QuanTalks

IISc Quantum Technology Initiative (IQTI) Seminar Series

When the Quantum world breaks through, and resistance becomes Quantized.

Friday, October 27th, 2023, 4 PM
Faculty Hall, Main Building, IISc

Click here to join the webinar

The great power of semiconductor technology is well known for having given us modern Information Technology and all that flows from it. In addition, modern semiconductor structures can be developed to investigate fundamental aspects of physics that are not accessible using naturally occurring solids. In this talk, examples will be given, in particular, the creation of devices where electrons are restricted to one dimension when it is found that a quantized staircase appears in which the conductance takes values of 2ne2/h, where n is an integer referring to the number of levels and the factor of 2 arises from the spin degeneracy. One of the characteristics of many aspects of electron transport in solids is that we can explain results by ignoring the strong repulsion between electrons. In one dimension the mutual interaction can play a dominant role. This is particularly the case in considering the transition regime between 1D and 2D, two dimensions that, until recently were not explored in detail. However, theory predicts that as the confinement weakens the carriers can move to the sides and adopt a zig-zag configuration to decrease the electron-electron repulsion. An unexpected feature of this particular electron configuration is that sometimes the electrons no longer behave as if they had the normal charge, e, but rather a fraction of that value such as e/5 or 2e/5. Simple theoretical concepts will be presented to explain these features.

Prof. Michael Pepper
Pender Professor of Nanoelectronics in University College London and Fellow of Trinity College, Cambridge

Prof. Michael Pepper is a Pender Professor of Nanoelectronics in University College London and a Fellow of Trinity College, Cambridge. Formerly a Professor of Physics in Cambridge University prior to which he held positions in both industry and university having worked in the Research Laboratories of Philips, Plessey, and GEC before founding as Managing Director the first corporate research laboratory of Toshiba outside Japan in 1991. His early work pioneered the use of semiconductor devices to investigate problems in fundamental condensed matter physics. He investigated many of the predictions of N.F. Mott and P.W. Anderson on the localization of electrons in semiconductor devices. As part of this work, he showed the localization,ion of electrons in strong magnetic fields and was part of the collaboration which resulted in the discovery of the Quantum Hall Effect in 1980. He then developed in Silicon and then Gallium Arsenide the first semiconductor nanostructures in which the dimensionality of electron transport could be changed by controlling electric fields. In particular, the transition to one dimension was demonstrated as the first electrically controllable zero-dimension quantum dot. This resulted in a worldwide activity based on the demonstration of many new physical phenomena such as the quantization of the 1D ballistic resistance. With his group he has discovered many new quantum effects most recently the long sought Non-Magnetic Fractional Quantisation of Conductance. The work at Toshiba Research Europe, Cambridge, as it is now known, has given rise to radically new technologies based on the development of fundamental science such as quantum communication systems with cryptography based on single photon detection and transmission.

In addition to the development of quantum communications, the work included the pioneering development of terahertz radiation, emitted by excitation of semiconductors, where it was shown that terahertz could distinguish between cancerous and healthy tissue. In order to rapidly develop the work it was spun out of Toshiba Research in 2001 to form TeraView Ltd where Pepper is the Scientific Director. He has been closely involved with the development of new applications of terahertz in industrial process control, security, and medicine. As a result of an international collaboration on the applications of terahertz radiation to pharmaceutical tablets Pepper was appointed Honorary Professor of Pharmaceutical Science at the University of Otago, New Zealand.

As a result of his work, he has received many honors, including the Royal Medal of the Royal Society, many named lectures, and honorary degrees.

High Tea at 5.30 PM

iqti.iisc.ac.in @IIScQuanTech @IIScQuanTech