Z_2 Vortices in SO(3) invariant models of frustrated AFmagnets

Discussion meeting

Motterials/ UCSB

September 20, 2007

Bibliography

H. Kawamura and S. Miyashita: J. Phys. Soc. Jpn. **53** (1984) 4138.

H. Kawamura and M. Kikuchi: Phys. Rev. B **47** (1993) 1134.

B. W. Southern and **A.P. Young:** **Phys. Rev. B. 48 (1993) 13170**

B. W. Southern and H.-J. Xu: Phys. Rev. B **52** (1995) R3836.

M. Wintel, H. U. Everts, and W. Apel: Phys. Rev. B **52** (1995) 13480.

Experiments:

Y. Ajiro *et al.*: J. Phys. Soc. Jpn. **57** (1988) 2268. **$HCrO_2$ and $LiCrO_2$**

S. Nakatsuji *et al.*: Science **309** (2005) 1697. $NiGa_2S_4$

Y. Nambu, S. Nakatsuji, and Y. Maeno: J. Phys. Soc. Jpn. **75** (2006) 043711.

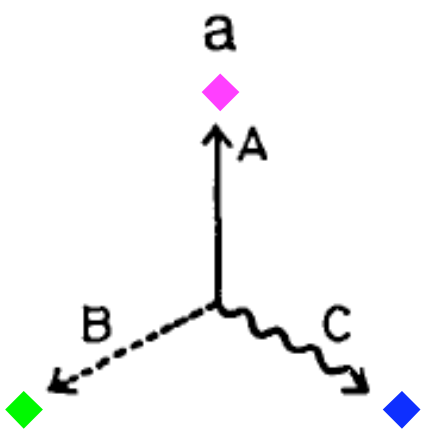
A. Olariu *et al.*: Phys. Rev. Lett. **97** (2006) 167203. $NaCrO_2$

Recent papers:

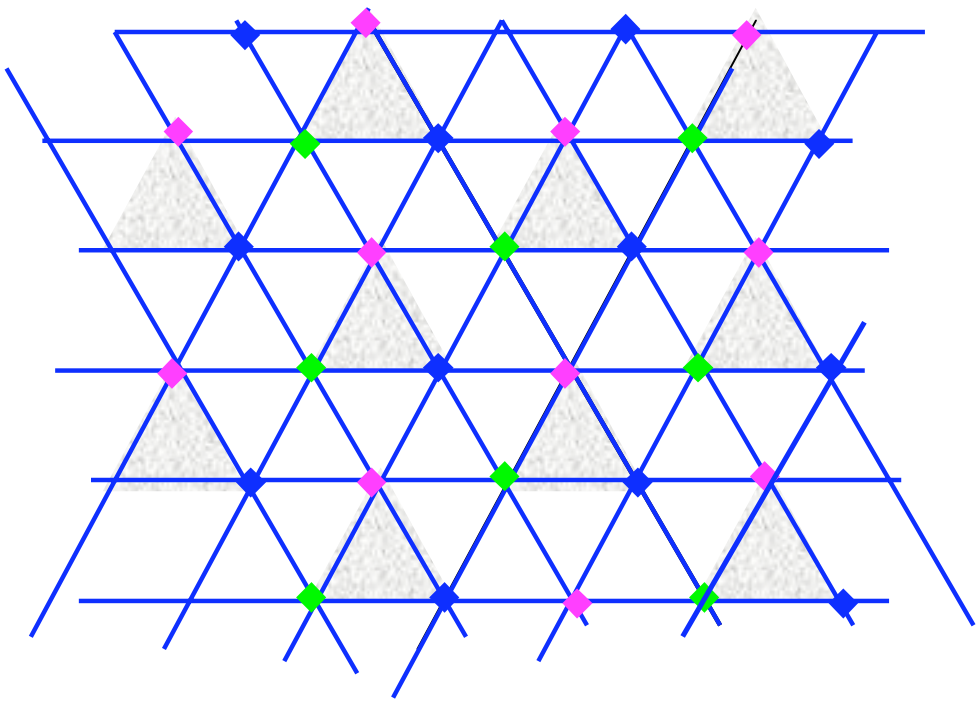
Hikaru Kawamura & A. Yamamoto J. Phys. Soc. Jpn 76 (2007) 073704

Satoshi Fujimoto Phys. Rev. B. 73 (2006) 184401

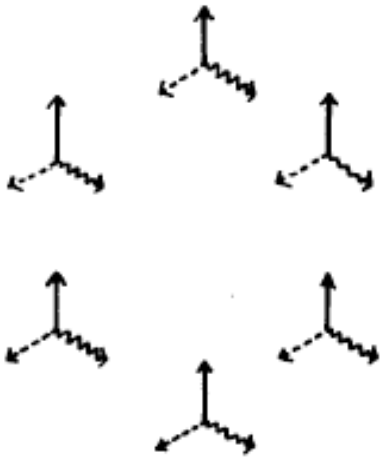
Order Parameter (Heisenberg Hamiltonian)



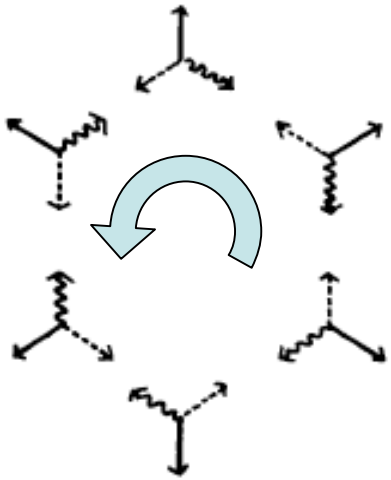
T=0 order parameter
on triangular superlattice
of shaded upwards pointing triangles



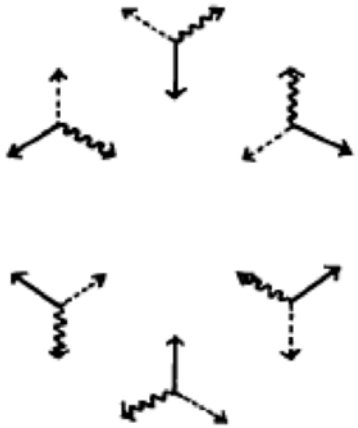
Z_2 Vortex



vortex free configuration



1 vortex



≡ anti-vortex

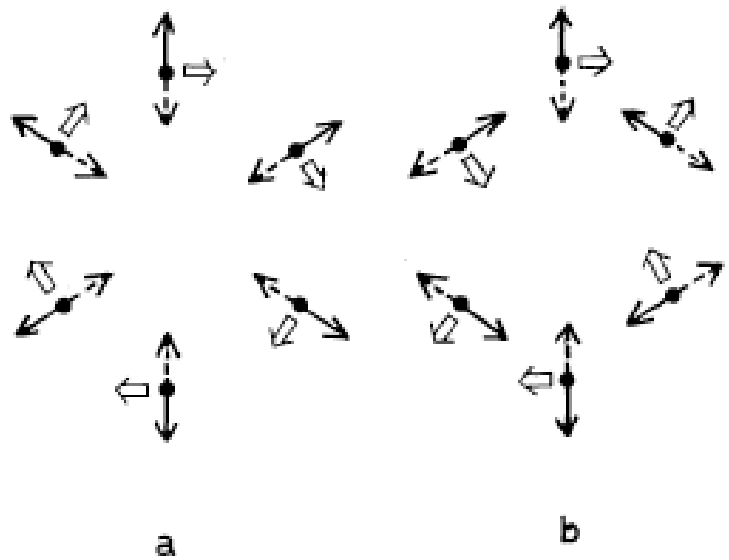


Fig. 3. Another example of vortex configuration, where spins on one sublattice are perpendicular to the plane of the page while spins on other two sublattices rotate around this axis. The chirality vectors defined by (2.2) lie on the plane of the page and rotate clockwise (a) or counterclockwise (b) when one makes a clockwise turn around the vortex core. Configuration (a) can be continuously transformed into configuration (b) and vice versa.

Vorticity around a closed contour versus T

$$V[C] = \frac{1}{2} T_r \left(\prod_{i \in C} U_i\right).$$

$$U = \exp\left(\frac{\omega}{2i} \hat{\boldsymbol{n}} \cdot \boldsymbol{\sigma}\right)$$

“Activation energy” ~ 3J

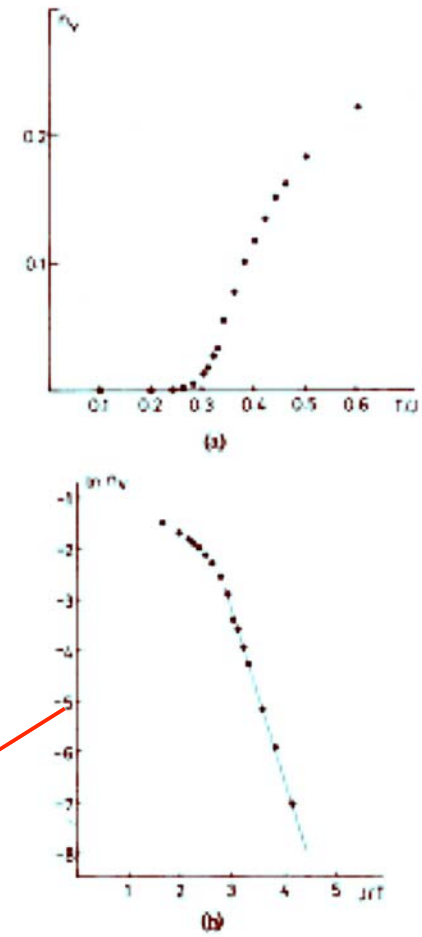
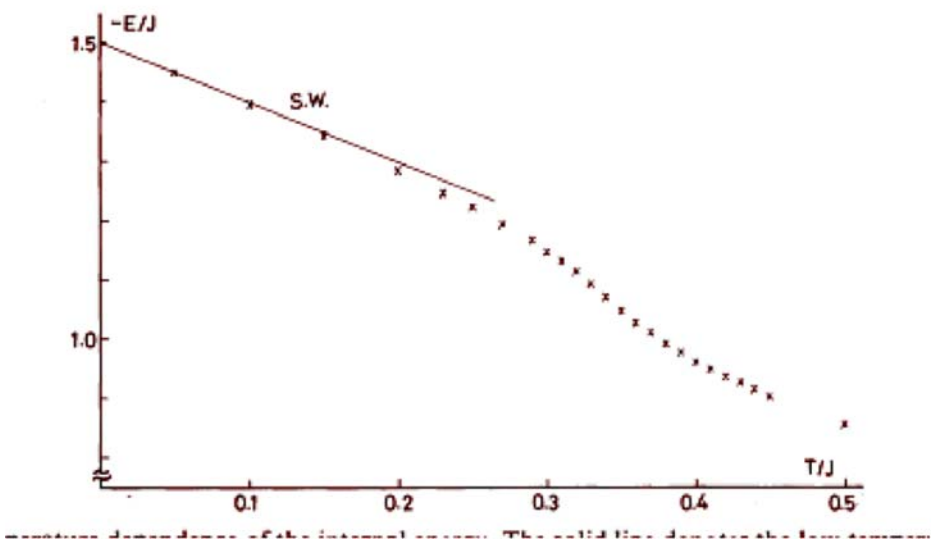


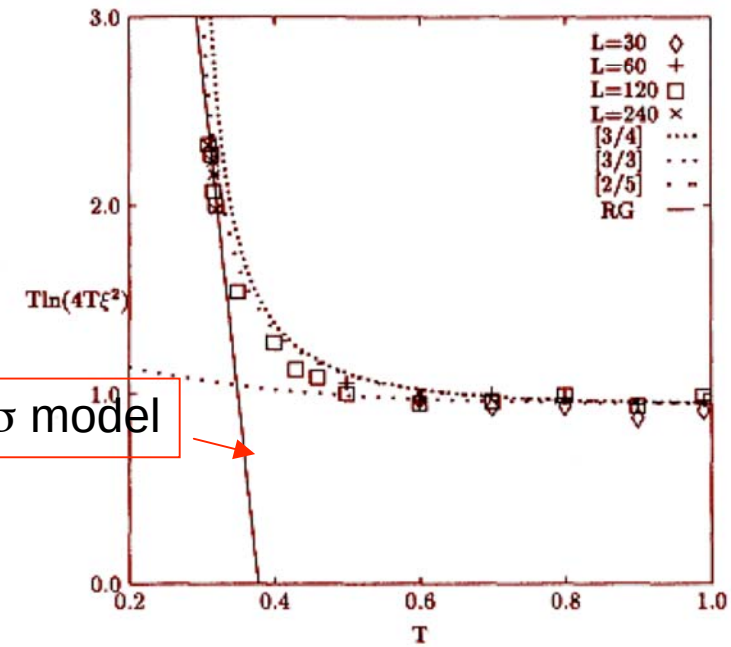
Fig. 10. Temperature dependence of the number density of the Z_2 vortices: (a) n_v vs. J/T and (b) $\ln n_v$ vs. J/T. The lattice size is $L = 30$.

Classical Heisenberg model on the triangular lattice

Internal energy versus T
K & M (1984)

spin-spin ξ versus T
Southern & Young (1993)

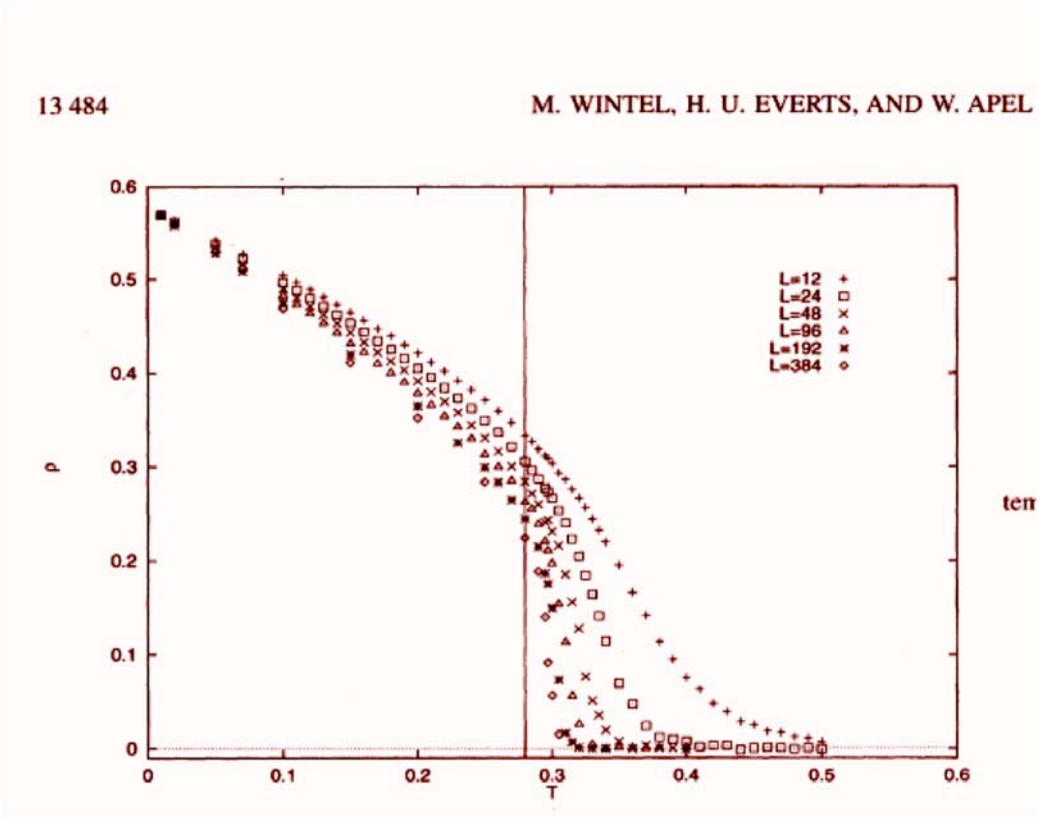




N-l σ model

FIG. 4. $T\ln(4T\xi^2)$ as a function of temperature T. The

spin stiffness versus T (Wintel et al 95)



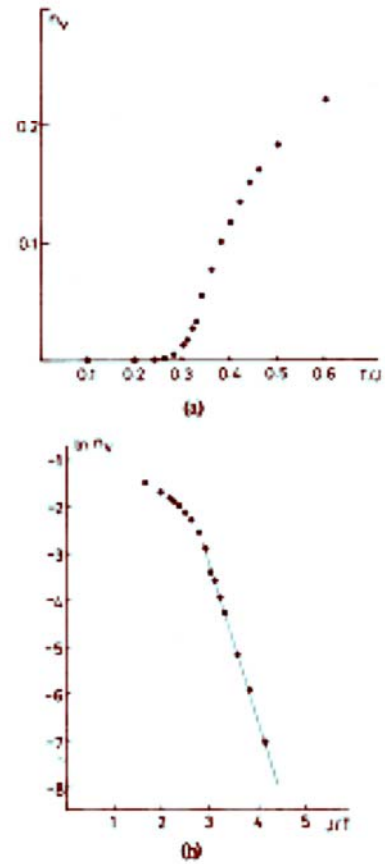


Fig. 10. Temperature dependence of the number density of the Z_2 vortices: (a) n_v vs. J/T and (b) $\ln n_v$ vs. J/T. The lattice size is $L = 30$.