Implementation and tests of Multiple species collision operator in Gyrokinetic code GS2

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Abstract

It is essential to study collisional effects in tokamak plasmas, because it may alter the momentum redistribution of impurities and main ions. Thus it is required to have a robust and an accurate collision operator to treat cross-species collisions. Since collision frequency has Z^4 dependence where Z is the charge, it is essential to consider the impurities. However, Their densities are significantly less than main ion' density. Fully linearised gyroaveraged Fokker-Plank collision operator has been implemented in Gyrokinetic code GS2. Previous collision operator was gyroaveraged, had pitch angle scattering, diffusion operator and a modeled field particle operator which conserved the particles, momentum, and energy satisfied the Boltzmann's H theorem [1]. It was self-collision operator and had finite Larmor radius effects included in it. It was implicit in time and met all these properties precisely in the code. Newly implemented collision operator is the extension of previous collision operator which accounts for cross-species collisions and satisfies the conservation of particles, momentum, and energy. It also increases the total entropy in time which is an outcome of Boltzmann's H theorem. Sugama's collision operator [2] has been adopted to include inter-species collisions in GS2. Sugama's field particles operator is modified to retain the exact numerical conservation properties. Recursive Sherman Morrison numerical scheme is implemented to invert the matrix obtained to treat collision operator implicitly. It has been verified that it satisfies the conservation properties and H Theorem in the GS2. Effects of impurities along with the main ions has been tested for cyclone base case.

References

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