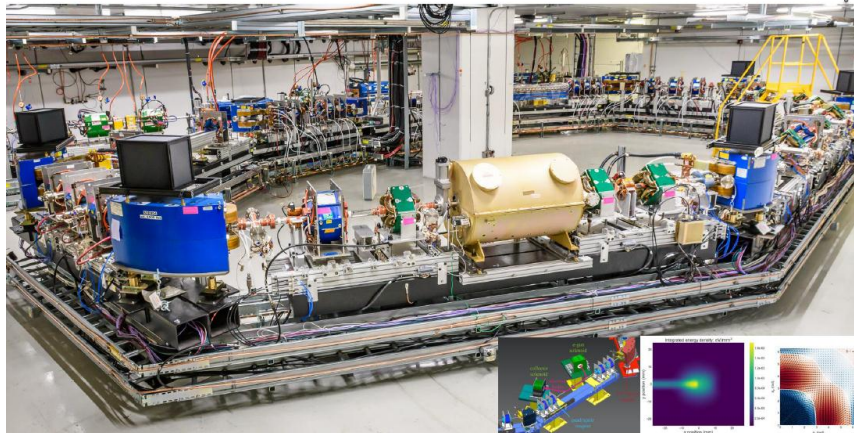


# Advanced Research in IOTA: Beyond PIP-II, Nonlinear Dynamics, Optical Stochastic Cooling and Quantum Science

*JAI – Oxford, Accelerator Science Seminars 2019*

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**18<sup>th</sup> of April at 4.00pm in the Dennis Sciama lecture theatre**



## Abstract

Fermilab's flagship particle physics program is focused on the international neutrino experiment DUNE (Deep Underground Neutrino Experiment) aimed at a comprehensive understanding of the mysterious 'neutrino' sector in the Standard Model. The program requires generation of intense beams of neutrinos via high intensity proton beams, in the Fermilab accelerator complex known as PIP-II. Schemes to generate and sustain high intensity proton beams in a stable manner requires high level control of the confining nonlinear electromagnetic fields confining the beam against various scattering and self-fields arising from collective Coulomb interaction (space charge). A prototype test storage ring IOTA -- conceived, designed, constructed and currently under operation at Fermilab -- allows the beam physics community to explore for the first-time advanced concepts to go beyond PIP-II, and in addition allows various advanced fundamental beam dynamics concepts e.g. nonlinear dynamics of 'integrable optics' test electromagnetic lattice, optical stochastic phase-space cooling of charged particles and testing various 'quantum science' concepts such as 'quantum entanglement' for a single electron and associated photon fields. The lecture will provide a high-level overview of the IOTA program.

**Professor Swapan Chattopadhyay** is a particle physicist and accelerator scientist, noted for his pioneering contributions to innovative particle colliders, photon sources and "ultra-fast" sciences. In recent years, he helped spear-head the US-DOE initiative in "Quantum Sensors for Fundamental Science, Quantum Information Science and Computing". Currently Chattopadhyay is a Distinguished Scientist in the Director's Senior Leadership Team at Fermilab (USA). Concurrently he holds a joint appointment with Northern Illinois University (USA), where he is Professor and Director of Accelerator Research and holds the Presidential Chair for Research, Scholarship and Artistry. He is a Visiting Professor of Physics at the University of Oxford and at University of California at Berkeley, an honorary Scientific Associate at CERN and past Inaugural Director of the Cockcroft Institute, UK (2007-2014) where he held the Sir John Cockcroft Chair of Physics. He served as the Associate Laboratory Director for Accelerators at Thomas Jefferson National Accelerator Facility (USA, 2001-2007), as the Founding Director of the Center for Beam Physics, a Senior Staff Scientist and a Professor in the Graduate School at Lawrence Berkeley National Laboratory and University of California at Berkeley (USA, 1984-2001), and as a Scientific Associate at CERN (1982-1984). Prof. Chattopadhyay received his PhD in Physics from University of California at Berkeley in 1982, following his undergraduate Bachelor's and Master's degrees at the University of Calcutta and Indian Institute of Technology (Kharagpur) in India, respectively.

