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Application of the Semi–Implicit Numerical Method on the Radial Impurity Transport Equation and Determination of O4+ Emissivity with Two Separate PEC Databases

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The radial impurity transport equation describes the distribution of impurity ion species with different charge states perpendicular to magnetic surfaces of tokamak plasma. The impurity transport equation for each ion with ionization state Z is a second order, coupled, parabolic partial differential equation described in terms of number densities of charge states Z, Z-1 and Z+1. A semi–implicit numerical method has been applied over radial impurity transport equation to obtain the number densities of oxygen ions in present case. The numerical method applied suggests segregating the terms of the transport equation into implicit and explicit forms thereby adhering to a single time treatment (either implicit or explicit) for each of its constituent term. A forward in time and central in space (FTCS) scheme of discretization have been applied first. The terms associated with diffusivity and ionization and recombination terms of charge state Z are next rendered implicit; terms associated with convective velocity, ionization of charge state Z-1 and recombination of charge state Z+1 remain explicit. The system studied is the Aditya tokamak (ro=0.25 m, R=0.75 m, Bt =0.75 T) installed at the Institute for Plasma Research, Gandhinagar, India. Plasma in Aditya is circular in cross–section being confined within limiter. The number density of O4+ ions determined using semi–implicit numerical method is used further to obtain radial emissivity profile of (650.024 nm) transition of O4+ ion and compare it with experiment data. The emissivity values of 650.024 nm characteristic line of Be–like O4+ ion, in visible–spectral region, have been obtained by measuring the brightness in high magnetic field (inboard) and low magnetic field (outboard) regions of Aditya tokamak and applying an Abel–like matrix inversion on it. Present study compares the emissivity calculated with number density of O4+ ion obtained using semi–implicit method with O4+ emissivity obtained experimentally using two databases of Photon Emissivity coefficients (PECs) namely the ADAS (Atomic Data and Analysis Structure) and NIFS (National Institute of Fusion Science) database. The PECs in two databases differ due to a difference in the atomic processes considered while calculating them. This difference thereby influences the radial emissivity profiles of O4+ ion studied in present case.

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