MACHINE LEARNING METHOD FOR PREDICTION AND DETECTION OF PLASMA CONFINEMENT STATES AND ELM ACTIVITY

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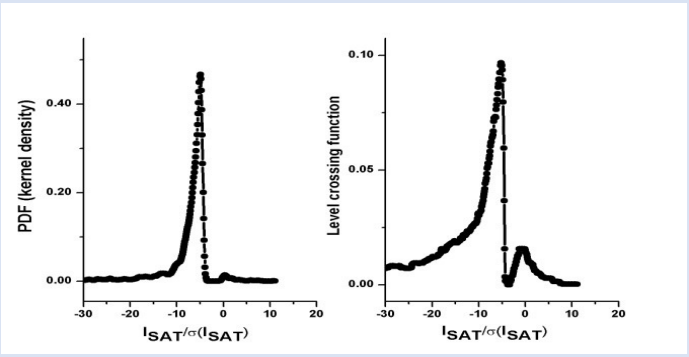
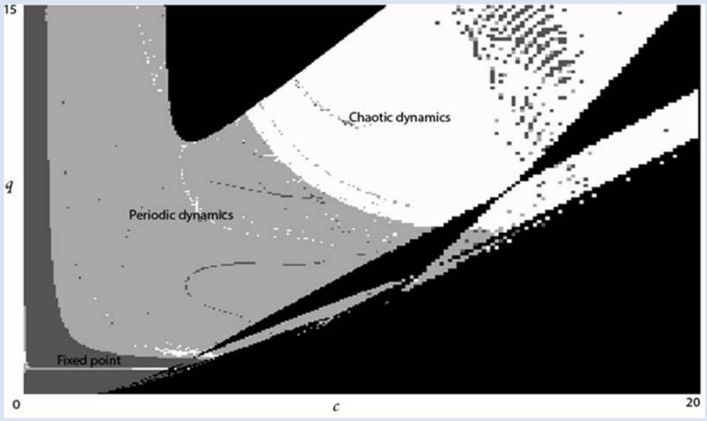
ABSTRACT

• Bifurcations are ubiquitous in plasmas and they are of crucial importance in structural formation of magnetically confined plasmas. Since most of the models address the deterministic aspect of the relevant dynamics, we initiate the study of combination of deterministic and stochastic aspects of these events.

BACKGROUND

The two stable equilibria in the H-mode suggest that ELMs, which dominate the dynamics of this particular confinement regime, represent stochastic bifurcations between two stable states. The appearance of the second stable equilibrium may be detected at its inception so that the pdf may be regarded as precursors of the confinement changes. We inspect the possibility to modify an existing deterministic model in order to exhibit stochastic characteristics of the ELM dynamics in the H-mode .

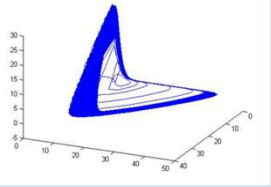


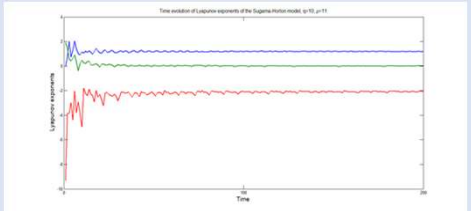


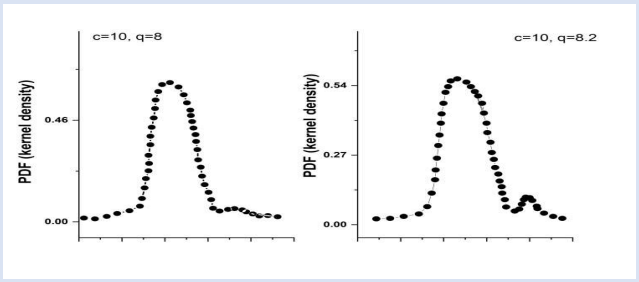
METHODS

Sugama-Horton model

$$\frac{du}{dt} = q - \sqrt{u}\,k$$
$$\frac{dk}{dt} = \sqrt{u}\,k - cu^{-\frac{1}{2}}\,f\,k - d^{-1}(u)\,k^2$$
$$\frac{df}{dt} = cu^{-\frac{1}{2}}\,f\,k - c\,m(u)\,f$$

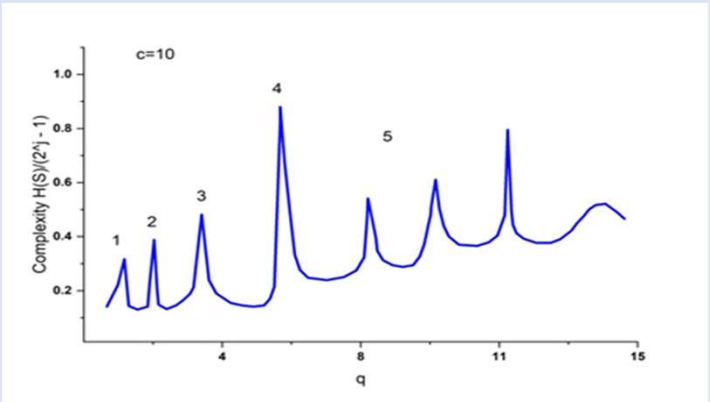


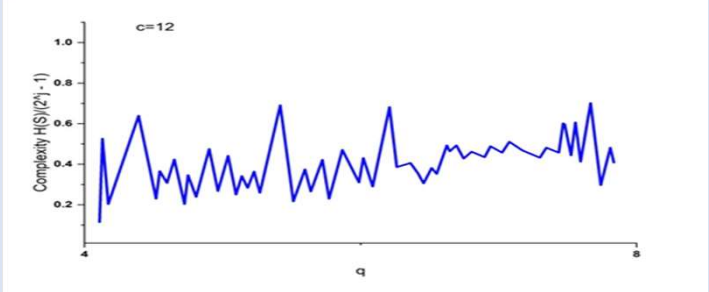




STOCHASTIC MODEL

$$DU(t) = q\,dt - \sqrt{U}\,K\,dt + \sigma_1 dW_1(t)$$
$$DK(t) = \sqrt{U}\,K\,dt - cU^{-\frac{1}{2}}\,F\,K\,dt - U\,K^2 dt + \sigma_2 dW_2(t)$$
$$DF(t) = cU^{-\frac{1}{2}}\,F\,K\,dt - c\,m(U)\,F\,dt + \sigma_3 dW_3(t)$$





CONCLUSION

- Stochastic model as a modified deterministic model yields good agreement with experimental findings
- Wavelet based machine learning method points precisely to the parameter values at which bifurcations occur
- Wavelet machine may be easily upgraded to a n AI tool by combining it with neural networks, for example.