Detection of filamentary structrures using transfer entropy in TJ-II and W7-X

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A new method to detect filamentary structures in magnetic confined plasmas is presented. The method, transfer entropy (TE), is a technique which detects causality between signals [1][2]. It measures information flow from different signals. In this work, it is applied to probes distributed at different locations in the plasma. The results show connexions between signals with some time lag. Thus, the TE is capable of detecting when the filaments are passing through distant probes.

We apply the TE to the fluctuating electrostatic potential in a resistive MHD model. Probes distributed along the poloidal direction identify the periodicity of the filament. Furthermore, knowing the periodicity allow us to calculate the length of the filament. The directionality of TE is used to obtain their poloidal velocity. Finally, the radial width of filaments is calculated by probes distributed along the radial direction.

Figure 1: *Filamentary structure in TJ-II*

The method is applied to TJ-II and W7-X devices. Both machines have low magnetic shear which generates low order rational surfaces that dominate a wide radial region. In our simulations, filaments have the same periodicity as the rational surfaces and they are rotating with the same poloidal velocity as the plasma. This well-known characteristic helps to detect and contrast the filaments using the present method. Our results are consistent with expected values and with recent experiments in TJ-II [3].

References

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