Electron and Ion Stiffness in the Weiland model

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The Weiland model[1] is usually considered non-stiff[2] despite it manages very well to reproduce heat modulation experiments in JET[3] and ASDEX-U[4]. In order to measure the stiffness of this model its diffusivities were rewritten in the form of a gyro-Bohm critical gradient model (CGM)[5][6]. The Weiland diffusivity in a CGM form becomes, $\chi = \chi^{gB}\chi_s(R/L_T - R/L_{T,th})^{\alpha}\mathrm{H}(R/L_T - R/L_{T,th})$, with χ^{gB} – the gyro-Bohm diffusivity, χ_s – the stiffness number, $R/L_T - R/L_{T,th}$ – the height above threshold and H – the Heaviside function. A difference from earlier stiffness analysis is that the diffusivities have an $\alpha = 1/2$ dependence and not $\alpha = 1$. In the Weiland model this proportionality is not fixed, but varies with the plasma parameters. $\alpha = 1/2$ corresponds to the case when modes are well above the threshold. In this regime IFS-PPPL[7] gives the same value of α as the Weiland model.

Simulations of scans of applied electron or ion heating power, permitted estimation of the stiffness numbers, χ_s of the Weiland model by determination of the slope of χ/χ^{gB} versus $(R/L_T - R/L_{T,th})^{1/2}$. The stiffness numbers are significantly large, yielding evidence of stiffness of the Weiland model. There are also evidence of a correlation between the modes responsible for the drive of the diffusivities and the stiffness numbers. As a consequence the ion stiffness in the Weiland model increases with stronger electron heating.

References

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