International Tables for Crystallography (2013). Vol. D, Figure 3.4.4.9, p. 537.

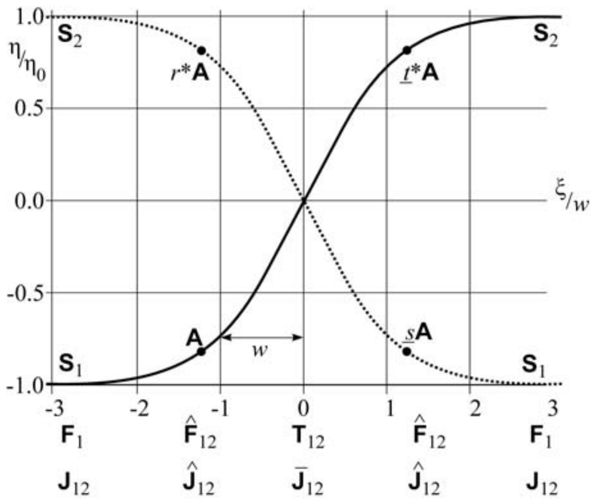

Fig. 3.4.4.7. Profiles of the one-component order parameter $\eta(\xi)$ in a symmetric wall (solid curve) and in the reversed wall (dotted curve). The wall is symmetric and reversible (SR).

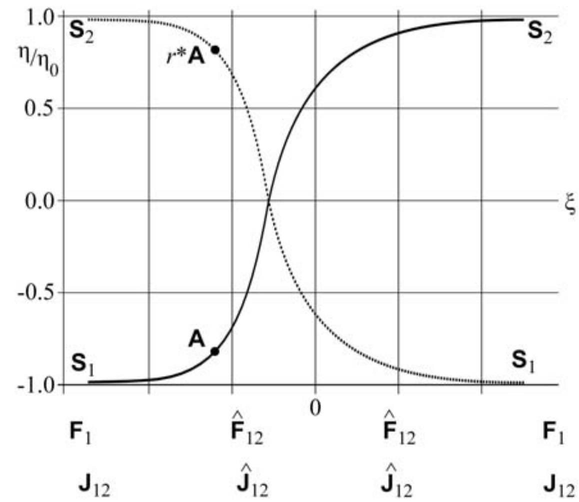

Fig. 3.4.4.8. Profiles of the one-component order parameter $\eta(\xi)$ in an asymmetric wall (solid curve) and in the reversed asymmetric wall (dotted curve). The wall is asymmetric and state-reversible (AR*).

The relation between a wall profile $\eta(\xi)$ of a *symmetric reversible* (SR) *wall* and the profile $\eta^{\rm rev}(\xi)$ of the reversed wall is illustrated in Fig. 3.4.4.7, where the the dotted curve is the wall profile $\eta^{\rm rev}(\xi)$ of the reversed wall. The profile $\eta^{\rm rev}(\xi)$ of the reversed wall is completely determined by the the profile $\eta(\xi)$ of the initial wall, since both profiles are related by equations

$$\eta^{\rm rev}(\xi) = -\eta(\xi) = \eta(-\xi). \qquad (3.4.4.30)$$

The first part of the equation corresponds to a state-exchanging operation $r^\star_{12}$ (*cf.* point $r^\star$A in Fig. 3.4.4.7) and the second one to a side-reversing operation $\underline{s}_{12}$ (point $\underline{s}$A in the same figure). In a symmetric reversible wall, both types of reversing operations exist (see Table 3.4.4.3).

In a *symmetric irreversible* (SI) *wall* both initial and reversed wall profiles fulfil symmetry condition (3.4.4.24) but equations (3.4.4.30) relating both profiles do not exist. The profiles $\eta(\xi)$ and $\eta^{\rm rev}(\xi)$ may differ in shape and surface wall energy. Charged domain walls are always irreversible.

A possible profile of an *asymmetric domain wall* is depicted in Fig. 3.4.4.8 (full curve). There is no relation between the negative part $\eta(\xi) < 0$ and positive part $\eta(\xi) > 0$ of the wall profile $\eta(\xi)$. Owing to the absence of non-trivial twin operations, there is no central plane with higher symmetry. The local symmetry (sectional layer group) at any location ξ within the wall is equal to the face group $\widehat{\mathsf{F}}_{12}$. This is also the global symmetry T_{12} of the entire wall, $\mathsf{T}_{12} = \widehat{\mathsf{F}}_{12}$.

The dotted curve in Fig. 3.4.4.8 represents the reversed-wall profile of an *asymmetric state-reversible* (AR*) *wall* that is related to the initial wall by state-exchanging operations $r^\star_{12}\widehat{\mathsf{F}}_{12}$ (see Table 3.4.4.5),

$$\eta^{\rm rev}(\xi) = -\eta(\xi). \qquad (3.4.4.31)$$

An example of an *asymmetric side-reversible* (A$\underline{\rm R}$) *wall* is shown in Fig. 3.4.4.9. In this case, an asymmetric wall (full curve) and reversed wall (dotted curve) are related by side-reversing operations $\underline{s}_{12}\widehat{\mathsf{F}}_{12}$:

$$\eta^{\rm rev}(\xi) = \eta(-\xi). \qquad (3.4.4.32)$$

In an *asymmetric irreversible* (AI) *wall*, both profiles $\eta(\xi)$ and $\eta^{\rm rev}(\xi)$ are asymmetric and there is no relation between these two profiles.

The *symmetry* $\mathsf{T}_{12}(\eta)$ *of a finite-thickness wall* with a profile $\eta(\xi)$ is equal to or lower than the symmetry T_{12} of the corresponding zero-thickness domain wall, $\mathsf{T}_{12} \supseteq \mathsf{T}_{12}(\eta)$. A symmetry descent $\mathsf{T}_{12} \supset \mathsf{T}_{12}(\eta)$ can be treated as a phase transition in the domain wall (see *e.g.* Bul'bich & Gufan, 1989*a*,*b*; Sonin & Tagancev, 1989). There are $n_{W(\eta)}$ equivalent *structural variants of the finite-thickness domain wall* with the same orientation and the same energy but with different structures of the wall,

$$n_{W(\eta)} = [\mathsf{T}_{12} : \mathsf{T}_{12}(\eta)] = |\mathsf{T}_{12}| : |\mathsf{T}_{12}(\eta)|. \qquad (3.4.4.33)$$

Domain-wall variants – two-dimensional analogues of domain states – can coexist and meet along line defects – one-dimensional analogues of a domain wall (Tagancev & Sonin, 1989).

Symmetry descent in domain walls of finite thickness may occur if the order parameter η has more than one nonzero component. We can demonstrate this on ferroic phases with an order parameter with two components η_1 and η_2. The profiles $\eta_1(\xi)$ and $\eta_2(\xi)$ can be found, as for a one-component order parameter, from the corresponding Landau free energy (see *e.g.* Cao & Barsch, 1990; Houchmandzadeh *et al.*, 1991; Ishibashi, 1992, 1993; Rychetský & Schranz, 1993, 1994; Schranz, 1995; Huang *et al.*, 1997; Strukov & Levanyuk, 1998; Hatt & Hatch, 1999; Hatch & Cao, 1999).

Let us denote by $\mathsf{T}_{12}(\eta_1)$ the symmetry of the profile $\eta_1(\xi)$ and by $\mathsf{T}_{12}(\eta_2)$ the symmetry of the profile $\eta_2(\xi)$. Then the symmetry of the entire wall $\mathsf{T}_{12}(\eta)$ is a common part of the symmetries $\mathsf{T}_{12}(\eta_1)$ and $\mathsf{T}_{12}(\eta_2)$,

$$\mathsf{T}_{12}(\eta) = \mathsf{T}_{12}(\eta_1) \cap \mathsf{T}_{12}(\eta_2). \qquad (3.4.4.34)$$

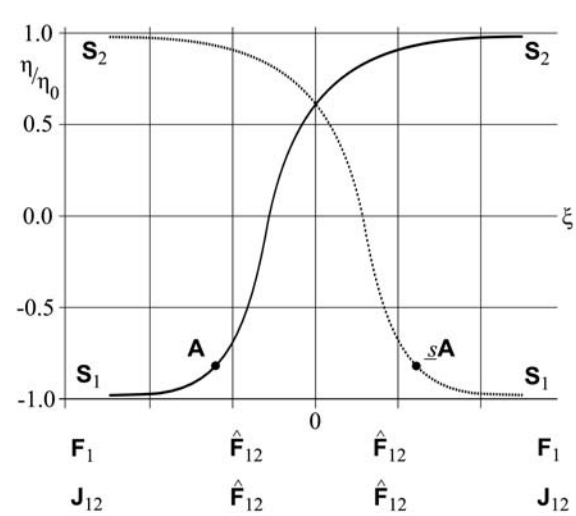

Fig. 3.4.4.9. Profiles of the one-component order parameter $\eta(\xi)$ in an asymmetric wall (solid curve) and in the reversed asymmetric wall (dotted curve). The wall is asymmetric and side-reversible (A$\underline{\rm R}$).

references