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Plasma heating and generation of energetic ions with novel three-ion ICRF scenarios on Alcator C-Mod and JET tokamak facilities[1]

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This talk will report the first experimental results of novel three-ion ICRF scenarios (two or more majority ion species and one minority) for plasma heating and generating energetic ions in fusion facilities [1]. The key feature of these scenarios is strong absorption of RF power possible at lower concentrations of minority ions than in two-ion plasmas. Effective plasma heating by injecting a small amount of ^{3}He ions into H-D plasma mixtures with $n_{\rm H}/n_e \sim 70\%$ has been successfully demonstrated in Alcator C-Mod and JET tokamaks. In C-Mod, efficient plasma heating was observed for ^{3}He concentrations from 0.4-2%. During the discharges, a strong increase in Alfvén eigenmode activity was found to coincide with the addition of ^{3}He to the H-D plasmas [2]. Even lower ^{3}He concentrations ($\sim 0.2\%$) were utilized in recent JET experiments. The potential of the D-(^{3}He)-H scenario for plasma heating and generating MeV-range ions in JET plasmas was confirmed by a set of independent measurements, including stabilization of sawteeth, characteristic γ-ray emission, fast-ion loss detector. Furthermore, toroidal Alfvén eigenmodes with a range of toroidal mode numbers n were detected, which is another indication for the presence of significant population of high-energy ^{3}He ions in a plasma. The discussed mechanism of resonant wave-particle interaction opens up various unexplored opportunities for ICRF system, including new scenarios for plasma heating. Three-ion ICRF scenarios are also relevant for the experimental programme of ITER. The possibility of using intrinsic ^{9}Be impurities as the minority (instead of ^{3}He) was suggested for heating bulk ions in D-T plasmas of JET and ITER [3], as well as heating trace amounts of ^{3}He and ^{4}He ions in H majority plasmas of ITER. The latest results and simulation comparisons will be presented.

[1] Y. Kazakov et al., *Nucl. Fusion* **55**, 032001 (2015)
[2] J. Wright et al. and Y. Lin et al., *this conference*
[3] Y. Kazakov et al., *Phys. Plasmas* **22**, 082511 (2015)

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