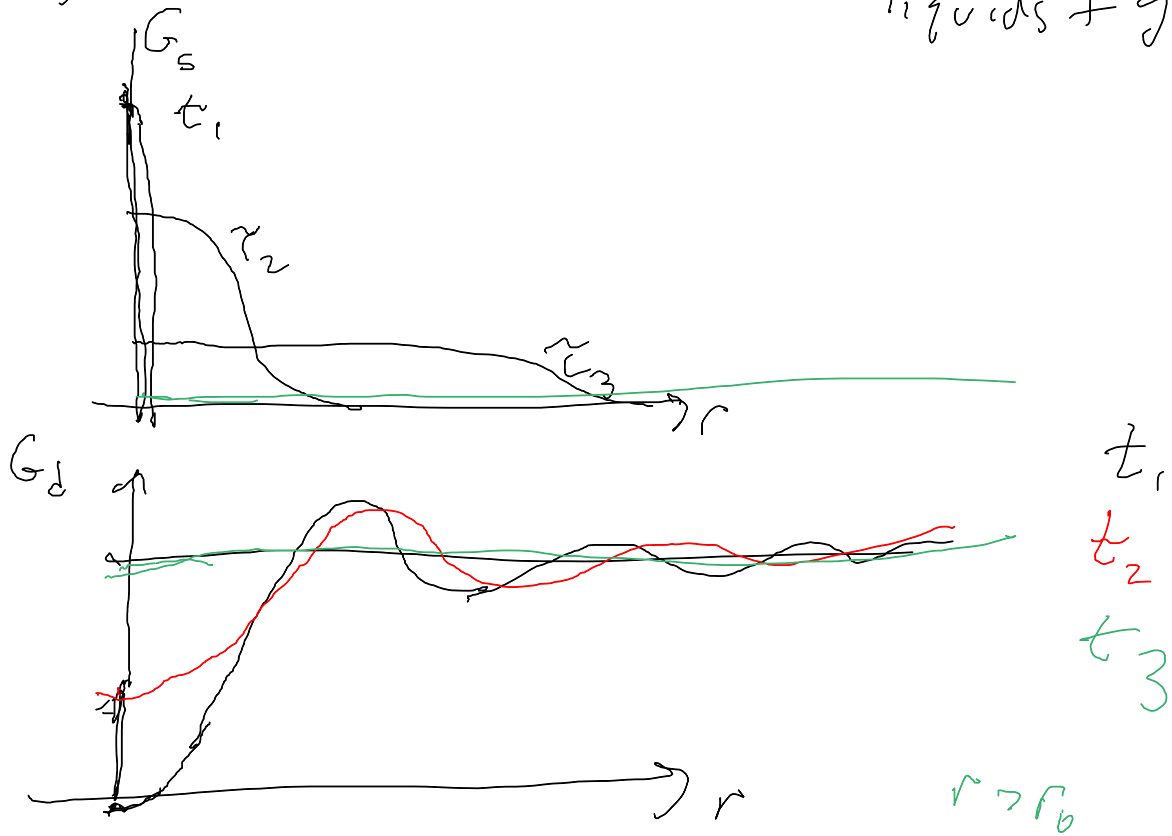
$$\int \omega\, S(Q,\omega)\, d\omega = \frac{\hbar Q^2}{2m}$$

$$\int S(Q,\omega)\, d\omega = S(Q)$$

liquids + gases



$r > r_0$

$t > t_0$

$$S(Q,\omega) = S^*(Q,\omega) = \int d^3r\, d\tau\, e^{(-i\omega\tau + iQ\cdot r)}\, G(r,\tau)$$

$$= \int d^3r\, d\tau\, e^{i\omega\tau - iQ\cdot r}\, G^*(r,\tau)$$

$$\Rightarrow \int d^3r\, d\tau\, e^{(\quad)}\, G^*(-r,-\tau)$$

$$G(r,t) = G^*(-r,-t)$$

$G(r,\tau)$ Gaussian Approx.

$$G_s \sim e^{-r^2/2\Gamma(t)} \left[\frac{1}{2\pi\Gamma(t)}\right]^{3/2}$$

$$\langle r^2 \rangle = \int r^2 G_s(r,\tau)\, d^3r \rightarrow 3\Gamma(t)$$

free particle $r^2 = \langle v^2 t^2 \rangle = t^2 \left(\frac{3kT}{m}\right) = 3\Gamma(t)$

$\Gamma(t) = 2D|t|$ $S(Q,\omega) \Rightarrow \dfrac{DQ^2}{\left[\omega^2 + (DQ^2)^2\right]}$

$$\frac{\partial \rho}{\partial t} + D\nabla^2 \rho = \delta(r,t)$$

$i\omega \langle \rho \rangle + DQ^2 \langle \rho \rangle = 1$

$$\frac{d^2\sigma}{d\Omega\, d\omega} = \frac{k_f}{k_0} \sum P_{n_0} \left| \sum_i a_i \langle n_f | e^{iQ\cdot R_i} | n_0 \rangle \right|^2 \delta(E)$$

inc $\Rightarrow$ $$\sum_i \left| a_i \langle \quad | \quad | \quad \rangle \right|^2$$

$$\vec{R}_i = \vec{\rho}_i + \vec{u}_i \qquad KE = \sum \frac{m_i \dot{u}_i^2}{2}$$

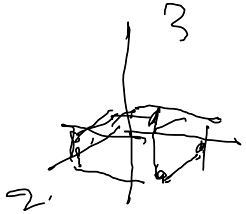
$$V = \frac{1}{2} \sum \alpha_{ij}^{\mu\nu} u_i^\mu u_j^\nu + \cdots$$

$$m \ddot{u}_i^\mu = -\frac{\partial V}{\partial u} = -\sum_{j,\nu} \alpha_{ij}^{\mu\nu} u_j^\nu$$

normal modes $$u_i^\nu(t) = \frac{\gamma^\nu}{\sqrt{M}} e^{i(q\cdot\rho_i - \omega t)}$$

$$\vec{q} = q_1 \vec{\tau}_1 + q_2 \vec{\tau}_2 + q_3 \tau_3$$

$$\tau_\alpha a_\beta = 2\pi \delta_{\alpha\beta}$$



$a_{1,2,3}$

$\rho_i = n_1 \vec{a}_1$

$$\omega^2 \gamma^{\mu} = \sum_{\nu} \lambda^{\mu\nu}(q)\, \gamma^{\nu}$$

$$\mathrm{Det}\, \| \omega^2 \delta_{\mu\nu} - \lambda^{\mu\nu}(q) \| = 0$$

$s \qquad \omega_s^2(q) > 0 \qquad s = 1, 2, 3$

$$\vec{u}_l = \sum_{s,q} A_{s,q}(t)\, \gamma_{s,q}\, e^{i(q \cdot r)}$$

$$KE = \sum_{s,q} \left(\dot{A}_{s,q} \dot{A}^{*}_{s,q} \right)$$

$$V = \sum_{s,q} \omega^2(s,q)\, A_{s,q} A^{*}_{s,q}$$

$$H = (\dot{A}\dot{A}^{*} + \omega^2 A A^{*}) \qquad A_{s,q} = [a_{s,q} + a^{\dagger}_{s,q}]\sqrt{\frac{\hbar}{2\omega_{s,q}}}$$

$$x = a + a^{\dagger} \qquad H = \hbar\omega_{s,q}[a^{\dagger}a + 1/2]$$

$$\vec{u}_i = \sum_{s,q} \sqrt{\frac{\hbar}{2\omega_{s,q} M N}}\, \vec{\gamma}(s,q)\,[a_{s,q} + a^{\dagger}_{s,q}]$$

$$= \left(\xi_i(s,q)\, a_{s,q} + \xi^{*}(s,q)\, a^{\dagger}_{s,q} \right)$$

$$\langle n_f | e^{iQ\cdot(\rho + u)} | n_0 \rangle$$

$$\prod_{s,q} \langle n_f | e^{iQ\cdot\rho_i} (e^{iQ\cdot(\xi a + \xi^{\dagger} a^{\dagger})} | n_0 \rangle$$

$$1 + i(Q\cdot\xi a) - (Q\cdot\xi)^2\, a^2 + (a^{\dagger})^2 + (a a^{\dagger}) Q^2$$