IAEA FEC 201

Contribution ID: **647** Type: **Oral**

Electromagnetic gyrokinetic analysis of the isotope effect

Friday, 21 October 2016 11:45 (20 minutes)

The thermal energy confinement time has been observed to largely vary with the exchange of the main isotope in broad experimental conditions in magnetically confined plasmas, leading to the so called isotope effect. Of particular interest is the isotope exchange between the fusion of deuterium-deuterium (DD) and deuterium-tritium (DT) nuclei, studied in dedicated experiments performed in the 1990's both in the Tokamak Fusion Test Reactor (TFTR) and in the Joint European Torus (JET), where a broad and unexpected variety of results including a clearly improved confinement in DT was obtained and a clear deviation from Gyro-Bohm scaling.
In this paper, the isotope effect is analyzed by performing gyrokinetic simulations with the GENE code for the ITER hybrid scenario including kinetic electrons, collisions, electromagnetic effects and up to five species. The impact of the energetic particles has been also analyzed with two additional fast ion species.
It is found that the interplay between nonlinear microturbulence effects generate an isotope effect leading to an increase or decrease of ion heat fluxes from DD to DT plasmas in agreement with previous experimental findings and providing clues about how to proceed in the future for maximizing thermal energy confinement in the presence of DT mixture. In particular, at short plasma scales, the electrostatic potential radial correlation length always follows Gyro-Bohm scaling, however, in the cases where the heat flux highly reduces from DD to DT, an anti-correlation region at longer (meso) scales appears due to the concomitant interplay of nonlinear multiscale interactions involving external ExB flow shear, magnetic geometry, zonal flow activity and electromagnetic effects. Extended analyses show that the ExB flow shear quenches ion heat fluxes for DT more efficiently due to lower linear growth rates whereas a coupling between ion mass and zonal flow, which exists in any plasma condition, only becomes relevant at high beta leading to a deviation from Gyro-Bohm scaling including a reduction of the ion heat flux by half.

Paper Number

TH/6-3

Country or International Organization

FRANCE

Primary author: Dr GARCIA, Jeronimo (CEA IRFM)

Co-authors: Dr CHALLIS, Clive (Culham Centre for Fusion Energy); Prof. JENKO, Frank (Max Planck Institute for Plasma Physics); Dr GIRUZZI, Gerardo (IRFM, CEA); Dr GÖRLER, Tobias (Max Planck Institute for Plasma Physics)

Presenter: Dr GARCIA, Jeronimo (CEA IRFM)

Session Classification: Turbulence & Transport

Track Classification: THC - Magnetic Confinement Theory and Modelling: Confinement