Hydrodynamic behavior of ˆfluxoid’˜ in type II – superconductor based on the asymmetric zero–range process

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The points where the order parameter turns into zero and their phase experience a leap by multiple of 2π, are known as phase slip centers (B.Ivlev,N.Kopnin [1984]). PCSs can be formed as a result of thermodynamic fluctuations of the system. The probability of such an event is proportional to exp (−F /T) where F is the free−energy barrier between two uniform states before and after the phase slippage. This process is more probable near the critical temperature where the barrier is small (L.Langer, V.Ambegaokar [1967]). If X_t denotes this process then it is described by the following hyperbolic equation

$$\frac{\partial u}{\partial t} + \beta \frac{\partial}{\partial x}(F(u)) = 0 \qquad (*)$$

(J.Fouque, A.Benassi [1989] and E.Andjel, C.Kipnis [1984]) where the expectation

$$E\{X_{t/\varepsilon^\alpha}([x/\varepsilon])(1 - X_{t/\varepsilon^\alpha}([x/\varepsilon]\pm 1)\} \cong F[u_t^\varepsilon(x)]$$

and a small parameter $\varepsilon > 0$. For $x \in R$ we set $k = [x(\varepsilon)\ if\ \varepsilon u \leq x < \varepsilon(k+1)]$ and $\eta = \{\eta(k), k \in Z\} \in \{0,1\}^Z$ is called a configuration (1 for sites occupied with intensity $p \in [0,1]$ and 0 for vacant ones). In the asymmetric case $p \neq \frac{1}{2}$, the right scaling is $\alpha = 1$ and as $\varepsilon > 0$ and setting $\beta = p - 1,\ u_t^\varepsilon(x)$ converges to $u(x,t)$. If $p = \frac{1}{2}$ (in the symmetric case), $\alpha = 2$ is the right scaling and the limiting equation is parabolic. Simulations is a Monte−Carlo method solving Burger−type equation (*). This equation rules the hydrodynamic limit behavior of a simple exclusion process: particles are on a linear lattice and wait an exponential amount of time before jumping to the right if there is no particle already there.