Phase behavior of a family of continuous two-dimensional $n$-vector models with $n = 2, 3, \text{and} 4$

E. Lomba*, N.G. Almarza and C. Martín
IQFR-CSIC,
Calle Serrano 119,
E-28006 Madrid

The presence of an unusual order-disorder transition in the two dimensional XY model has been known since the pioneering works of Berezinskii and Kosterlitz and Thouless. More generally, it has been found that similar transitions appear in lattice models of particular relevance in field theory and elementary-particle physics, such as the bidimensional $RP^{n-1}$ (real projective space in $n$-dimensions).

In this work we investigate the phase behavior of a family of continuous bidimensional $n$-vector models (with $n = 2, 3, \text{and} 4$) using Monte Carlo simulation, in which the explicit interaction is given by a hard sphere potential of diameter $\sigma$ with embedded $n$-dimensional spins, i.e.

$$u(r_{ij}, \omega_i, \omega_j) = u_{HS}(r_{ij}) + u_{ang}(r_{ij}, \omega_i, \omega_j),$$  

where $u_{HS}(r)$ is a hard sphere interaction, and the angular interaction is described by

$$u_{ang}(r, \omega_i, \omega_j) = -K u_0(r) \frac{1}{n-1} \left(\hat{s}_i \cdot \hat{s}_j\right)^2 n - 1$$  

with $\hat{s}_i = (s_{i1}, s_{i2}, \ldots, s_{in})$ being a $n$-dimensional unit vector describing the orientation of the spin in particle $i$. In Eq. (2) the spin coupling is defined by

$$u_0(r) = \begin{cases} e^{-\kappa(r-\sigma)} & \text{for } \sigma < r < R, \\ 0 & \text{for } r > R. \end{cases}$$  

Figura 1. Simulation results for the phase diagram of the planar $RP^{n-1}$ spin fluid for $n = 2, 3, \text{and} 4$. Symbols joined with dotted lines correspond to the states at which the BKT transition takes place and the line separates orientationally disordered states (lower densities) from states with quasi-long range order (higher density, quasi nematic states).

*E.Lomba@iqfr.csic.es

1 V. Berezinskii, Sov. Phys.-JETP, 32, 493 (1971)