Physics 410 - 2004

Thermal Physics

Problem Set 2

1. Consider a system of $N = 100$ spins, each of magnetic moment $m = e\hbar/(2m_e)$ (e and m_e are the electron charge and mass), in a magnetic field $B = 1$ T. Assume that, as a result of interaction between the magnetic moments, each energy level $-2msB$ ($2s$ is the spin excess) is split, so that the energy levels of the stationary states fill the gap $2mB$ between the levels with given s and $s+1$ uniformly. For $s = N^{1/2}$ find the distance between the energy levels of interacting moments. Make an estimate of how long it will take to determine that the system is in a stationary state. For what N (approximately) does this time become of the order of the age of the universe? (5 pt)

2. Provide details of the transition

$$\sum_{s=-\infty}^{\infty} s^2 P(N,s) \to \int_{-\infty}^{\infty} s^2 P(N,s)\, ds$$

   and explain when it applies ($P(N,s)$ is the probability to have spin excess $2s$ in a system of N spins) (6 pt)

3. Problem 6, Chapter 2 (4 pt)

You need to have 15 points

The problems are from Kittel & Kroemer, *Thermal Physics*, 2nd edition, (Freeman, NY 1980).