} = \mu \mathbf{H} \tag{3}$$

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

$$B_1 \cos\theta_1 = B_2 \cos\theta_2 \tag{4}$$

$$\frac{B_1 \sin\theta_1}{\mu_1} = \frac{B_2 \sin\theta_2}{\mu_2} \tag{5}$$

Dividing these two equations, we get

$$\frac{\tan\theta_1}{\tan\theta_2} = \frac{\mu_1}{\mu_2} \tag{6}$$

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