

SCIENTIFIC REPORT

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PURPOSE OF THE VISIT

My research activity is principally performed in collaboration with Iacopo Carusotto, who at the time of the visit was chercheur associé of CNRS at the Institut Henri Poincaré. The purpose of my visit to Paris was to proceed along my main research line, but also to join I. Carusotto's collaborations on related radiation-matter interaction topics in several Paris institutions.

DESCRIPTION OF THE WORK CARRIED OUT DURING THE VISIT

During my visit, I had the chance of having a continuous and fruitful interaction with my host Dr. Carusotto. Together, we addressed the possible application of an atomic Mott insulator as a photon energy lifter: a device designed to change the energy of a slowly travelling photon. In particular, we concentrated on the specific atomic level configuration needed for a practical implementation of this kind of device using experimentally realistic systems.

While carrying on this project, I also had the opportunity to get in contact with my host's closest collaborators and get useful feedback from them.

Prof. Castin (ENS) and his collaborators Dr. Weiss (University of Holdenburg) and Dr. Werner (ENS) raised interesting questions about the assumptions underlying the model I am using, concerning the role of dimensionality in the description of light propagation and the effects of the finite size of the system on absorption.

I also had stimulating discussion with Prof. Ciuti and Dr. De Liberato (University of Paris 7) about the Hopfield approach used in my work: Dr. De Liberato is presently working on a related project concerning the application of the Hopfield-Bogoliubov formalism to study dynamical Casimir effect and it was very useful to exchange our expertises.

I was hosted at the Henry Poincaré Institute where I participated to the workshop Quantum Gases (see <http://www.phys.ens.fr/~castin/ihp07.html>) which is presently in progress at the Institute. In this framework, I attended seminars and lectures on different topics, such as the effects of interaction and disorder in bosonic and fermionic gases, the behaviour of Feshbach resonances, the superfluidity in bosonic and fermionic systems with different configurations, application of condensed matter physics concepts to quantum computation, and quantum non linear optics.

DESCRIPTION OF THE MAIN RESULTS OBTAINED

The main result of my stay in Paris has been the identification of the 3-level atomic configuration needed to obtain a slow group velocity of light and simultaneously a vanishing reflectivity at the system interfaces. These are essential requirements in view of the photon energy lifter operation.

We characterized the different regimes as a function of the system parameters such as the coupling Rabi frequency, the detuning of the coupling laser beam and the variation in the atomic resonance frequency, induced for example by a Zeeman effect. Thanks to these last results, the study of the 1D configuration is almost completed.

Taking advantage of the suggestions coming from the discussions I had in Paris, I am presently starting to attack the full 3D problem.

PROJECTED PUBLICATIONS TO RESULT FROM GRANT

During this short term visit we almost completed the research project on 'Light propagation in atomic Mott insulator'. We should be able to publish these results within few months.

In the meanwhile, I am presenting these results as a poster at several summer schools, e.g., the one 'Advances on Nanophotonics II' in Erice (June,22nd - July,2nd) and the one 'Novel quantum phases and non equilibrium phenomena in cold atomic gases' that will take place in Trieste at ICTP (August,27th - September,7th).