David N. Jamieson

Centre for Quantum Computation and Communication Technology (CQC2T)

School of Physics, University of Melbourne, Australia

Towards the quantum internet of the mid-21st C: Building quantum bits in silicon

Martedì 5 febbraio, 14:00

sala Castagnoli, Dipartimento di Fisica, via P. Giuria 1

contatto: **Paolo Olivero (olivero@to.infn.it)**

Dipartimento di Fisica

Università di Torino

Abstract

The 2012 Physics Nobel prize recognised Serge Haroche and David Wineland for their pioneering work measuring and manipulating individual quantum systems with many consequences including the first steps towards a quantum computer. Their work involved the manipulation of photons in cavities and the laser cooling of trapped ions in a vacuum.This presentation describes a different approach to quantum computer technology based on engineered single donor atoms in the most important material of the IT industry: silicon.

Ultimately this approach aims to exploit the fact that isotopically pure 28-Si is free of unpaired spins: a “semiconductor vacuum”. Our approach is to use Ion Beam Induced Charge (IBIC) to engineer silicon nano-scale Complementary Metal-Oxide-Semiconductor (CMOS) field effect devices with a single phosphorous atom implanted with our deterministic doping method that is cited by the International semiconductor roadmap for 2011. Our devices have now proved the ability to perform single shot readout of the donor electron spin. We use electron spin resonance to drive Rabi oscillations to show a coherence time (T2) exceeding 200 μs suggesting a single electron spin can be used as a long-lived quantum bit. Further, the same device has allowed us to perform nuclear magnetic resonance on the single 31-P nuclear spin by coupling the electron and nuclear spins and hence providing access to an even longer-lived nuclear qubit.

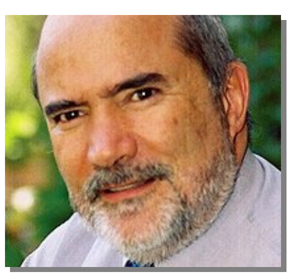
This presentation reviews the remaining challenges of building a large scale silicon quantum device for computation and communication that will continue to sustain our civilization built on the band-gap of silicon throughout the 21st C.

D. N. Jamieson et al., Appl. Phys. Lett. 86, 202101 (2005)

A. Morello et al., Nature 467, 687 (2010)

J. J. Pla et al., Nature 489, 541 (2012)

The Author



David N. Jamieson is Professor of Physics at the University of Melbourne and Head of the School of Physics of the University of Melbourne. He completed his PhD in Physics at the University of Melbourne in 1985 and then spent 4 years working at Caltech (USA) and the University of Oxford (UK) as a postdoctoral research fellow. His research expertise in the field of ion beam physics, particularly in the use of focused ion beams for materials modification and analysis. He published over 250 papers in scientific journals, conference proceedings and 1 book. He served as the Vice President (2003-2004) and President (2005-2006) of the Australian Institute of Physics (AIP), and is a Fellow of the AIP and the Institute of Physics UK. He was previously Director (1996-2008) of the Microanalytical Reseach Centre (MARC) in the School of Physics at the University of Melbourne.