Simple 1D Fokker-Planck modelling of ion cyclotron resonance frequency heating at arbitrary cyclotron harmonics accounting for Coulomb relaxation on non-Maxwellian populations

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To rigorously assess the impact of ion cyclotron resonance frequency (ICRF) heating on the distribution functions of the various plasma constituents, a set of coupled Fokker-Planck equations needs to be solved. As doing so while accounting for all details of the wave-particle interaction is time consuming, simpler models are often preferred to get a first impression of how the wave power affects the plasma. Stix [T.H. Stix, *Nuclear Fusion* (1975) 15 p. 737, T.H. Stix, “Waves in Plasmas” (1992) AIP, New York, p. 510-513] proposed a method to analytically compute the isotropic (pitch angle averaged) distribution function of a population heated by electromagnetic waves. To ensure that the solution can be found in analytical form, the applicability of the provided expression was somewhat limited, though: Stix assumed that the particles are heated at their fundamental cyclotron frequency and that a not too energetic minority tail is formed. Moreover, the background plasma particle populations were assumed to be in thermal equilibrium.

Allowing for numerical rather than analytical integration and adopting the general - nonlinear - Coulomb collision operator for arbitrary distributions (see e.g. [C.F.F. Karney, *Comp. Phys. Rep.* (1986) 4, p. 183-244]), the method proposed by Stix can however be extended immediately to describe ICRF heating not only of small minorities but also of large minorities and bulk plasma populations at any cyclotron harmonic, fully accounting for their Coulomb collisional interaction by solving a set of coupled Fokker-Planck equations in which none of the species is *a priori* assumed to be Maxwellian. To account for the electron self-collision dynamics at fusion relevant temperatures, the relativistic Coulomb collision operator is used for the latter species.

A number of examples is given to illustrate the potential of the method.