# INSTANS Summer School 2007 at Oxford

January 3, 2008

## 1 Summary

A central part of the original INSTANS proposal was to hold two summer schools, one in year 2 and one in year 4. The first school took place at Oxford from 26. August to 02. September 2007. Six lecturers gace a total of 38 one-hour lectures. The lecturers were

1. Paul Fendley (Topological Quantum Computation)
2. Thierry Giamarchi (Low Dimensional Strongly Correlated Systems)
3. Giuseppe Mussardo (Semiclassical and Integrable Methods in QFT)
4. Hubert Saleur (Integrable Models and Impurity Problems)
5. Kareljan Schoutens (Phases of rotating bosons)
6. Ignacio Latorre (DMRG and quantum entanglement)

A total of 56 graduate students and post-docs as well as six senior scientists participated in the school. The participants were housed at Worcester College Oxford and the lectures took place in the state of the art Martin Woods lecture theatre in the Physics Department of Oxford University.

The feedback from the participants was excellent. The general feeling was that the lectures were of the highest quality and participants felt that they had learned a lot during the school. Despite a very intense schedule the enthusiasm of both lecturers and participants remained undiminished until the very end.

In summary the school was a great success. The training provided to the participants was of excellent quality and covered a number of different areas in the INSTANS remit.

## 2 Scientific Content

The six lecturers had been chosen to cover a broad spectrum of topics within the INSTANS remit.

**Prof. Fendley** gave six lectures on "nonabelian anyons", which are a central ingredient in topological quantum computation. The latter is a very hot topic at the moment as it suggests the possibility of quantum computation without the need for error correction. Prof Fendley introduced the concept of nonabelian anyons and gave an introduction to the underlying mathematical structure.

**Prof. Giamarchi** gave a series of eight blackboard lectures on bosonization methods for strongly correlated one dimensional systems of fermions and bosons. The lecture course was loosely based on Prof. Giamarchi's book on this topic. Bosonization is a standard method of analyzing low dimensional strongly correlated fermion and boson systems and have enabled much of the recent progress in nanoscale systems such as carbon nanotubes and quantum wires. They also have found important applications to ultra-cold atomic gases. Prof. Giamarchi's lectures provided an entirely self-contained, thorough treatment of the fundamentals of bosonization.

**Prof. Latorre** presented six lectures on quantum information and the simulation of quantum systems. Quantum information theory has recertly led to a clear understanding why certain quantum systems can be analyzed very efficiently on a classical computer while others can't. One of the central topics covered by INSTANS are strongly correlated low dimensional systems and Prof. Latorre explained DMRG, PEPS and MERA algorithms of studying them.

**Prof. Mussardo** gave six lectures on semiclassical and integrable methods in two dimensional quantum field theory. Amongst other applications these methods have recently allowed the calculation of dynamical response functions in (quasi) one dimensional quantum magnets and Mott insulators and much insight has been gained from these calculations. They are significantly beyond the material covered in advanced graduate courses at most Universities. Hence the summer school provided an excellent opportunity for the participants to learn about these methods.

**Prof. Saleur** gave eight lectures on bosonization in two dimensions, conformal field theory, boundary conformal field theory and the field theory approach to the Kondo problem. The core of these lectures was concerned with the application of conformal field theory techniques to quantum impurity problems. While these methods have proved to be very powerful and useful in analyzing quantum impurity problems, they are usually considered to be too advanced to be covered in graduate courses and the summer school provided an excellent opportunity for the participants to learn about them.

**Prof. Schoutens** gave four lectures on phases of rotating bosons. These are/can be realized in systems of trapped ultracold atomic gases. Prof. Schoutens' lectures provided an introduction to this exciting area. This was particularly useful as most of the participants had condensed matter or field theory backgrounds.

# 3 Final Programme of the Meeting

| | Monday | Tuesday | Wednesday |
|---|---|---|---|
| 9:30–10:30 | Saleur | Latorre | Fendley |
| 10:30–11:30 | Schoutens | Schoutens | Mussardo |
| 11:30–12:00 | Coffee | Coffee | Coffee |
| 12:00–13:00 | Latorre | Mussardo | Saleur |
| 13:00–14:30 | Lunch | Lunch | Lunch |
| 14:30–15:30 | Saleur | Latorre | Fendley |
| 15:30–16:30 | Schoutens | Fendley | Mussardo |
| 16:30–17:00 | Break | Break | Break |
| 17:00–18:00 | Mussardo | Schoutens | Saleur |

| | Thursday | Friday | Saturday | Sunday |
|---|---|---|---|---|
| 9:30–10:30 | Giamarchi | Mussardo | Saleur | Giamarchi |
| 10:30–11:30 | Latorre | Fendley | Latorre | Giamarchi |
| 11:30–12:00 | Coffee | Coffee | Break | |
| 12:00–13:00 | Saleur | Giamarchi | Giamarchi | |
| 13:00–14:30 | Lunch | Lunch | Lunch | |
| 14:30–15:30 | Giamarchi | Mussardo | Saleur | |
| 15:30–16:30 | Latorre | Fendley | Fendley | |
| 16:30–17:00 | Break | Break | Break | |
| 17:00–18:00 | Saleur | Giamarchi | Giamarchi | |