# Lecture 18 (2-1), Feb 27, 2023

## Overview of Thermal Physics

- Systems of particles typically exhibit *universal* behaviour: behaviour that applies to all systems, regardless of composition
- e.g. speed of particles in any gas that isn't too cold or too dense follows a Maxwell-Boltzmann speed distribution $n(v) \propto ve^{-kv^2}$ in 2D, $n(v) \propto v^2e^{-kv^2}$ in 3D
- Statistical mechanics forms an "explanation" of thermodynamics, providing a bridge between the microscopic and the macroscopic, through the main postulate of SM
- What do we need to describe a system of $N$ particles microscopically?
  - This gives the most detailed description
  - In classical mechanics we would have $\vec{r}_i(t), \dot{\vec{r}}_i(t)$ for $i = 1, \cdots, N$
  - For large $N$ (on the order of $10^{23}$) this would be hopeless to compute and useless to interpret
- To describe them macroscopically instead we use:
  1. The number of particles $N$
  2. The volume $V$
  3. The pressure $p$
  4. The temperature $T$
- Statistical mechanics connects these two
- Note both thermodynamics and statistically mechanics deal with systems in thermodynamic equilibrium:
  1. The system is uniform throughout its volume (density, pressure, temperature)
  2. These properties do not change in time
  3. No macroscopic fluxes – on average the net flow through any surface is zero
- Ideal classical gases have many particles, can be treated as point like objects classically and obeys the ideal gas law $pV = NkT$ where $k$ is the Boltzmann constant $k = 1.38 \times 10^{-23}$ J/K