$$\mathcal{E}_{me}(\text{domain}) = b e \sin^2\theta \tag{3.2}$$

and

$$\mathcal{E}_{me} = b e \sin^2\theta\cos^2\phi \tag{3.3}$$

where $b = b_1$ or b_2 for the <100> problem or the <111> problem, respectively.

Consider the domain configuration in Figure 3.2(b). Again the energy in the domain is

$$\mathcal{E}_{me}(\text{domain}) = b e \sin^2\theta.$$

The transition through the wall proceeds in the (x,z) plane by varying ξ continuously from $-\theta$ to θ. The energy in the wall is

$$\mathcal{E}_{me} = b e \sin^2\xi, \quad -\theta \leq \xi \leq \theta. \tag{3.4}$$

Equation (3.2), Equation (3.3), and Equation (3.4) are the primary equations derived in this section.

3.1.2. Exchange Energy

Within the concepts of domain theory, the exchange energy is believed to reside only in the domain walls or transition regions between adjacent domains. The usual method for obtaining this domain wall energy is through a Landau-Lifshitz domain wall calculation.[33] This has been fully developed in the literature[22,32] and will be described only briefly here. The method consists of writing a one dimensional integral expression for the energy in the transition region between domains. The terms which contribute to the wall energy are the exchange energy and the excess crystalline or magnetoelastic anisotropy energy incurred by the transition through the wall. It is assumed that $\vec{\nabla}\cdot\vec{M} = 0$ (θ = constant) holds through the wall. This one dimensional integral energy expression is minimized by variational calculus. The result predicts that at all points within the wall the exchange energy is equal to the excess anisotropy energy. It is found that the wall energy per unit area is given by

$$\sigma_W = 2\sqrt{A}\,\sin\theta \int_{\phi_1}^{\phi_2} |(\mathcal{E}_{me}(\text{domain}) - \mathcal{E}_{me})^{\frac{1}{2}}|\, d\phi. \tag{3.5}$$

The crystal anisotropy energy has not been considered. A is again the exchange constant and ϕ_1 and ϕ_2 are the azimuthal orientation of the magnetization in the adjacent domains separated by the wall.

In this section, the domain wall energies in Figure 3.2(a) and Figure 3.2(b) will be obtained. They will be called σ_W^s and σ_W^p, respectively. For Figure 3.2(a), using Equation (3.2) and Equation (3.3) with Equation (3.5) gives

$$\sigma_W^s = 2\sqrt{A|be|}\,\sin^2\theta \int_0^{\pi} \sin\phi\, d\phi$$

or

$$\sigma_W^s = 4\sqrt{A|be|}\,\sin^2\theta \tag{3.6}$$

For Figure 3.2(b), using Equation (3.2) and Equation (3.4) with Equation (3.5) gives

$$\sigma_W^p = 2\sqrt{A|be|} \int_{-\theta}^{\theta} (\sin^2\theta - \sin^2\xi)^{1/2}\, d\xi.$$

Making the substitution

$$\sin x = \sin\theta\sin\xi = a\sin\xi$$