General Theory of the Plasmoid Instability

Luca Comisso, Manasvi Lingam, Yi-Min Huang, Amitava Bhattacharjee, PPPL/Princeton University

Objectives

- Study the linear properties of the plasmoid instability in time evolving current sheets.
- Develop quantitative prediction for the onset of fast plasmoid-mediated reconnection.

Accomplishments

- The previous treatments of the plasmoid instability have been generalized by formulating a principle of least time for plasmoids in time evolving current sheets.
- It has been shown that the scaling relations of all relevant parameters are dependent not only on the Lundquist number, but also on the perturbation amplitude and the characteristic rate of current sheet thinning
- The plasmoid instability remains quiescent for a certain period of time until the thinning reaches a critical value. Once this value is attained, the instability occurs on a very short time scale.
- The scaling relations of the plasmoid instability are not true power laws.

Impact

- The developed theory provides the first accurate quantitative predictions for the properties of the plasmoid instability in large Lundquist number plasmas

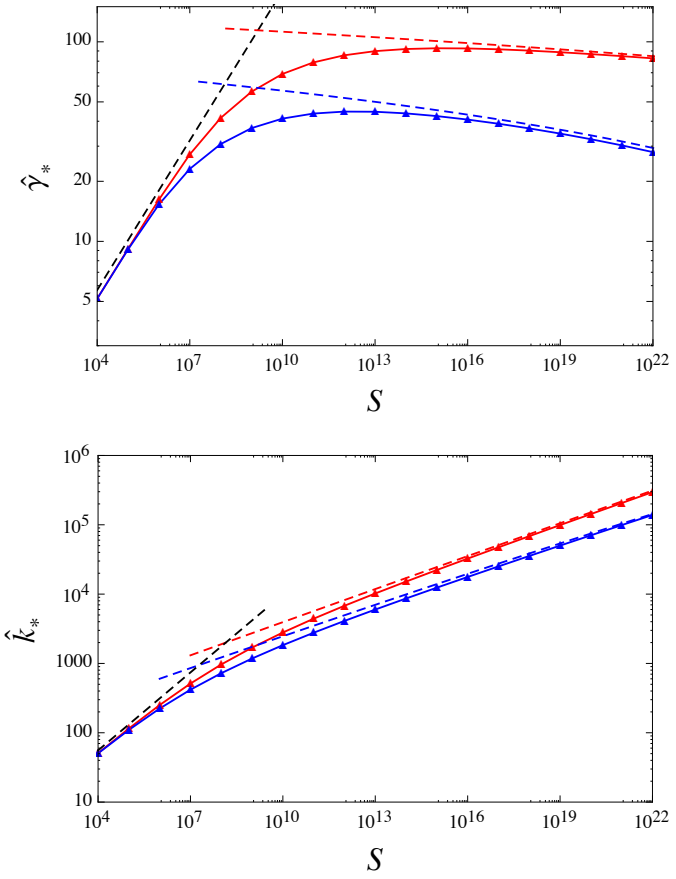

Fig.1 - Dependence of the growth rate (top) and the wavenumber (bottom) as a function of the Lundquist number S, for different perturbation amplitudes. The black dashed lines represent the earlier scalings, which are not applicable for large-S plasmas, while the solid curves represent the accurate results obtained with the new theoretical approach.

Reference: L. Comisso, M. Lingam, Y.-M. Huang, and A. Bhattacharjee, Phys. Plasmas 23, 100702 (2016).

Funding: Grant No. DE-AC02-09CH-11466 and NSF Grant Nos. AGS-1338944 and AGS-1460169