# ORDERING PROCESS AND BLOCH WALL DYNAMICS IN NEARLY 1D ANISOTROPIC SPIN SYSTEM

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I reported the ordering process of nearly one-dimensional anisotropic spin system quenched to the unstable phase. The model considered here is the Ginzburg-Landau(GL) system with anisotropy in nearly one-dimensional space, [1, 2]

$$\dot{\psi}(x,t) = \psi - |\psi|^2\psi + \gamma\psi^* + \frac{\partial^2\psi}{\partial x^2} \tag{1}$$

where $\psi$ is the complex spin order parameter, and $\gamma$ is the strength of anisotropy. Without loss of generality $\gamma$ is chosen to be positive. The field and the space have been normalized in an appropriate way.

For the isotropic case $\gamma = 0$, the system has the rotational symmetry $\psi \to \psi e^{i\theta}$, $\theta$ being a spatially constant phase. The introduction of anisotropy($\gamma \neq 0$) breaks this symmetry and produces a magnetic easy axis. As is well known the above system gives two types of domain walls. The first is the Néel (Ising) wall, at the center of which the order parameter vanishes. The second is the Bloch wall, at the center of which the order parameter does not vanish and has chirality. The Néel wall and the Bloch wall are stable respectively for $\gamma > \frac{1}{3}$ and $0 < \gamma < \frac{1}{3}$. In this session we discuss the situation where the Bloch walls are stable. In the Néel wall case the study has been done by Nagai and Kawasaki. Our approach to this model is essentially same as Nagai and Kawasaki used for those studies. [3]

In an early stage in ordering process unstable regions with $\psi \approx 0$ grow toward $\psi \approx \pm X_0 (X_0 = \sqrt{1+\gamma})$, which tends to form domain structures each of which approximately has $\psi \approx X_0$ or $-X_0$. In this way after the amplitude relaxation in the early stage dynamics the amplitude of order parameter $|\psi|$ takes the equilibrium value $X_0$ over almost all the space. After this relaxation process the evolution of the system is described by pair annihilation process of domain walls. In the case of Bloch wall it has two opposite geometrical structures, so that it has two possible inner structures, twisted or not. In the Néel wall case such structure is not present.

The evolution of the domain size and twistness is derived as,

$$\dot{y_i} = A[Q_{i+1}\exp(-y_{i+1}/\xi) + Q_{i-1}\exp(-y_{i-1}/\xi) - 2Q_i\exp(-y_i/\xi)] \tag{2}$$

where $A = 4\sqrt{2\gamma}(1-3\gamma)/(1-\gamma/3)$, and $y_i = x_i - x_{i-1} (> 0)$,$x_i$ being the position of the $i$-th Bloch wall, is the distance between neighboring domain walls, and the variable $Q_i$ takes two values, 1 or -1, according to the structure of domain. If the length of a domain becomes of the order of the Bloch wall size $y_c$, the annihilation of the domain takes place. Here the annihilation is taken into account, adding the subsidiary condition that *if* $y_j < y_c$, *then the replacement* $y_{j-1} + y_j + y_{j+1} \to y_{j'}$ *and* $Q_{j-1}Q_jQ_{j+1} \to Q_{j'}$ is made. For two Bloch wall cases schematic representation is show in FIG.1.

From the above description one can find out that if two walls have the different handed rotation ($Q = 1$) its domain length shrinks logarithmically. If two walls have the same handed rotation ($Q = -1$) its domain length enlarges logarithmically. Consequently both these processes contributes to the enlargement of mean domain size. We also investigated the distribution of the domain sizes for each $Q$. In the small scale region the distribution has $Q$-dependence, while in the large scale region it has no $Q$-dependence and has the exponential form, which means the annihilation process makes no correlation. For the Ising system the distribution function has been exactly calculated. [4, 5] We also discussed for structure factor and other results. For details, see Ref.[6].

**FIG.1** The interaction of 2 Bloch wall: non twisted $Q = 1$ (right) and twisted $Q = -1$ (left)

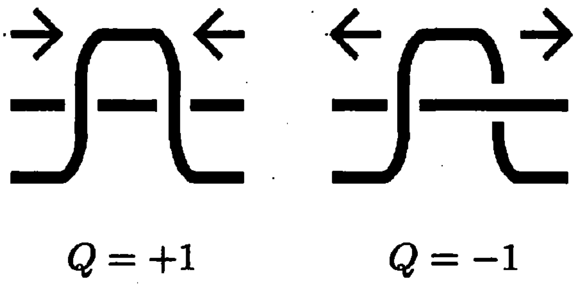
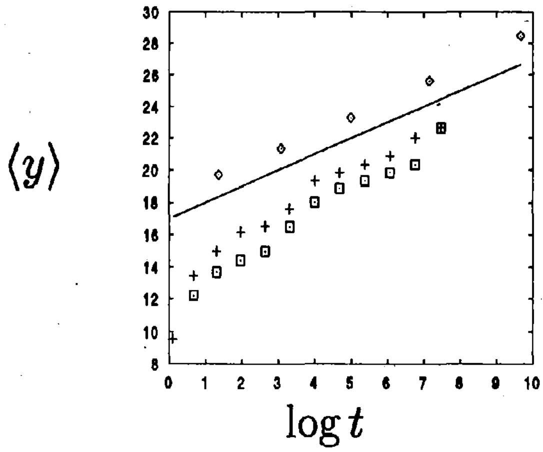



**FIG.2** Temporal evolution of average domain size $\langle y \rangle$ at time $t$. The diamond symbol is the result obtained by numerically solving (1). Plus and box symbols stand for the evolution of domain sizes calculated with (2) for different two initial conditions. Solid line is the slope 1. One observes the average domain size grows logarithmically in time.

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