Applications of Statistical Mechanics

PROF. FAUSTO BORGONOVI

COURSE AIMS

To deal with few important problems in the modern statistical mechanics. In particular a deep understanding of one major topics is required at the end of the course.

COURSE CONTENT AND STRUCTURE

1)PHASE TRANSITIONS

A) Classification - I and II order Transitions - Ferromagnetic Transition - Phenomenology of Ferromagnetism - Heisenberg Model - Ising Model in D=1 and D=2 - Mean Field Theory - Correlation Functions - Spontaneous Magnetization – Bragg-Williams and Bethe-Peierls approximation schemes -

B) Critical Phenomena - Spontaneous Symmetry Breaking - Fluctuation-Response Theorem - Critical Exponents – Widom scaling – Fisher, Rushbrooke and Widom equations - Kadanoff's Theory - Scaling Theory - Renormalization Group.

2)CHAOS IN CLASSICAL SYSTEMS

A) Action-Angle Variables – Perturbation theory in Classical Mechanics : Poincare' – Von Zeipel series - Integrability - Area-Preserving Maps - Poincare' Surface of Section - KAM Theorem - Twist Map - Rotation Number - Kicked Dynamics - Tanget Map - Parabolic, Elliptic and Hyperbolic Fixed Points - Stable and Unstable Variety - Homoclinic Points Poincare' -Birkhoff Theorem - Transition to Global Stochasticity - Chirikov Overlapping Resonance Method - Greene's Method - Rational Approximants - Golden Mean.

B) Diffusion Equation - Stochastic and Markovian Processes - Chapman-Kolmogorov equation – Fokker-Planck equation – Brownian motion – Einstein relation.

C) Ergodic Theory -Metrical Indecomponibility - Birkhoff's Theorem - Lyapunov Exponents - Mixing - Baker map – Randomness - Bernoulli shift -

READING LIST (1)

K.HUANG, Statistical Mechanics , J.Wiley & sons, (1987).

J.J.BINNEY, N.J.DOWRICK, A.J.FISHER and M.E.J.NEWMAN, The Theory of Critical Phenomena, An Introduction to the Renormalization Group, Oxford Science Publications.

M.TODA, R.KUBO, N.SAITO Statistical Physics I Springer Series in Solid-State Science (1995).

READING LIST (2)

A.J.LICHTENBERG, M.A.LIEBERMAN Regular and Stochastic Motion, Applied Math. Series 38, (1983).

ARNOLD, A.AVEZ, Ergodic Problems of Classical Mechanics, Addison-Wesley Publishing; (1989).

L.E.REICHL, A Modern Course in Statistical Physics, John Wiley & Sons (1998)

A.I.KHINCHIN, Mathematical Foundations of Statistical Mechanics, Dover, New York (1949)

C.KITTEL , Elementary Statistical Physics, John Wiley & Sons, Inc. New York, 1958

TEACHING METHOD

Lectures. Homework exercises.

COURSE ASSESSMENT

The examination consists of a seminar.

NOTES

Students are required to have a good knowledge of thermodynamics (entropy, energy, and state equation), mechanics (Hamilton equations, canonical variables, and phase space) and quantum mechanics (Schrodinger equation, eigenvalues and eigenvectors).

Also , they are strong encouraged to attend lessons on Statistical Mechanics I too.

Prof. Borgonovi receives students after lectures. Students may also write to:

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