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Competing nematic interactions in the XY model in two and three dimensions, GABRIEL CANOVA,

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■ Although there is no long-range order at finite temperature in two-dimensional systems with continuous symmetry, it is well known that the 2d XY model exhibits an unusual infinite order phase transition, associated with integer-vortex unbinding, which belongs to the Kosterlitz-Thouless (KT) universality class. In Ref. [1], a generalization of the XY model with a mixture of ferromagnetic and nematic-like interactions was studied:

$$H = - \sum_{\langle ij \rangle} [\Delta \cos(\theta_i - \theta_j) + (1 - \Delta) \cos(q\theta_i - q\theta_j)],$$

with $0 \geq \Delta \leq 1$. While the first term favors parallel alignment of the spins, the second one tends to induce a $2k\pi/q$ relative orientation between them ($k \leq q$). The higher order harmonics (in particular, $q = 3$ and 8) lead to further ordered phases and complex phase diagrams. Using a combination of extensive Monte Carlo simulations, finite size scaling and by studying the helicity modulus we extend the results of Refs. [1,2] and study the three dimensional case as well. In particular, for $q = 8$, the usual ferromagnetic phase is divided in two new phases with different kinds of ferromagnetic alignment and topological defects. The transitions between the ordered phases belong to a wide variety of classes, ranging from Ising 2D, Kosterlitz-Thouless and an unusual set of critical exponents. The results seem to be consistent in three dimensions, but the transitions between ordered phases with the paramagnetic one are second order and belong to the 3D XY universality class.

[1] Poderoso, Arenzon and Levin, Phys. Rev. Lett. **106** (2011) 067202

[2] Canova, Levin and Arenzon, Phys. Rev. E, **89** (2014) 012126