Phys635, MBQM II-Semester 2022/23, Tutorial 2, Wed 25.1.

Please sit in your assignment teams, two or three teams to a table (behave like Bosons, not like Fermions). Do the "Stages" in the order below. When all teams finished a stage, elect a student to present and explain on the board.

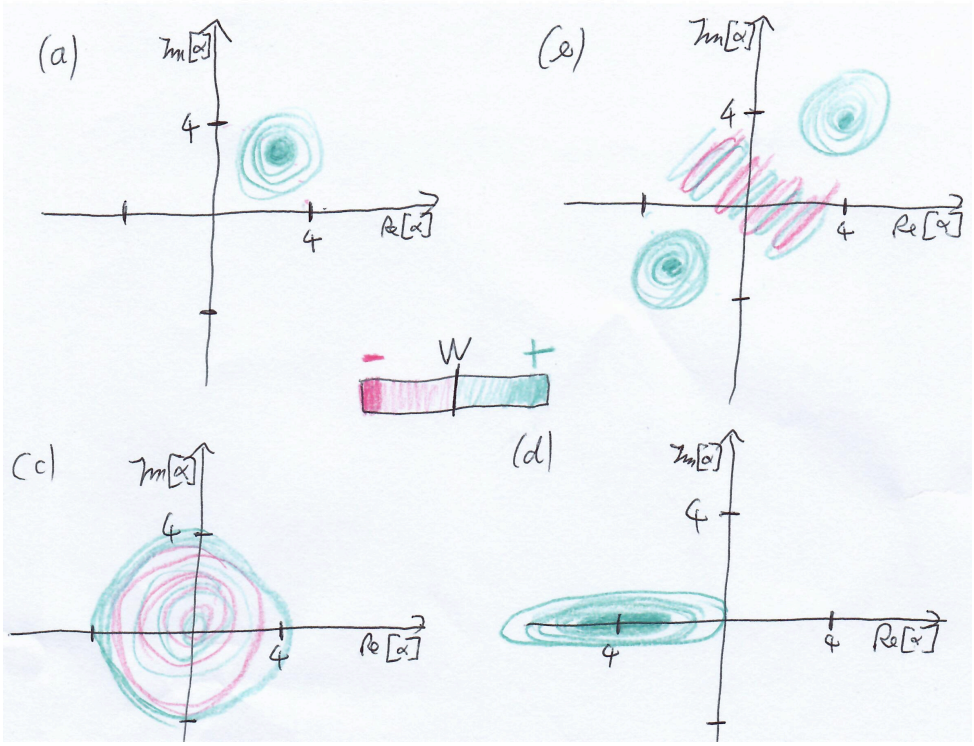
Stage 1 If you haven't done it yet, please to Stage 3 of tutorial 1.

Stage 2 Consider the following two-mode Hamiltonian for Fermions:

$$\hat{H} = 2E_c\hat{c}^\dagger\hat{c} + E_d\hat{d}^\dagger\hat{d} + J\hat{c}\hat{d} + J\hat{d}^\dagger\hat{c}^\dagger + J\hat{c}^\dagger\hat{d} + J\hat{d}^\dagger\hat{c}. \tag{1}$$

Find its eigenenergies and eigenstates.

Stage 3 What is the interpretation of the following Wigner functions for a single mode many-body state, in terms of the mean and fluctuations of (i) particle number and (ii) the phase of the underlying field?



Stage 4 Quantum Fields: Discuss the following in your team, then on your table. Use the board as well.

(i) Suppose you want to solve Eq. (2.33) for the quantum field operator in some brute force manner. How could you try this in principle? When does it work? When does it not work?

(ii) What is a quantum field?

(iii) Which disciplines use quantum fields? How are they used there.