

MID-TERM -2

**Physics 751
Advanced Solid State Physics
Fall, 2001**

1. A uniform $S = 1/2$ Fermi gas interacts only through a potential

$$U(k) = \lambda k^2 \tag{1}$$

find the self-energy and the effective mass to the leading order in λ .

2. A general homogeneous equation for the zero sound is

$$(s - \cos \theta) \chi(\theta, \phi) = \cos \theta \int F(\tilde{\theta}) \chi(\theta', \phi') \frac{d\Omega'}{4\pi} \tag{2}$$

where

$$\cos \tilde{\theta} = \cos \theta \cos \theta' + \sin \theta \sin \theta' \cos(\phi - \phi') \tag{3}$$

Find the velocities of the zero sound for $F = F_0 + F_1 \cos \tilde{\theta}$. When the solution with $\chi(\theta, \phi) = f(\theta) e^{i\phi}$ is possible?

3. Consider a 3D Fermi gas with a small constant interaction U . Obtain the result for $Im\Sigma(\omega, p_F)$ to the leading order in U (it should be of the order of U^2).