NCSX Transport Assessment

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•Monte–Carlo simulations:

•Done with guiding–center (GC) codes GC3, GTC in Boozer coordinates (r or $\psi_t = B_0 r^2/2, \theta, \zeta$), using N_h largest–amplitude harmonics, with decomposition
$B = \sum_{m,n} B_{mn}(r)\cos(n\zeta - m\theta)$
(typically $N_h \sim$ 10–20).

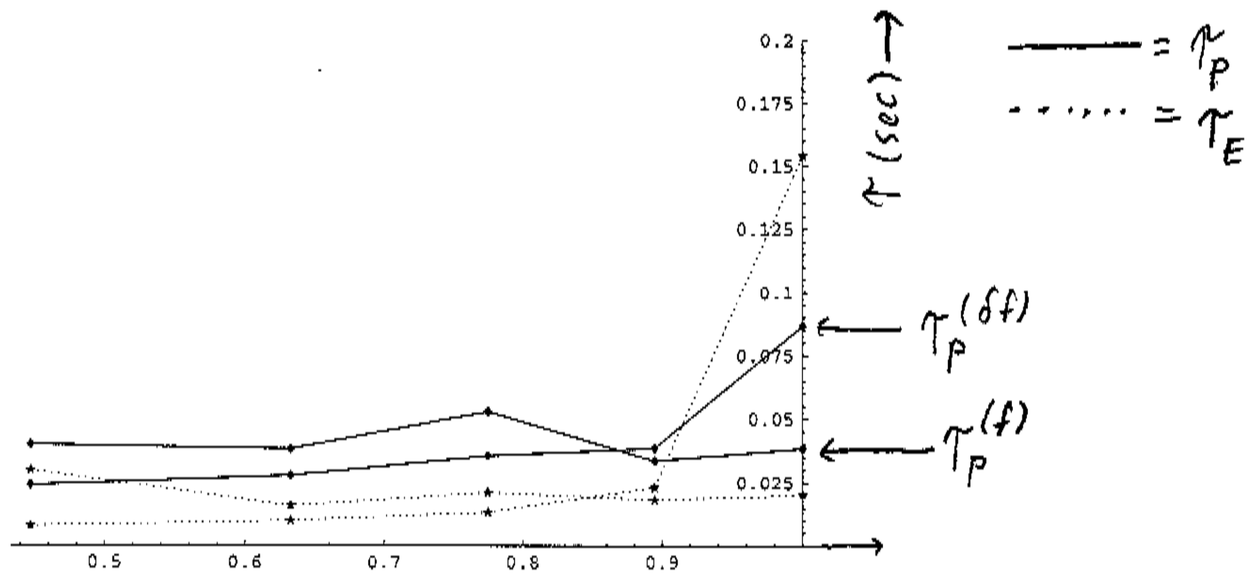
•Now shifting to GTC as workhorse for configuration evaluation: Speed–optimized δf–code, runs on T3E, making full Maxwellian ensembles accessible. Benchmarked against GC3, ORBITMN.
Can compute D either via the Fokker-Planck formula
$D(r) \simeq \frac{1}{2}\partial_t\langle(\delta r)^2\rangle$
used by GC3, or via computing the particle flux
$\Gamma = \Delta V_r^{-1}\int_{\Delta V_r} d\mathbf{z}\dot{r}_E\delta f \simeq D\kappa_n n(r)$.
($\Delta V_r \simeq \Delta r\partial_r V(r) \equiv$ volume of shell at radius r.)

•Can compute global $\tau(r)$'s, close to way computed experimentally:
$\tau_p(r) = N(r)/[A(r)\Gamma(r)]$, $\tau_E(r) = W(r)/[A(r)Q(r)]$.
∘Computes particle, heat fluxes Γ, Q in 2 ways:
(a)δf–method (Close to $\rho_b/a \ll 1$ theory):
$\{\Gamma, Q\} = \sum_{m\in\Delta V_r}\dot{r}_E w_m\{1, Mv^2/2\}$.
(b)Full-f method (Closer to experiment):
$A(r)\Gamma(r) = -d_t N(r) + S_n(r)$,
$A(r)Q(r) = -d_t W(r) + S_E(r)$.

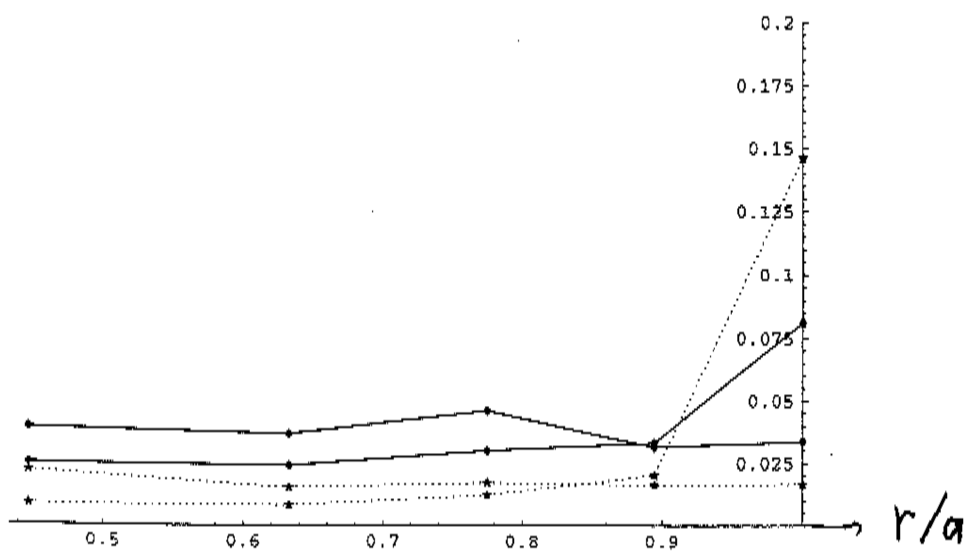
•Compare $\delta f, f$ methods for computing τ's:

•Except near edge, where flattening of given $p'(r)$ causes fluxes $\propto p'$ to become small, the δf fluxes are somewhat larger than the full-f fluxes, consistent with findings[5] of the effect of finite ρ_b/a in tokamaks.

C10:



C85:



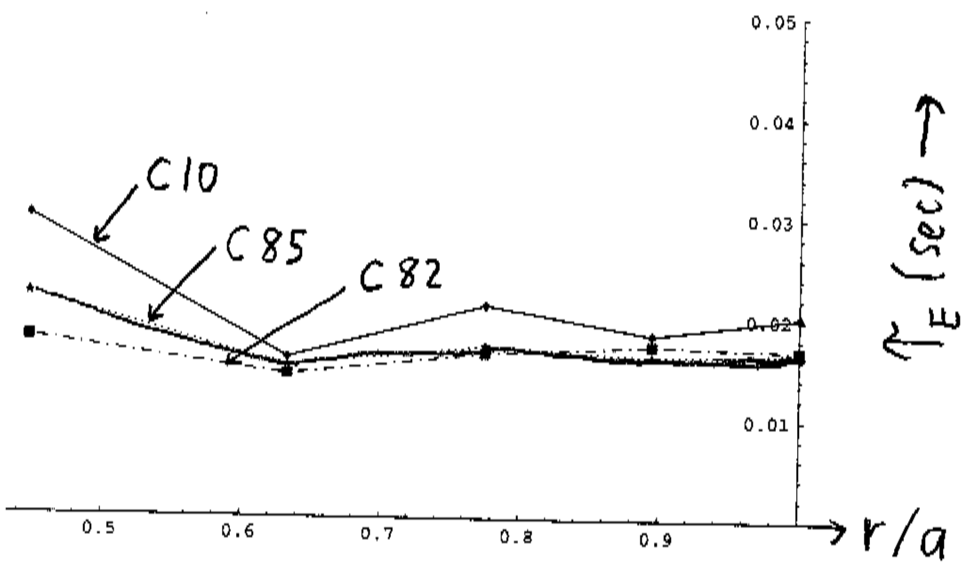
$B = 1.26\ T,\quad T_0 = 2.14\ keV,\quad n_{e0} = 6.73 \times 10^{19}\ m^{-3}$

•Include ambipolar field $E_r = -\partial_r \Phi \simeq -B_0 r \partial_\psi \Phi$:

•For $E_r = 0$, the nonaxisymmetric flux Q_i^{na} is comparable with the symmetric flux Q_i^{sym}, consistent with previous GC3 results.

•For current assessment, adopt model potential profile
$e\Phi/T_{i0} = \alpha\psi/\psi_{wall}$, and take $\alpha = 1$.

•Compare C10, C82, and C85:



∘Summarize neoclassical confinement in C10, C82, C85 (for $B = 1.26$ T, $T_0 = 2.14$ keV, $n_{e0} = 6.73 \times 10^{19}/\mathrm{m}^3$):

	τ_p (sec)	τ_{Ee}	τ_{Ei}
C10_sym	3.1	2.8	.074
C10,$\alpha = 1$	.54	.36	.020
C82_sym	2.9	2.6	.065
C82,$\alpha = 1$	.48	.31	.017
C85_sym	2.9	2.55	.071
C85,$\alpha = 1$	.34	.21	.016

∘Have
$1/\tau_E = 1/\tau_E^{nc} + 1/\tau_E^{an}$.
Write $\tau_E = H\tau_E^{ISS}, \tau_E^{nc} = H_n\tau_E^{ISS}, \tau_E^{an} = H_a\tau_E^{ISS}$.
$\Rightarrow 1/H = 1/H_n + 1/H_a$.
·If demand $H = 2.3$, need $H_n \simeq 4.6$.

·If $Q_e^{nc}/W \ll Q_i^{nc}/W$ (true here), then
$\tau_E^{nc} \simeq (W/W_i)\tau_{Ei}^{nc} \simeq (1+\bar{Z})\tau_{Ei}^{nc}$, with $\bar{Z} \simeq 1.2$.
$\Rightarrow$Need $\tau_{Ei}^{nc}/\tau_E^{ISS} \simeq H_n/(1+\bar{Z}) \simeq 2$.

∘This (marginally) satisfied for all of C10, C82, C85 above: $\tau_E^{ISS} \simeq .0076$ sec.