# Numerically improved bootstrap current formula for more proper pedestal physics validation[a)]

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Necessity for more accurate prediction for the bootstrap current has been elevated due to its critical impact on the current-driven edge localized mode instabilities and on the magnetic equilibrium reconstruction in diverted edge region. Experimental validations of the edge pedestal physics, profile structures, and the ELM instabilities are highly dependent on the analytic prediction for bootstrap current profile in the edge pedestal. Analytic formulas exist, but with limited and rather unknown accuracy due to various approximations required in the analytic formulation. Experimental evidence on MAST [2010 IAEA FEC] showed a significant discrepancy (over 50%) between the experimentally inferred edge bootstrap current and the theoretically predicted values using the Sauter formula. A question naturally rises on how accurate the analytic formulas are in conventional and spherical tokamaks.

XGC0 kinetic transport code has been used to evaluate the bootstrap current in model H-mode pedestal profile in realistic diverted edge geometry. It is found that the existing analytic formulas agree well with numerical simulation results in weakly collisional regime, in which most of the theories are more faithfully developed. However, the existing analytic formulas do not agree well with the numerical results in the collisional regime. In conventional tokamks (DIII-D and C-Mod) about 25% difference is common between the Sauter formula and the numerical results. In a spherical tokamak, such as NSTX or MAST, difference between the Sauter formula and the numerical results are found to be as large is 50%. A new bootstrap current formula has been developed and will be presented, which is a modified version of Sauter formula, that can bring the agreement with the numerical results within simulation error bar.

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