

22.103 Microscopic Theory of Transport
(Fall 2003)

Problem Set No. 3

Due: October 14, 2003

Problem 1

Derive the three equations of continuum mechanics, the continuity equation for the mass density $\rho(\underline{r}, t)$, the momentum equation for mass current density $\underline{j}^M(\underline{r}, t) = \rho(\underline{r}, t)\underline{v}(\underline{r}, t)$, and the energy equation for the temperature density $T(\underline{r}, t)$. List and discuss briefly the assumptions invoked in deriving these results, in particular, point out how the transport coefficients, viscosity and conductivity, enter into the description.

Problem 2

Obtain the set of linearized hydrodynamics equations from the results of Problem 1. Transform the dependent variables from (ρ, \underline{v}, T) to (s, p, w, μ_1, μ_2) , where s is the entropy density, p the pressure, w the longitudinal current, and μ_1, μ_2 the transverse currents.

Problem 3

Use the linearized hydrodynamics equations of Problem 2 to calculate the dynamic structure factor $S(k, \omega)$. Show your result can be put into the form Eq.(5.3.15) in Boon-Yip.

Problem 4

Discuss the line shape of the dynamic structure factor by giving physical meaning to the peaks in the spectrum, and discussing what physical quantities are associated with the heights, positions and widths of the peaks.