

Physics 5690
Quantum Many-Body Physics
Problem Set 5

Due: Monday, April 14, 2003

5.1 Consider a uniform system of spin-1/2 fermions at temperature T interacting via a spin-independent two-body interaction $V(\mathbf{r}_1 - \mathbf{r}_2)$.

- (a) Draw all second-order diagrams contributing to the proper self energy and write out the corresponding mathematical expressions using the Feynman rules in \mathbf{k}, ω_n space.
- (b) Evaluate all frequency sums appearing in these expressions. (You need not perform the momentum integrations).

5.2 Prove that

$$\frac{1}{2\pi i} \int_C f(z) \tanh z \, dz = \sum_{n=-\infty}^{\infty} f\left(\frac{2n+1}{2}i\pi\right),$$

$$\frac{1}{2\pi i} \int_C f(z) \coth z \, dz = \sum_{n=-\infty}^{\infty} f\left(\frac{2n}{2}i\pi\right),$$

where C is a contour enclosing the poles of $\tanh z$ for the first integral or $\coth z$ for the second integral.