§18. The Correlation Dimension and Lyapunov Spectrum of the Electron Temperature Oscillation in the Central Region of the TEXTOR Tokamak

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Equations governing plasma behavior are nonlinear ones. Therefore there are many examples showing low-dimensional fluctuations[1]. The reports on density and magnetic fluctuation at periphery of Tokamak plasma have been made[2]. Here, the results of the chaotic analysis on sawtooth oscillations observed in the center region of the TEXTOR Tokamak are presented.
Items on which we put emphasis are (1) what is the number of correlation dimension and (2) what is the maximum Lyapunov exponent if a deterministic chaos exist on the signals. Time series of the electron temperature signals were averaged over 5 points and substructed DC and low frequency components. The preprocessed time series data can produce an attractor in a phase space if the osillation is dissipassive. From an attractor, we may deduce the correlation dimension and the Lyapunov exponents which may determine whether the chaotic oscillations exsist or not in the signal. In the calculation of the corellation dimensions, we have used an algorithm proposed by Grassberger and Procaccia[3]. We estimate Lyapunov spectrum according to the method proposed

by S. Sato et al.[4]. Figure 1 showes correlation dimenssions D as a function of embedding dimensions. For high and middle plasma currents (I_3, I_4, I_5), D is approching to a saturation value 2.5. For those, the maximum Lyapunov exponents are estimated to be around 0.7 ~ 1.0. Figure 2 showes the example of converging behaviour of the maximum Lyapunov exponent.
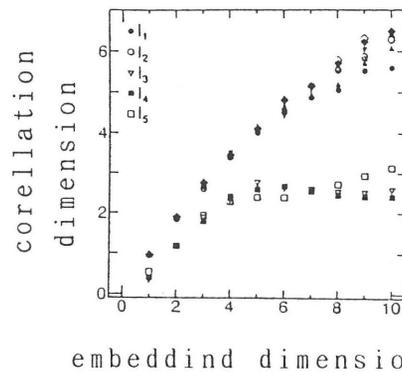

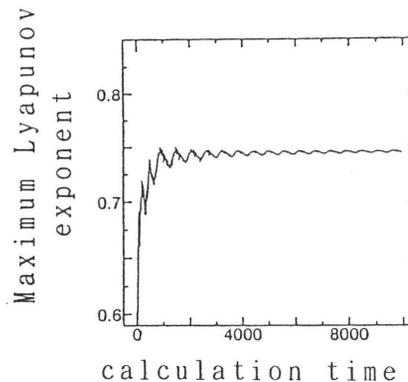Fig.1 correlation dimenssions as a function of embedding dimension

Fig. 2 Example of converging behaviour of the maximum Lyapunov exponent.

References
1) Kawai, Y., NIFS-MEMO-12. 1993
2) Prado, C.P.C. et al., Plasma Physics and Controlled Fusion, 30(1991)493
3) Grassberger, P. et al., Physica 9D(1983)189
4) Sato, s. et al., Prog. Theor. Phys. 77(1987)1