Cooperative elliptical instability and plasma blob generation

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There is strong experimental evidence, e.g. from the tokamaks DIII-D and ASDEX Upgrade [1, 2], that plasma blobs are generated at the separatrix. If blobs are generated at the separatrix, there should be some instability mechanism at the separatrix responsible for the blob ejection.

In previous investigations it was found that an $m = 1$ poloidal mode number inside the main plasma column give rise to high-intensity bursts in CSDX [3]. This behavior is also typical for other linear devices [4, 5]. Because of the $E \times B$ drift every perturbation in the potential results in a vortex. An $m = 1$ mode in the potential consists of a negative and positive perturbation, which are vortices rotating in opposite directions and therefore an $m = 1$ mode is a counter-rotating vortex pair. From fluid mechanics it is known that counter-rotating vortex pairs are subject to the elliptic instability, which is a three-dimensional instability of a two-dimensional flow. This instability can modify the internal structure of the vortex core leading to injection of smaller vortices, which could be a generation mechanism for plasma blobs. Also modes in large scale fusion devices can be considered as vortex chains. Since the elliptical instability results from shear interactions of different vortices within these vortex chains, understanding this mechanism can help to understand the generation of plasma blobs in general. Using fast camera measurements first evidence of the existence of the cooperative elliptic instability in magnetized plasmas can be provided.

References

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