

Solid State Physics IV: Magnetism

Problem set 2

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Instructions: Please solve the problem and return it to me (hirschberger@ap.t.u-tokyo.ac.jp) by **December 23rd, 2022 at 17:30 Japanese Standard Time** at the latest. Please include your U. Tokyo student ID number. Written comments should be in English, but you can type the solution or hand-write it as you choose.

Problems 1-3: (were given in problem set 1)

Problem 4:

Calculate the eigenvalues of the effective spin Hamiltonian

$$\mathcal{H}_{spin} = \frac{1}{4}(E_s + E_t) - \frac{1}{4}(E_s - E_t) \boldsymbol{\sigma}_1 \cdot \boldsymbol{\sigma}_2$$

where the direct product of spin operators (Pauli matrix vectors $\boldsymbol{\sigma}_i$) is defined as in Lecture 7. Discuss in the context of the triplet and singlet eigenstates defined for the full exchange Hamiltonian in Lecture 7.

Problem 5:

Draw the wavevector (q) dependence of the Pauli paramagnetic susceptibility and Landau diamagnetic susceptibility. Explain the notion of a single-particle (electron / hole) excitation of the Fermi sea, as discussed in the lecture. Explain why the Pauli and Landau susceptibilities are suppressed to zero when the wavevector is $|q| \gg 2k_F$, where k_F is the Fermi wavevector in the spherical Fermi surface approximation.