

Pre-doctoral school on Interaction of Light with Cold Atoms

Proposal of School

on the 30 of January - 10 of February 2017

at ICTP-SAIFR on the IFT-UNESP (São Paulo)

Organizers

Romain Pierre Marcel Bachelard

Instituto de Física de São Carlos-USP

Philippe Wilhelm Courteille

Instituto de Física de São Carlos-USP

Robin Kaiser

Institut Non Linéaire de Nice (France)

Rodrigo Figueiredo Shiozaki

Instituto de Física de São Carlos-USP / Universidade Federal de São Carlos

Raul Celistrino Teixeira

Instituto de Física de São Carlos-USP / Universidade Federal de São Carlos

1 - Introduction

Light-matter interaction is one of the oldest scientific topics, and one of the broadest and most fundamental. Yet, incessant developments of both, new light scattering materials and new sources of light, keep the interest in this topic alive. Particularly fertile were progresses made during the past three decades in the preparation of cold matter and the suppression of classical noise allowing for the emergence and even the experimental manipulation of special coherence properties for both the matter and the light. These developments brought the fields of quantum optics and ultracold matter closer to applications, for example, in quantum sensing and quantum information processing.

This school aims at training young graduate students in the physics of light interacting with cold atoms, introducing them to the basics, and familiarizing them with applications in modern technology. It will gather a few dozens of students from Brazil, South America, and abroad to follow the courses of renowned lecturers and get a grasp on the most recent trends in the field of cold matter and quantum optics. The details on the organization follow in the next sections.

2 - Organization

Apart from the staff of ICTP-SAIFR, the organization will be supported by:

- Romain P. M. Bachelard, Instituto de Física de São Carlos-USP (lattes.cnpq.br/4344589799192534)
- Philippe W. Courteille, Instituto de Física de São Carlos-USP (lattes.cnpq.br/3084890968061662)
- Robin Kaiser, Institut Non Linéaire de Nice, France (www.kaiserlux.de/coldatoms)
- Rodrigo F. Shiozaki, Instituto de Física de São Carlos-USP* (lattes.cnpq.br/6108339817883159)
- Raul C. Teixeira, Instituto de Física de São Carlos-USP* (lattes.cnpq.br/3189953952347778)

* These two researchers recently obtained a Professor position at the Universidade Federal de São Carlos.

These researchers have already organized several events, the most recent being a workshop on Collective Scattering of Light (<http://www.ifsc.usp.br/~bachelard/coscali2016>).

3 – Program

The school will be composed of a series of introductory lectures, followed by more specialized lectures (although pedagogical presentations will be suggested to all speakers). In addition, two poster sessions will be organized for the students, and the opportunity to present their research project will be offered to the best students, under the form of short (10 minutes) talks. Thus the students are encouraged not only to learn about physics, but also how to present it.

The *three introductory lectures* will be composed each of 4 lectures of 1h30, to be delivered during the first week of the school. They will be given by:

- Jean-Michel Raimond*: “*Second quantization, photons and atoms*” (6h)
CV: www.cqed.org/spip.php?article21&lang=fr
- Claus Zimmermann: “*Cooling and trapping atoms*” (6h)
CV: fit.uni-tuebingen.de/Portfolio?id=289
- Jean Dalibard*: “*Optical lattices*” (6h)
CV: www.phys.ens.fr/~dalibard/index_en.html

The lecturers will be invited to give a session of practical exercises to complete the students’ training.

A series of three *specialized lectures* will be given during the second week, and will last four hours each. The speakers will be:

- Luiz Davidovitch: “*Quantum information with photons*” (4h)
CV: www.if.ufrj.br/~ldavid/eng/index.php
- Matthias Weidemüller: “*Cold Rydberg systems*” (4h)
CV: www.physi.uni-heidelberg.de/Forschung/QD/index.php?show=people&member=weidemueller_matthias
- Robin Kaiser: “*Coherence and diffusion in light-matter interactions*” (4h)
CV: www.kaiserlux.de/coldatoms

Finally, four *long talks* of one hour and a half will be provided by experts on the recent developments of light-cold atoms interaction in Brazil. The speakers will be:

- Daniel Felinto*: “*Non-classical states of light*” (1h30)
CV: lattes.cnpq.br/6850973264206190
- Philippe W. Courteille: “*Cold atoms in optical cavities for quantum sensing*” (1h30)
CV: www.ifsc.usp.br/~strontium/
- Luís G. Marcassa*: “*Ultra-cold molecules*” (1h30)
CV: lattes.cnpq.br/8110689415962084
- Paulo A. Nussenzveig*: “*Quantum optics for quantum information*” (1h30)
CV: lattes.cnpq.br/4861897515540913

4 – Scientific contribution

The presence of outstanding speakers with highest international renown, such as Luiz Davidovitch and Matthias Weidemüller guarantees that the students attending the event will benefit from an excellent training. This will contribute greatly to their education, both for master and PhD students.

The lectures may also attract students to the important topics of ultracold matter and its interaction with light, quantum optics, and quantum information. Thus the groups participating in the event may eventually benefit from the venue of students interested in working in the field.

The lectures with an * refer to people who did not confirm yet their participation, due to our late learning of the deadline (announcement on the 17.12.2015 from the Boletim SBF).

5 – Public

The students we aim at attracting to the school are master students and PhD students, from fields related to those of light scattering, quantum information and quantum optics. The participation of undergraduate students with exceptional track record will also be considered.

6 – Budget

Our objective is to gather about 50 students from the fields discussed during the school. The organizers plan to send proposals to the Brazilian funding agencies (FAPESP, CAPES and CNPq) to be able to complement, as much as possible, the ICTP-SAIFR fundings.

Lecturers/speakers:

Among the six lecturers of introductory and specialized lectures, Robin Kaiser (INLN, France) benefits until July 2017 from a Pesquisador Visitante Especial grant from CNPq, so his participation to the school does not require extra funding.

The Universität Tübingen (Germany), from which Claus Zimmermann comes from, has recently installed a strategical partnership with the Universidade de São Paulo, and exchanges of researchers between the institutions will be financially supported. Thus we will seek support for C. Zimmermann's flight to São Paulo state by coupling his venue as a lecturer with a visit to USP, so he may need only local support for his participation in the school.

Three lecturers will require support for their travel from Europe (M. Weidemüller, J.-M. Raimond, and J. Dalibard), and L. Davidovitch for his travel from Rio de Janeiro. All four lecturers will also need support for a one-week stay at the school.

Finally, the speakers for the *long talks* are expected to join for only one or two days, so their expenses should be minimal.

The budget estimation is based on a per-diem of R\$325, and on flight tickets of R\$3.500 from Europe and R\$800 for national flights (on average).

Students:

As for the students, we will support their venue as much as possible, depending on the ICTP-SAIFR fundings, as well as that of the Brazilian funding agencies. The selection of the students admitted to and funded by the school will be based on:

- Academic record of the student,
- Motivation letter to justify their participation,
- Adequacy between the student research project and the school topics,
- Capacity of the student to obtain funding from other sources.

Note that priority will be given to Brazilian and South-American students, and a proportion of 40% Brazilian students, 40% South-American students, and 20% from abroad is expected.

The budget estimation is based on a per-diem of R\$140 (R\$105/student in triple room, plus R\$35 as a food allowance, for 25 students), and on flight tickets of R\$800 for national flights (on average, and for 10 students) and R\$1.500 for flights from South America (for 10 students).

Finally, if the budget allows, we will support the travel of students from developing countries on other continents (R\$3.500 per ticket, for 5 students potentially).

The overall (tentative) budget is the following:

Item	Unitary value (R\$)	Number of units	Total (R\$)
International flight (lecturers)	3.500	3	10.500
National flight (lecturers/speakers)	800	2	1.600
5-day local support (lecturers)	1.625	5	8.125
1-day local support (speakers)	325	4	1.300
12-day local support (students)	1.680	25	42.000
National flights (students)	800	10	8.000
International flight (South-American students)	1.500	10	15.000
International flight (students/other continents)	3.500	5	17.500
		Total	R\$104.025

7 - Diffusion

Announcing the school is crucial to turn the school into a successful event, in order to optimize both number and quality of the participating students. Announcement of the school will be sent to collaborators throughout Brazil, South America and abroad, but will also be divulgated through the announcements of the Sociedade Brasileira de Física, the FAPs, and the Pós-Graduações de Física of Brazilian universities.

A poster and a webpage of the school will also be created.