PC 3151 – Thermal Physics of Bose and Fermi Gases

Lecturer: Prof. M. Moore

Books:

- Bowley, R. & Sanchez, M – Introductory Statistical Mechanics (Oxford) ("B&S")
- Kittel, D. & Kroemer, H. – Thermal Physics (Freeman) ("K&K")
- Mandl, F. – Statistical Physics (Wiley) ("M") (most of the basic ideas)
- Hook & Hall – Solid State Physics (Manchester Physics Series) (H&H)

Introduction

We will take some very fundamental ideas from quantum mechanics and thermal physics and apply them to systems which are very important, and also close to research frontiers.

We will deal with a wide variety of systems, e.g.:

- Ultra-cold dilute gases
- Stars
- Metals
- Semiconductors
- Liquid helium
- Blackbody radiation

Ideal Gases

Our calculations will all be for ideal gases. They have the property that particles do not interact with each other.

For many systems one can usually calculate the effect of weak interactions between particles pertubatively. We consider N particles in a volume V. We will ignore internal motion of particles e.g. rotation and vibration. We just consider translational motion. Calculations directly apply to monatomic gases: e.g. helium, but also electrons, neutrons, photons etc. The inclusion of the internal motion of particles is not difficult.

Two significant problems:

1) Particles obey Quantum Mechanics.
2) Particles are indistinguishable.