

International Conference on

Quantum Physics and Nuclear Engineering

March 14-16, 2016 London, UK



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Quantum beam science: A bridge between nuclear science and nuclear application

At the end of 19th century, a series of revolutionary discoveries were made to lay the foundations of the today's Quantum Beam Science. These are the discovery of X-ray by Roentgen in 1895, spontaneous radioactivity from uranium salt by Becquerel in 1896, followed by discoveries of radioactivity from polonium and radium by Curies in 1897. In 1899 and 1900, Rutherford and Villard separated radiation into three types based on penetration of objects and deflection by a magnetic field and named them alpha, beta and gamma rays. Because alpha particles occur naturally, much of the early knowledge of atomic and nuclear physics, as exemplified by the Rutherford's gold foil experiment leading to the discovery of atomic nucleus. But the particles and electrons emitted from radioactive nuclei have specific energies and low flux. Hence a generator was developed by Cockcroft and Walton to accelerate the protons performing the first artificial nuclear disintegration. Subsequently, the discovery of neutrons by Chadwick and nuclear fission by Hahn, Meitner and Strassmann and the realization of nuclear chain reaction initiated nuclear energy research establishing the nuclear reactors, providing neutron sources with decent flux. The history shows how the discovery of these radiations goes hand in hand with the understanding of the atomic and nuclear phenomena and their applications. The most eminent application is the utilization of nuclear power for energy production leading to the establishment of atomic energy research institutes worldwide in the middle of 20th century. Though the nuclear power aspect was the primary aim of these institutes, nevertheless the utilization of concomitant radiations, i.e. quantum beams, in different field, such as medical, agricultural and condensed matter applications have been investigated intensively at the same time. In this talk, I would like to exemplify the development of the quantum beam science in connection with nuclear science and application in the Quantum Beam Science Directorate activities at Japan Atomic Energy Agency.

Biography

Kazuhisa Kakurai has completed his PhD from TU Berlin and has been working at the Hahn-Meitner Institut, Berlin. He joined the Institute for Solid State Physics of the University of Tokyo as an Assistant Professor and became a Professor in 1997. He was the Director General of the Quantum Beam Science (QuBS) Directorate at the JAEA until 2014 and now serves as a General Adviser in the QuBS Center, JAEA in Japan. He is also Visiting Scientist at CEMS, RIKEN in Wako, Japan.

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