Terahertz Waves and the Future of Fusion Energy

Terahertz (THz) waves occupy the frontier between microwaves and infrared light, offering unique opportunities for both fundamental science and emerging technologies. This colloquium introduces the physics of high-power THz-wave generation using gyrotrons and highlights their critical role in electron cyclotron heating and current drive for magnetic confinement fusion. Recent advances in high-power gyrotron development and global progress toward ITER and compact tokamaks will be presented, together with future prospects for THz technologies in fusion energy and beyond. The talk aims to demonstrate how fundamental physics and vacuum electronics are enabling next-generation energy systems and expanding the frontiers of THz science.