The Imry-Ma scaling law

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We have studied the influence of randomly distributed impurities on the range of orientational ordering of an ensemble of anisotropic rod-like objects. The impurities impose the random-anisotropy (RA) type of disorder. We have used a Lebwohl-Lasher type model, where the orientational ordering is described by the nematic director field in points of a cubic lattice in two (d=2) and three (d=3) dimensional space. Configuration of directors has been obtained by minimizing the total interaction energy of the system. Such a system represents a simplest toy model in which domain-type formation can be studied in phases or structures obtained via a continuous symmetry breaking transition. Due to pronounced universalities in such systems detail investigation of such a simple model could reveal useful information at a fundamental level. We have studied the range of ordering as a function of the sample history, anchoring strength and concentration of impurities.

Our simulations reveal that configurations reached by a quench from the isotropic phase always exhibit short range order (SRO). On the contrary, configuration reached from, e.g., a homogeneous initial condition could exhibit also long range or quasi long range. This observation is the key result of our study. Therefore, via different initial conditions range of ordering could be controlled. We further show that structures with SRO obey the Imry-Ma scaling law $\xi \propto W^{-2/(d-4)}$ [1], which relates the average domain size ξ with the disorder strength W. Note that this pivotal law describing ordering of weakly disordered systems exhibiting continuous symmetry breaking is still disputable.

References

(1) Y. Imry, and S. Ma, *Phys. Rev. Lett.*, **1975**, *35*, 1399