PURDUE UNIVERSITY | School of Nuclear Engineering

Nuclear Engineering Seminar

Dr. Chiping Chen,

Brookline Consultants, Needham, Massachusetts

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Limits of energy confinement time and fusion energy gain in magnetic confinement fusion

Abstract

Nuclear fusion energy is a promising candidate for clean energy. New fusion energy records have been achieved recently in inertial and magnetic confinement experiments. Energy confinement is a critical scientific issue in magnetic confinement fusion (MCF) research. It is intimately related to fusion energy gain. In this talk, discussions are made concerning limits of energy confinement time and sustainable fusion energy gain in MCF. A theoretical upper limit of energy confinement time in a MFC reactor is predicted based on radiation reaction associated with spontaneous electron cyclotron radiation (SECR). Agreement is found between theory and experiments at the Tokamak Fusion Test Reactor (TFTR), the DIII-D tokamak, the Joint European Torus (JET), and the Wendelstein 7-X stellarator. An advanced Lawson criterion for deuterium-tritium (D-T) ignition is obtained. A theoretical upper limit of sustainable D-T fusion energy gain is predicted, offering plausible explanations for the sustained D-T fusion energy gain of in TFTR, the equivalent D-T fusion energy gain of inferred from D-D fusion in DIII-D, and the new D-T fusion energy record in JET with sustained for 5 seconds. Directions of research for overcoming the limits are discussed.

Dr. Chen is the founder of Brookline Consultants in Needham, Massachusetts established forty years ago while he was a research scientist at the Massachusetts Institute of Technology's Plasma Science and Fusion Center where he later served as the Leader of Intense Beam Theoretical Research Group. Since 2013, he has been providing his scientific consulting services exclusively to fusion energy research and development companies. He played an instrumental role in recent discoveries of limits of energy confinement time and fusion energy gain in magnetic confinement fusion.