Problem C11.1 Show that

$$\Delta^{\mathrm{adv}}_{AB}(\omega) = \Delta_{AB}(\omega - i0^{+})$$

Problem H11.1

(a) For real τ, let

$$\Delta_{AB}(-i\tau) := \langle \mathrm{T} A(-i\tau) B(0) \rangle$$

where the imaginary-time ordering T was defined in the lecture. Show that this expression is well-defined for $-\beta \leq \tau \leq \beta$.

(b) Demonstrate the following periodicity relation

$$\Delta_{AB}(-i[\tau + \beta]) = \pm \Delta_{AB}(-i\tau)$$

for bosonic, fermionic operators A and B.

(c) Consider a system with a conserved charge Q, so that one can introduce a chemical potential into the statistical operator,

$$\rho = \exp\{\beta(\mu Q - H)\}$$

Furthermore, let the operator A carry the charge q_A, that is,

$$[Q, A] = q_A A$$

How does the presence of μ modify the periodicity relation in (b)?