2) Transport of energy in stochastic fields

Theoretical Studies on Heat Diffusion across Magnetic Island and Local Stochastic Magnetic Field

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The heat diffusion across magnetic islands is studied numerically. For a single island, the enhanced radial heat diffusivity, χ_r, due to the parallel transport along the field lines is increased over a region of about the island width w. The maximum enhanced heat conductivity at the rational surface is proportional to $w^2(\chi_{\|}\chi_{\perp})^{1/2}$ for sufficiently high values of $\chi_{\|}/\chi_{\perp}$, where $\chi_{\|}/\chi_{\perp}$ is the ratios between the parallel and the perpendicular heat diffusivity. For low ratios of $\chi_{\|}/\chi_{\perp}$, however, the maximum value of χ_r is proportional to $w^4\chi_{\|}$.

For the heat diffusion across a local stochastic magnetic field, the heat diffusion is found to be consist of three regimes:

(a) The quasi-linear regime $W_k/W_{c,k}<1$, where the transport is determined by the additive effect of individual islands. Here W_k is the island width of the k*th* component magnetic perturbation calculated from the single island formula, $W_{c,k}=a(\chi_{\perp}/\chi_{\|})^{1/4}[8L_q/(\varepsilon a n_k)]^{1/2}$ is the "critical island width", $\varepsilon=a/R$ and $L_q=q/(dq/dr)$. In this regime our numerical results agree with the quasi-linear analytical theory developed recently.

(b) The transitional regime $W_k \sim W_{c,k}$, where χ_r increases slowly with increasing $\chi_{\|}$.

(c) The regime $W_k >> W_{c,k}$, where χ_r approximately scales with $\chi_{\|}$.