

1 Purpose of the visit

The purpose of my visit in the group of Professor Hubert Saleur in Saclay is to develop one or more scientific collaboration on subjects related to quantum mesoscopic physics and possibly cold atom problems. Discussions on these matters were initiated before I came to Saclay and it appeared natural to extend these discussions by a longer visit. The institute where Professor Hubert Saleur is working has a strong reputation in quantum field theory and it is a very good place to broaden my knowledge on more formal technics.

2 Description of the work carried out

I have started basically two projects during my short stay. (i) one project with O. Parcollet and X. Waintail (SPEC, Saclay) which is to study the formation of a Wigner crystal from a gas of bosons interacting via dipole interactions. This problem is of strong interest for experiments in cold atomic gases where the regime of Wigner crystallization is certainly feasible with heteronuclear molecules. The way to proceed that we follow is to build an extension of a Monte-Carlo analysis that was previously carried out for fermions. Part of our work has been to determine the relevant physical scale for this problem as well as the possible phases that can appear and how to detect them from the Monte-Carlo simulations. (ii) the second project has been started in collaboration with C. Pépin and concerns the study of fluctuations around a quantum critical point with an associated helicoidal order parameter. This is a fundamental problem that could be applied in particular to heavy fermions compounds, where Fulde-Ferrel-Larkin-Ovchinnikov (FFLO) phases is suspected to emerge at strong magnetic fields. This is also typically a strong coupling problem where conduction electrons are non-perturbatively affected by critical bosonic fluctuations from the order parameter. Most of my work on this problem has been devoted so far in understanding specific diagrammatic technics that are usually used for this kind of problem.

3 Description of the main results obtained

For project (i), we have identified physical parameters that control the Wigner crystallization and shown its experimental feasibility. We have obtained a Monte-Carlo code that is now running for bosons and which gives energies with a very good precision. For project (ii), no specific results have been obtained so far but the problem has been clearly defined. Both projects are still ongoing.

4 Future collaboration with host institution and projected publications

Both projects are on good tracks but still need some work to be completed. They should both lead to publication. In the future, I plan to develop more my collaborations with the group of Professor Hubert Saleur and I was hired as a post-doc in his group starting next september.