8.512 Theory of Solids II
Spring 2009

8.512 Theory of Solids **Problem Set 11** **Due May 6, 2009**

1. Using the results of Problem 1, Set 10,

   (a) Calculate the low temperature $\chi_{\|}(T)$ for a Heisenberg antiferromagnet. Show that it is proportional to T^2.

   (b) For an antiferromagnet with an Ising anisotropy, argue that $\chi_{\|} \sim e^{-\Delta/T}$. What is the value of Δ?

2. Consider an antiferromagnet with exchange $-J$ on a cubic lattice with an anisotropy term $-DS_z^2$ where $D > 0$. We showed in class that the spin wave spectrum is

$$w(\mathbf{k}) = \sqrt{(w_0 + w_A)^2 - w_0^2|\gamma_k|^2} \tag{1}$$

   where $w_0 = 2zJS$, $w_A = 2DS$, $\gamma_k = \frac{1}{z}\sum_{\{\boldsymbol{\delta}\}} e^{i\mathbf{k}\cdot\boldsymbol{\delta}}$, and $\{\boldsymbol{\delta}\}$ is the set of vectors to the z nearest neighbors.

   (a) Show that in an external field H_z parallel to $\hat{z}$, the doubly degenerate spectrum is split as

$$w_{H_z}(\mathbf{k}) = w(\mathbf{k}) \pm g\mu_B H_z \quad . \tag{2}$$

   (b) Now consider an external field in the transverse direction, i.e., $\mathbf{H} = H_y\hat{y}$. What happens to the spin wave spectrum?