



*2015 International Jacques Solvay Chair in Physics
Programme*

Professor Peter Zoller
University of Innsbruck, Austria

Inaugural Lecture

Tuesday 6 October 2015 at 4.00 P.M. in the Solvay Room

A Quantum Leap in Quantum Information

Building Quantum Computers and Quantum Simulators with Cold Atoms and Ions

On a microscopic scale our world is governed by quantum physics. Apart from fundamental questions and 'mysteries' of quantum physics, learning how to control this microscopic world is also an opportunity for new applications and quantum technologies - potentially more powerful than their classical counterparts. In this lecture we discuss recent progress in building quantum computers and quantum simulators. We will focus on quantum optical systems of atoms and ions manipulated by laser light, providing prime examples of quantum systems, which can be controlled on the level of single quanta. This includes a discussion of trapped ions as a universal quantum processor, and digital and analog quantum simulation of strongly correlated quantum matter with atoms in optical lattices. We conclude with an outlook on a 'quantum internet' and building a 'quantum annealer'.



Lecture 1

Thursday 15 October 2015 at 4.00 P.M. in the Solvay Room

**'Towards quantum simulation of lattice gauge theories
with atom in optical lattices'**

Cold bosonic or fermionic atoms loaded into optical lattices provides a toolbox for engineering many-body quantum systems. In the past this has led to a very fruitful interaction with condensed matter physics, building quantum simulators of strongly correlated systems with cold atoms. In this talk we will be interested in quantum simulation of lattice gauge theories on the level of toy models in high energy physics. Examples to be discussed are the Schwinger Model, non-Abelian $SU(N)$ and $U(N)$ models as so-called 'quantum link models', and $CP(N-1)$ models related to $SU(N)$ quantum magnetism.

****A workshop on "Quantum Simulation with Cold Matter and Photons" (8-11 February 2016) is organized in context of the 2015 International Jacques Solvay Chair in Physics**

**** The rest of Prof. Zoller's lectures will be given in February
(dates to be announced in due course).**

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Lecture 2
Thursday 18 February 2016 at 4.00 P.M.
SOLVAY ROOM

**Driven-dissipative quantum many-body systems
a quantum optical perspective**

We will start with a brief introduction to quantum noise from the perspective of quantum optics. We then present examples from quantum optics, and cold atomic gases on engineered driven-dissipative many-body quantum systems, where the goal is to produce interesting and novel quantum phases and entangled states in this non-equilibrium setting. We will outline both the underlying theoretical aspects, as well as show recent experimental results with cold atoms and ions.

