A Global Simulation Study of ICRF Heating by TASK/WM and GNET in Helical Plasmas

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The ICRF heating in helical plasmas is studied combining two global simulation codes: a full wave field solver TASK/WM [1] and a drift kinetic equation solver GNET [2]. The codes are applied to the LHD plasma as a example.
The TASK/WM code solves Maxwell's equation for RF wave electric field, $\boldsymbol{E}_{\rm RF}$, with complex frequency, ω, as a boundary value problem in the 3-D magnetic configuration as

$$\nabla \times \nabla \times \boldsymbol{E}_{\rm RF} = \frac{\omega^2}{c^2} \overleftrightarrow{\epsilon} \cdot \boldsymbol{E}_{\rm RF} + i\omega\mu_0 \boldsymbol{j}_{\rm ext},$$

where the external current, $\boldsymbol{j}_{\rm ext}$, denotes the antenna current in ICRF heating.
The GNET solves a linearized drift kinetic equation for energetic ions including complicated behavior of trapped particles in 5-D phase space as

$$\frac{\partial f}{\partial t} + \left(\boldsymbol{v}_\parallel + \boldsymbol{v}_D\right) \cdot \nabla f + \boldsymbol{a} \cdot \nabla_{\boldsymbol{v}} f - C(f) - Q_{\rm ICRF}(f) - L_{\rm particle} = S_{\rm particle},$$

where $C(f)$ and $Q_{\rm ICRF}$ are the linear Coulomb Collision operator and the ICRF heating term. $S_{\rm particle}$ and $L_{\rm particle}$ are the particle source and sink (loss) terms, respectively.
The $Q_{\rm ICRF}$ term is modeled by the Monte Carlo method and the spatial profile of RF wave electric field is necessary for the accurate calculation of the ICRF heating. The both codes can treat a 3-D magnetic configuration based on the MHD equilibrium by VMEC code. Various parameters dependencies on the radial power deposition and the characteristics of energetic ion distributions in the phase space are investigated in LHD plasma.

[1] A. Fukuyama and T. Akutsu, *Proc. 19th Int. Conf. Fusion Energy 2002*, THP3-14.
[2] S. Murakami, *et al.*, Nucl. Fusion **46** (2006) S425.