BAYESIAN ANALYSIS ON PLASMA CONFINEMENT DATA BASES

R. Preuss, V. Dose, A. Dinklage
Max-Planck-Institut für Plasmaphysik,
EURATOM Association, D-85748 Garching, Germany
(e-mail: preuss@ipp.mpg.de, http://www.ipp.mpg.de/ preuss)

Abstract

Plasma experiments in large fusion devices represent high efforts and costs. Motivated by physical questions many experiments are performed under small variations of settings leading to clustered parameter spaces. Thereby being hardly well conditioned, data bases are fed by mean values and standard deviations of the measured quantities. In the analysis process the data descriptive equation can only approximate the overall confinement behaviour with a power law. Resulting from this approximation and the sparse parameter space outliers and non-Gaussian error statistics are to be expected. The question addressed here is to cope with them in order to develop a robust analysis.

In the sense of the maximum entropy principle a Gaussian results from the assumed knowledge of mean μ and variance σ^2. If we assume instead that the expectation value of $|d_i - \mu|$ is σ_i we obtain a Laplace distribution. It allows for considerable outlier tolerance compared to the Gaussian choice. A combination of the properties of a Gaussian and a Laplace distribution is obtained from an inverse hyperbolic cosine. Its small argument behaviour approximates a Gaussian while the wings of the distribution are Laplace-like.

We examine the impact of the three likelihood functions on Bayesian model comparison which is employed to determine the consistency of confinement data with different physical models. These models derive from different combinations of inclusion/neglect of ion collisions and diamagnetic response of the plasma to be reflected in equations which couple exponents of a power law ansatz. In order to check the validity of the procedure, subsets of confinement data with known behaviour in the above physical properties are tested against a set of models resulting in an acceptance probability of each model under consideration.

Key Words: Laplacian distribution, Hyberbolic likelihood, Model comparison