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Topological defects in a spin-nematic phase on the triangular lattice

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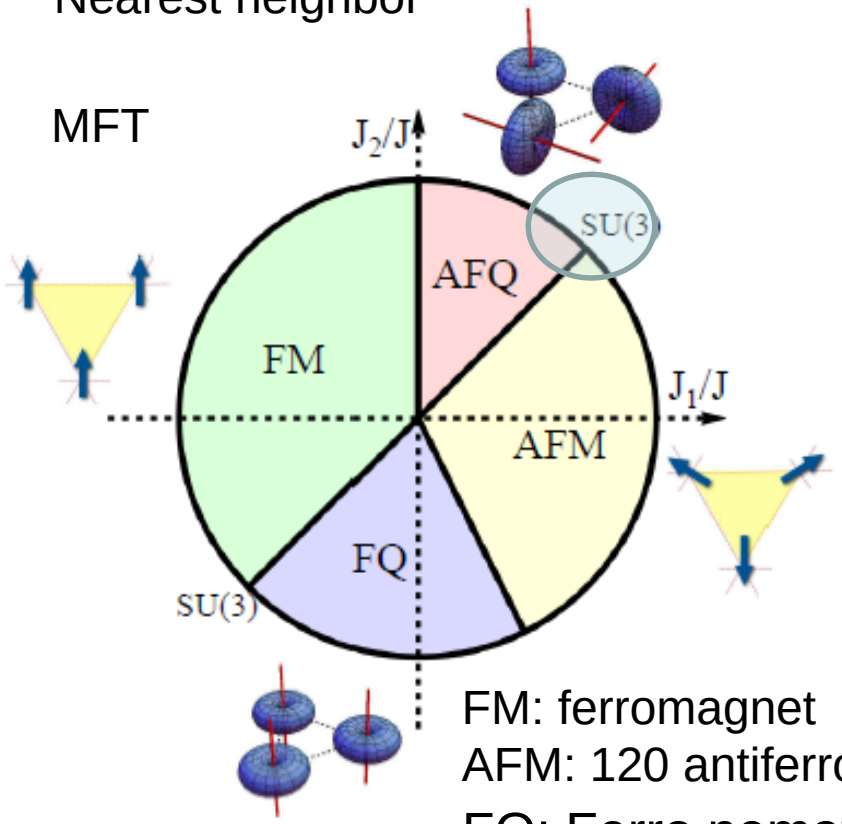
Spin-1 Bilinear-Biquadratic model on the triangular lattice

Spin 1

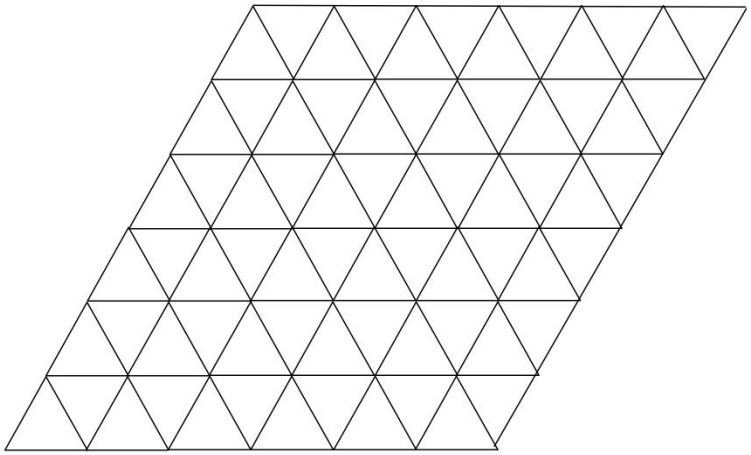
$$\mathcal{H} = \sum_{\langle \mathbf{l},\mathbf{m} \rangle} J_1(\mathbf{S_l} \cdot \mathbf{S_m}) + J_2(\mathbf{S_l} \cdot \mathbf{S_m})^2$$

Nearest neighbor

MFT



FM: ferromagnet
AFM: 120 antiferromagnet
FQ: Ferro nematic
AFQ: Antiferro nematic



Triangular lattice

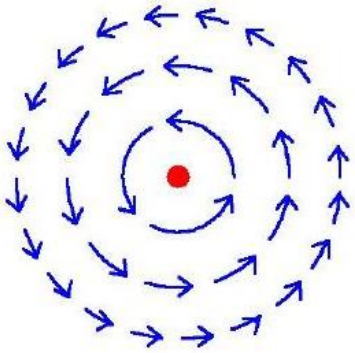
Related compounds:

$NiGa_2S_4$, Nakatsuji, et. al.

$Ba_3NiSb_2O_9$ Cheng, et. al.

Topological defect (π_1), soliton (π_2)

Example of π_1 defect: vortex in XY model



Example of π_2 soliton: Skyrmion in Heisenberg ferromagnet

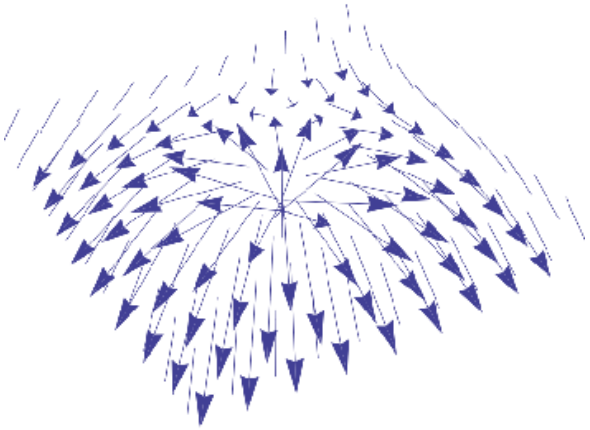


Table of topological defects

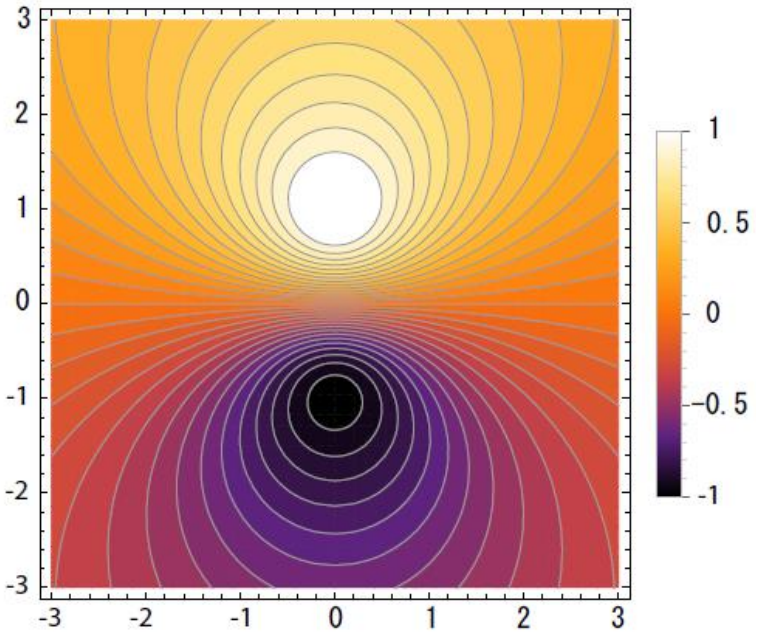
TABLE I: Topological defects in the BBQ model

BBQ in the triangular	MFT Ground state	GS order parameter space	π_1 (point defect)	π_2 (soliton)
$J_1/J_2 < 1$ $(J_{1,2} > 0)$	AF Quadrupolar	$SU(2)/\mathbb{Q}$	Quartanion	identity
$J_1 = J_2 > 0$	SU(3) AF	$SU(3)/(U(1) \times U(1))$	identity	$\mathbb{Z} \times \mathbb{Z}$
$1 < J_1/J_2 < -0.5$ $(J_1 > 0)$	120° AF	$SO(3)$=$SU(2)/\mathbb{Z}_2$	$\mathbb{Z}_2$	identity
$-0.5 < J_1/J_2 < 1$ $(J_2 < 0)$	FM Quadrupolar	$SO(3)/D_\infty = RP_2$	$\mathbb{Z}_2$	$\mathbb{Z} \geq 0$
$J_1 = J_2 < 0$	Ferro SU(3)	$SU(3)/(SU(2) \times U(1)) = CP_2$	identity	$\mathbb{Z}$
$1 < J_1/J_2$ $(J_{1,2} < 0)$ and $J_1 < 0, J_2 > 0$	FM	$SO(3)/SO(2)$=$SU(2)/U(1)$	identity	$\mathbb{Z}$

Q=(1,-1,0) case: Two of three sublattices = orthogonal CP_2 solitons

Charge 1
CP_2 soliton

<Sz> (<Sx,y>=0)



Director of the quadrupolor order