

Physics 304: Statistical & Thermal Physics

Fall 2026 TR 10:50- 12:05 PM

Course Description

Statistical mechanics is not simply a theory of heat. It explains how reversible microscopic laws give rise to irreversible macroscopic behavior. Centered on entropy, this course develops the statistical description of many-particle systems and confronts the origin of the arrow of time. We examine fundamental challenges such as the Loschmidt paradox and Maxwell's demon, which force us to think carefully about irreversibility, information, and the meaning of the Second Law.

From the explanation of blackbody radiation to the understanding of the structure of matter. Statistical ideas reach far beyond equilibrium physics. They shape condensed matter, biological systems, cosmology and more, connecting the behavior of everyday matter to the fate of the universe itself. By the end of the course, you will see statistical mechanics as a foundation of modern physics and as a subject that reshapes how we think about physical laws and evolution.

Topics Included

- Phase space and the statistical description of many-particle systems.
- Entropy and the foundations of macroscopic physics.
- Statistical ensembles and the partition function.
- Equilibrium distributions and the emergence of fundamental physical behavior.
- The thermodynamic laws from statistical principles.
- Irreversibility and the arrow of time.
- The Loschmidt paradox and Maxwell's demon as challenges to the Second Law.

