Onset of multiple transport barriers in tokamak configurations

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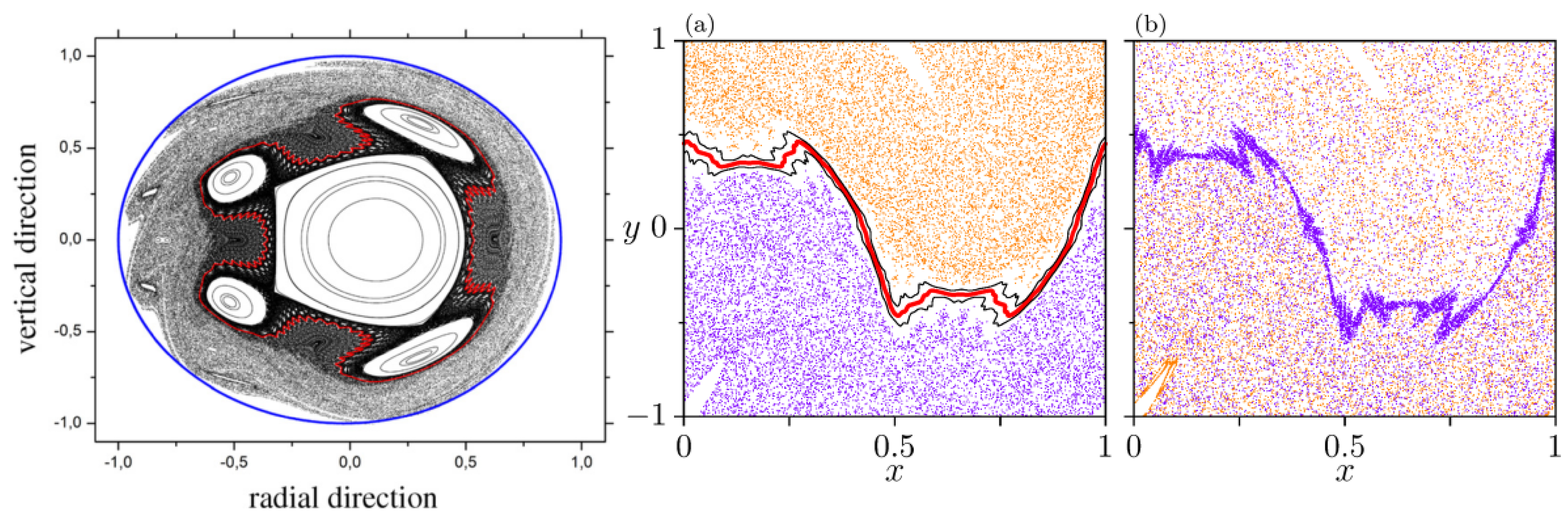
Objective

Investigate the formation of multiple transport barriers in tokamak plasmas due to modifications in magnetic profile

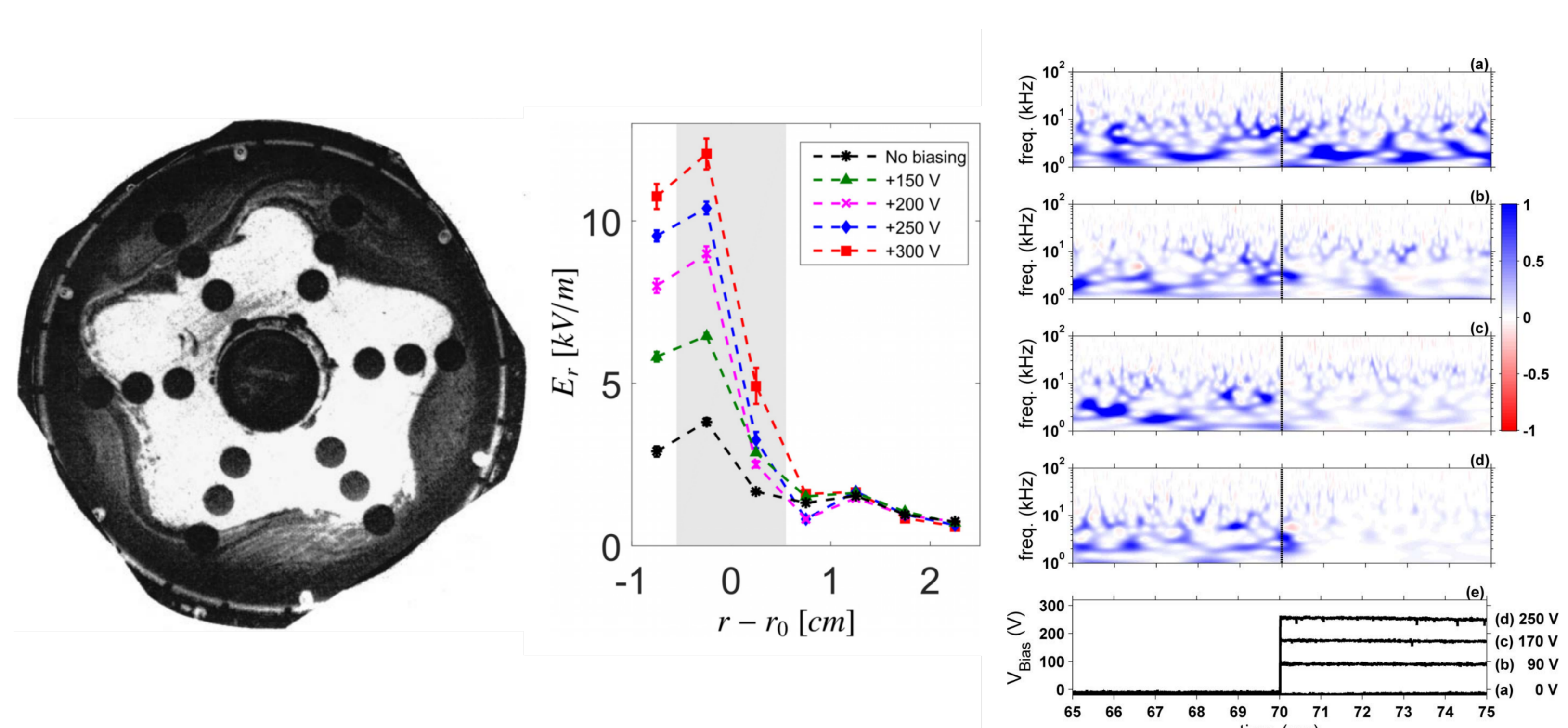
Shearless Transport Barriers

- Shearless curves at minimum profiles prevent chaotic transport (*1*)



Experimental Evidences of STB

- Electrostatic perturbations at plasma edge cause $\mathbf{E}\times\mathbf{B}$ turbulent transport
- Nonmonotonic profiles improve confinement (*2*).



Horton's Particle Transport Model

Horton Model: a test particle subject to plasma fields (*3*).

$$\frac{\mathrm{d}\mathbf{x}}{\mathrm{d}t} = v_{\parallel}\frac{\mathbf{B}}{B} + \frac{\mathbf{E}\times\mathbf{B}}{B^2}$$

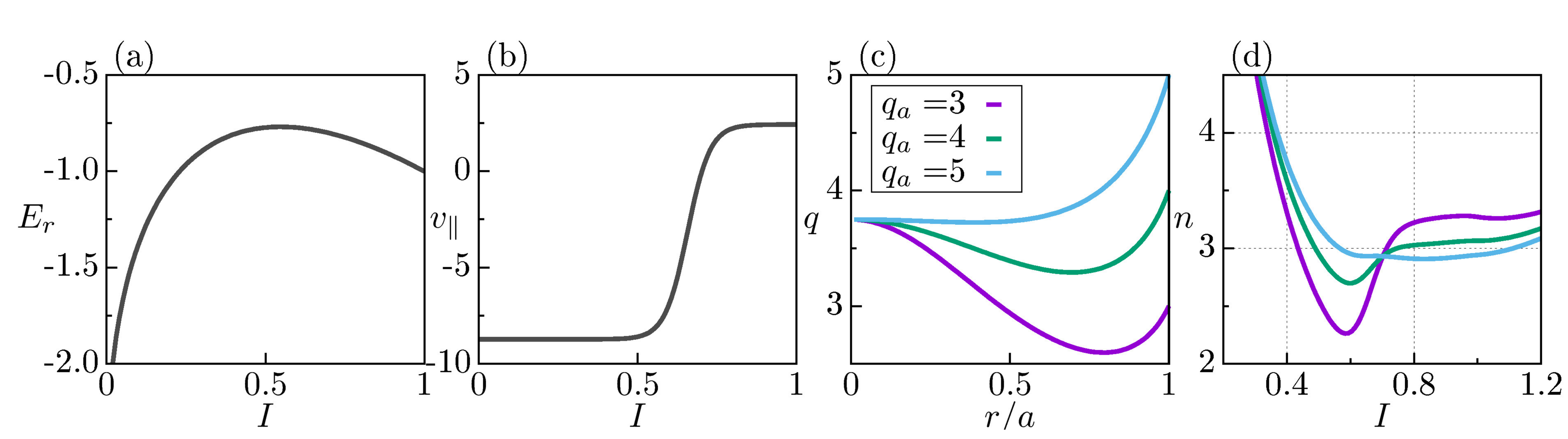
- $\mathbf{E} = \overline{\mathbf{E}_r} - \nabla\tilde{\phi}$
- $\tilde{\phi}(\mathbf{x},t) = \sum_n \phi_n \cos(M\theta - L\varphi - n\omega_0 t + \alpha_n)$

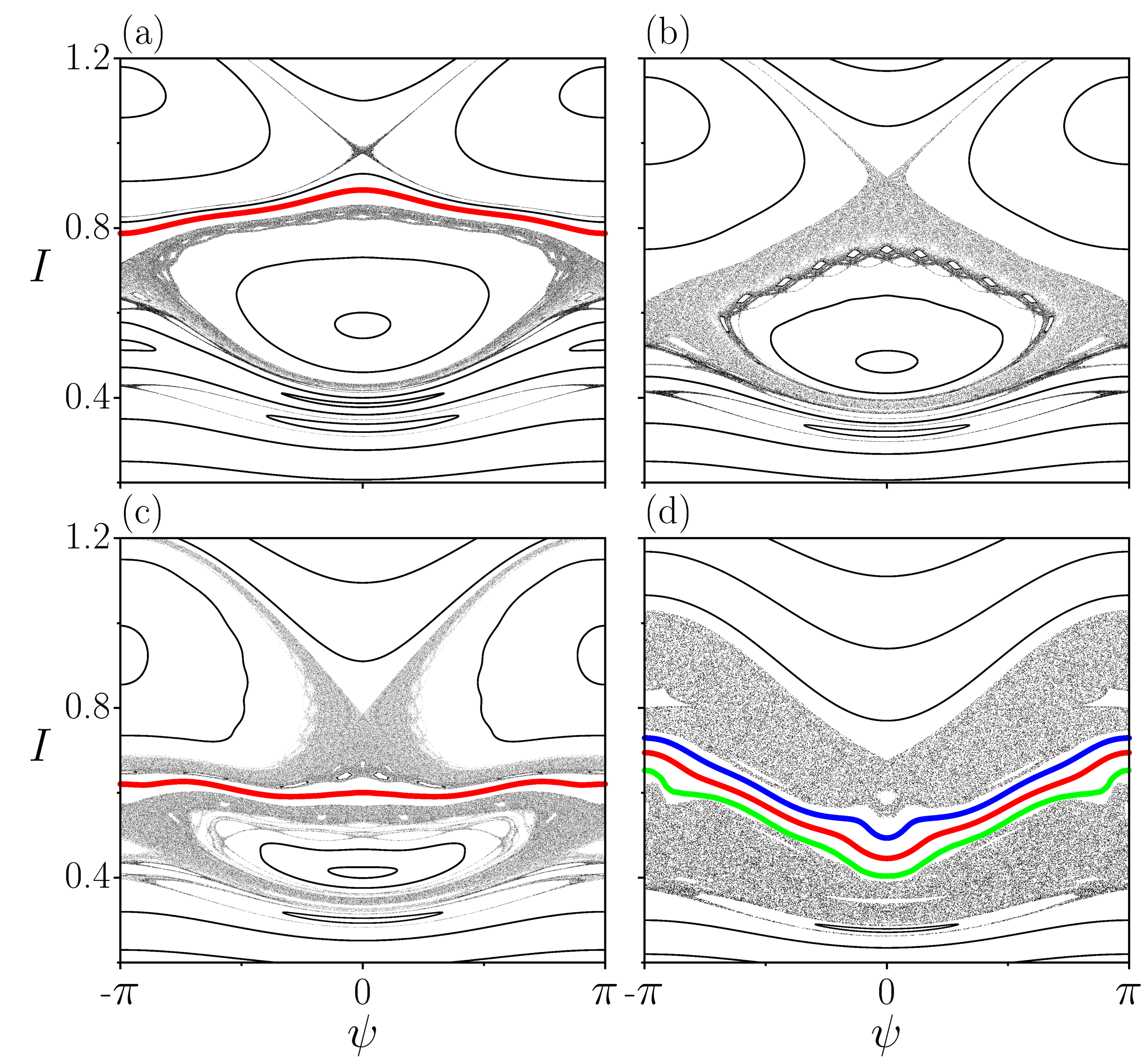
Action ($I = r^2/a^2$) and angle ($\psi = M\theta - L\varphi$) variables

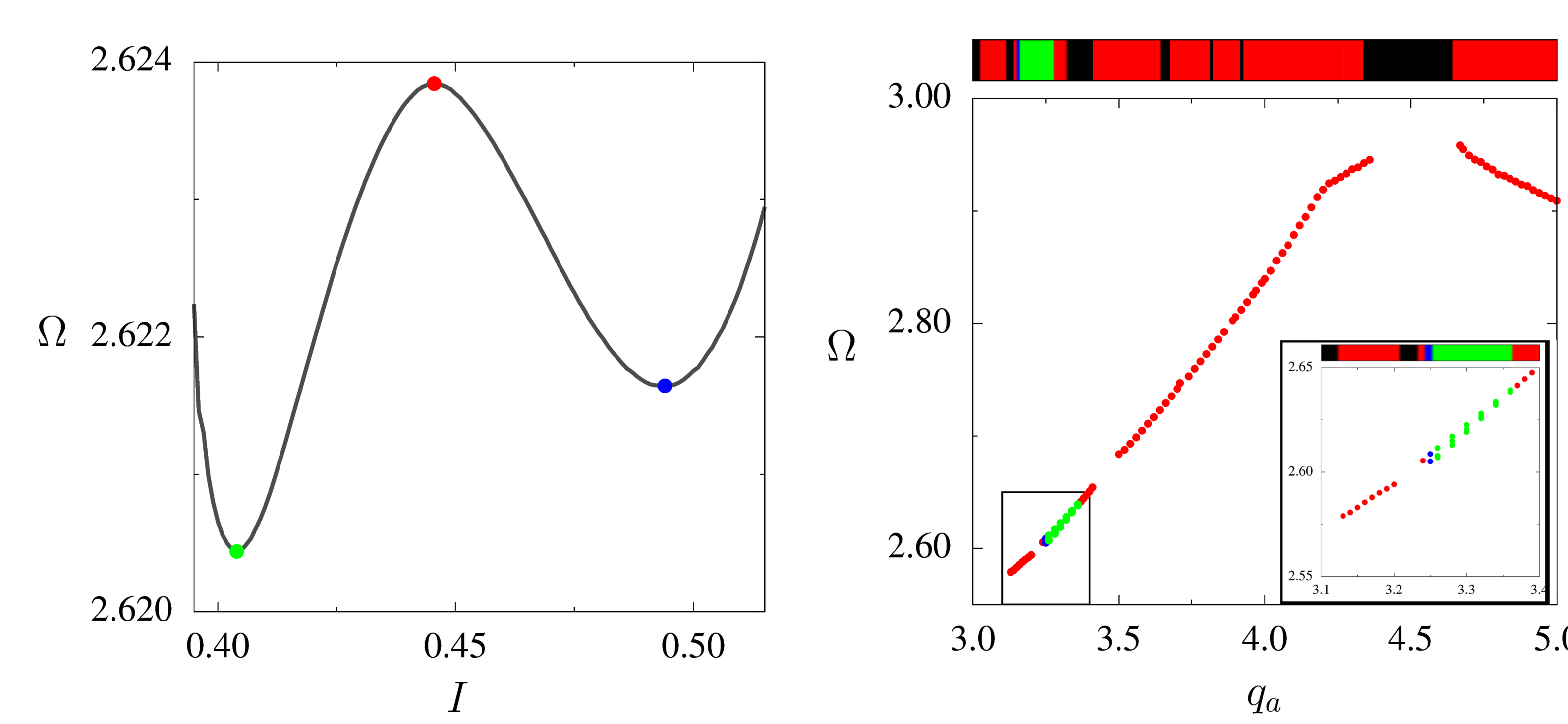
$$\frac{\mathrm{d}I}{\mathrm{d}t} = 2M\sum_n \phi_n \sin(\psi - n\omega_0 t + \alpha_n)$$

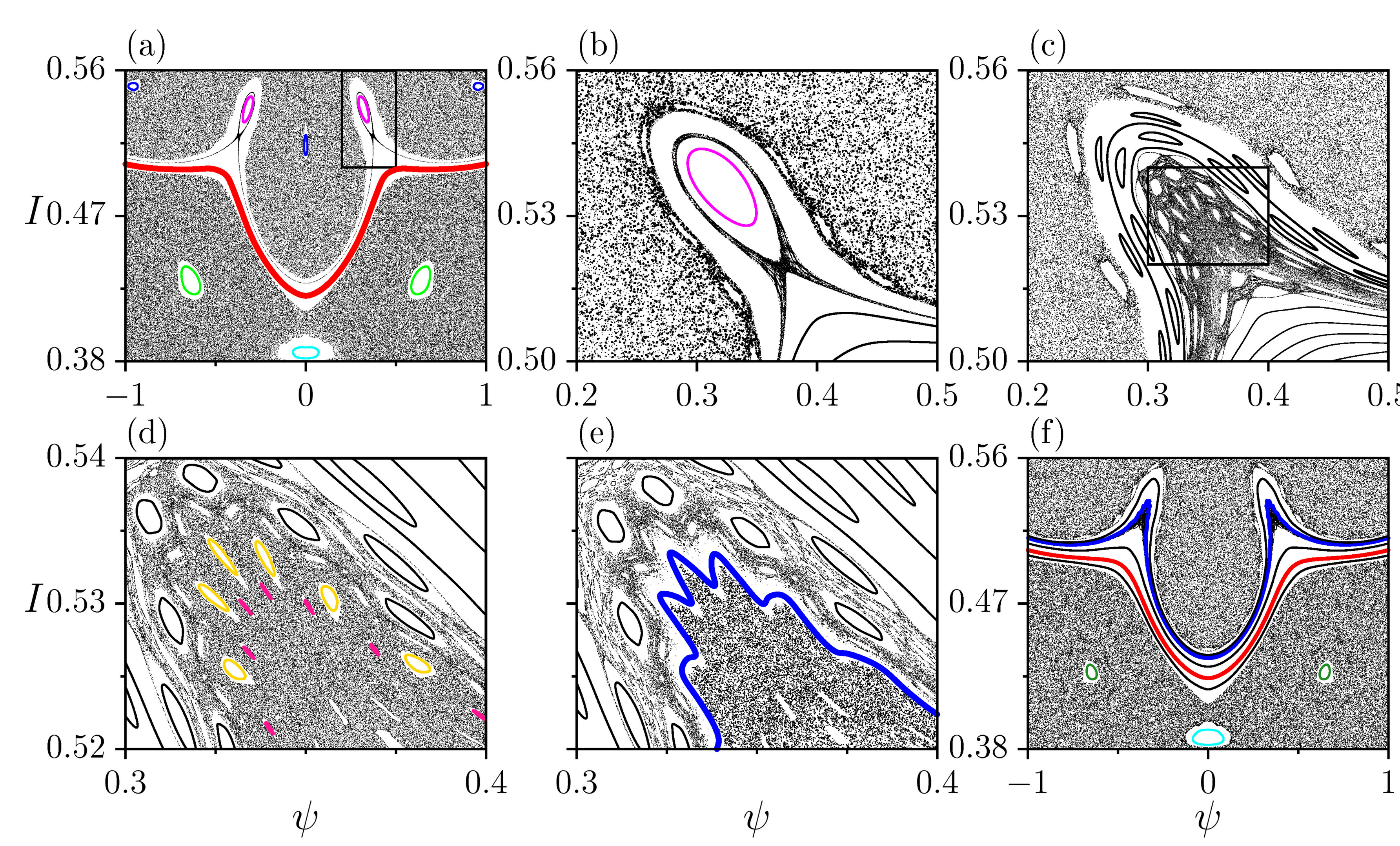
$$\frac{\mathrm{d}\psi}{\mathrm{d}t} = \epsilon\frac{v_{\parallel}(I)}{q(I)}\left[M - Lq(I)\right] - \frac{M\overline{E_r}(I)}{\sqrt{I}}$$

Plasma Configuration









Conclusions

- Nonmonotonic profiles produce STB
- Shearless curve break up/onset changing profile.
- Multiple shearless curves for some parameters (*4*)

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