Electron-cyclotron-resonance heating in Wendelstein 7-X: A versatile heating and current-drive method and a tool for in-depth physics studies: Paper

For stellarators, which need no or only small amounts of current drive, electron-cyclotron-resonance heating (ECRH) is a promising heating method even for the envisaged application in a fusion power plant. Wendelstein 7-X (W7-X) is equipped with a steady-state capable ECRH system, operating at 140 GHz, which corresponds to the 2nd cyclotron harmonic of the electrons at a magnetic field of 2.5 T. Ten gyrotrons are operational and already delivered 7 MW to W7-X plasmas. Combined with pellet injection, the highest triple product ($0.68 \times 10^{20} \text{ keV m}^{-3} \text{s}$), observed up to now in stellarators, was achieved (Sunn Pedersen et al 2018 Plasma Phys. Control. Fusion 61 014035). For the first time, W7-X plasmas were sustained by 2nd harmonic O-mode heating, approaching the collisionality regime for which W7-X was optimized. Power deposition scans did not show any indication of electron temperature profile resilience. In low-density, low-power plasmas a compensation of the bootstrap current with electron-cyclotron current drive (ECCD) was demonstrated. Sufficiently strong ECCD close to the plasma centre produced periodic internal plasma-crash events, which coincide with the appearance of low order rations of the rotational transform.