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Recent progress of magnetic reconnection research in the MAST spherical tokamak[1]

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In the last three years, magnetic reconnection research in the MAST spherical tokamak achieved major progress by use of new 32 chord ion Doppler tomography, 130 channel YAG- and 300 channel Ruby-Thomson scattering diagnostics. In addition to the significant plasma heating up to ~1keV [1], detailed full temperature profile measurements including the diffusion region have been achieved for the first time. 2D imaging measurements of T_i and T_e profiles have revealed that magnetic reconnection mostly heats ions globally in the downstream region of outflow jet and electrons locally at the X-point [2]. The higher toroidal field in MAST ($B_t > 0.3$T) strongly inhibits cross-field thermal transport scaling as $1/B_t^2$ and the characteristic peaked T_e profile at the X point is sustained on a millisecond time scale. In contrast, ions are mostly heated in the downstream region of outflow acceleration inside the current sheet width ($c/\omega_{pi} \sim 0.1$m) and around the stagnation point formed by reconnected flux mostly by viscosity dissipation and shock-like compressional damping of the outflow jet. Toroidal confinement also contributes to the characteristic T_i profile, forming a ring structure aligned with the closed flux surface. There is an effective confinement of the downstream thermal energy due to a thick layer of reconnected flux. The characteristic structure is sustained for longer than an ion-electron energy relaxation time ($\tau_{ei}^E \sim 4 - 11$ms) and the energy exchange between ions and electrons contributes to the bulk electron heating in the downstream region. The toroidal guide field mostly contributes to the formation of a localized electron heating structure at the X-point but not to bulk ion heating downstream. [1] Y. Ono *et al.*, Phys. Plasmas **22**, 055708 (2015). [2] H. Tanabe *et al.*, Phys. Rev. Lett. **115**, 215004 (2015).

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