WEEKLY CALENDAR

17 January 2006

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Materials Science & Engineering Seminar / General Seminar

3:40PM / Thursday, 19 January 2006 / Room 109 Nicholson

Host: Dr. John DiTusa

[Refreshments served at 3:15 PM in Room 229, Nicholson Hall]

Bose-Einstein Condensation of Excitons in Semiconductor Bilayers

Allan MacDonald, PhD

University of Texas at Austin

In 1924 Satyendra Nath Bose from Dacca University, in what was then India, wrote to Einstein asking for his help in getting a paper published. Bose had already sent the paper to the *Philosophical Magazine,* where it had been turned down. (Einstein translated it into German, and the paper was published in 1924 in *Zeitschrift für Physik.)* Because of this interaction Einstein temporarily turned away from his ultimately unsuccessful search for a unified theory of gravitation and electromagnetism and started work on the quantum theory of radiation. Thus was born the concept of "Bose-Einstein" statistics for quanta ("bosons") carrying an integer value of intrinsic angular momentum (spin). For bosons, unlike electrons and other fermion particles, there is no limit to the number that can simultaneously occupy any one quantum state. Einstein noted that if the number of such particles is conserved, even totally non-interacting particles should undergo a change of behaviour at low enough temperatures - Bose-Einstein condensation. In Bose-condensed systems most particles occupy the same quantum state, elevating quantum behavior from the microscopic world to the macroscopic world.

Bose-Einstein condensation (BEC) occurs in Helium liquids where it is responsible for superfluidity and in many metals where pairs of electrons (Cooper pairs) act as bosons and condense giving rise to superconductivity. More recently Bose-Einstein condensation was observed in vapors of weakly interacting alkali metal atoms providing a new window on the quantum behavior of many-interacting particles. I will discuss yet another example of Bose-Einstein condensation which has been discussed in the solid state physics literature for more than 40 years, but has been realized experimentally only recently. The bosons in this case are pairs formed from an electron in one semiconductor quantum well layer and a hole (a missing electron) in a second semiconductor quantum well layer, which combine in a bound state known as an exciton. Many of the properties of excitonic BECs follow from the fact that their number is not quite perfectly conserved, as Einstein had assumed. I will discuss recent experimental results on the properties of semiconductor bilayer exciton BECs and efforts to develop a theory that is able to account for what is seen.

Congratulations:

Dr. Jonathan Dowling has been elected Fellow of the Optical Society of America.

Dr. Jorge Pullin has been appointed as managing editor of the International Journal of Modern Physics D., a peer reviewed journal published by World Scientific in Singapore, and the leading journal in gravitation and cosmology published in Asia.

Visiting Prof. Rodolfo Gambini has been elected to the Academy of Sciences of the Third World (Trieste).

Publications:

O. Sarbach and **M. Tiglio**, "Boundary conditions for Einstein's field equations: mathematical and numerical analysis." *Journal of Hyperbolic Differential Equations*, Vol. 2, No. 4, pp. 1-45 (2005).

L. Lehner, O. Reula and **M. Tiglio**, "Multiblock simulations in general relativity: high order discretizations, numerical stability and applications." *Classical and Quantum Gravity* 22, pp. 1-39 (2005).

G.W. Ford and **R.F. O'Connell**, "Entropy of a quantum oscillator coupled to a heat bath and implications for quantum thermodynamics." Invited paper in Proceedings of the International Conference 'Frontiers of Quantum and Mesoscopic Thermodynamics,' *Physica E* 29, pp. 82-86 (2005).

Welcome to:

Dr. James Clem, a Postdoctoral Researcher with **Dr. Arlo Landolt**. Dr. Clem's office is located in Room 259 Nicholson, his telephone extension is 8-7648.