

Phase transitions in systems of particles with only hard-core interactions

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Outline

Lecture I:

General introduction to hard-core models

Lecture II:

Peierls' argument for crystalline order at high densities

High density expansion for ordered states

Singular expansions for systems with sliding instability

Lecture III:

Long rods, Onsager and Zwanzig models

Two Phase transitions in long rods

Entropy per site of full packing for large k

Lecture IV:

The Lee-Yang theory of phase transitions and the Lee -Yang Edge singularity

Connection to Directed and undirected branched polymers

Lecture V:

Phase transitions in hard rectangles, and hard cubes

References:

For Peierls argument: R. B. Griffiths, Phase transitions and critical phenomena, Ed. Domb and Green, Vol 1.

High density expansions: K. Ramola and D. Dhar, High-activity perturbation expansion for the hard square lattice gas, Phys. Rev. E 86, 031135 (2012); and references cited therein.

Long rods: N. Vigneshwar et al, On the orientational ordering of long rods on a lattice, A. Ghosh and D. Dhar, Europhys Lett. 78 (2007) 20003; Different phases of a system of hard rods on three dimensional cubic lattice, J. Stat. Mech. 2017 113304 (2017).

Lee-Yang theory: C. N. Yang and T. D. Lee, Phys. Rev.87, 404 (1952); S.-N. Lai and M. E. Fisher, J. Chem. Phys.103, 8144(1995).

Directed Animals: D. Dhar, Phys. Rev. Lett. 51, (1983) 853. Hard rectangles: T. Nath et al, Stability of columnar order in assemblies of hard rectangles or squares, Europhys. Lett. 114 (2016) 10003.

Hard Cubes: N. Vigneshwar et al, Phase diagram of a system of hard cubes on the cubic lattice, Phys. Rev. E99, 052129 (2019).