Evaluation of Charge Stability Diagrams Through Fourier Analysis

Tancredi Salamone[1]
Emmanuel Charion[1]
Pierre-André Mortemousque[1]
Yann-Michel Niquet[2]
Biel Martinez i Diaz[1]

[1]*Univ. Grenoble Alpes, CEA, LETI, F-38000, Grenoble, France*
[2]*Univ. Grenoble Alpes, CEA, IRIG-MEM-L_Sim, F-38000, Grenoble, France*

tancredi.salamone@cea.fr

Abstract

Charge stability diagrams provide means for establishing the quality of quantum dot nanostructures [1-3]. The classification of such diagrams is often done through visual inspection of individual diagrams or by machine learning. However, these procedures do not provide any physical insights. Here we present a method based on Fourier analysis that allows automated evaluation and extraction of more details on the underlying physics. By studying the power spectral density (PSD) of a set of charge stability diagrams we calculate estimators representing the quality of each diagram. The estimator is calculated as the mean of the PSD above a certain threshold frequency. Our analysis shows promising results in discriminating between high-quality and low-quality diagrams, as well as in detecting peculiar features such as stochastic events.

References

[1]   F. A. Zwanenburg et al., Rev. Mod. Phys., 85 (2013) 961.
[2]   R. Hanson et al., Rev. Mod. Phys., 79 (2007) 1217.
[3]   G. Burkard et al., Rev. Mod. Phys., 95 (2023) 025003.
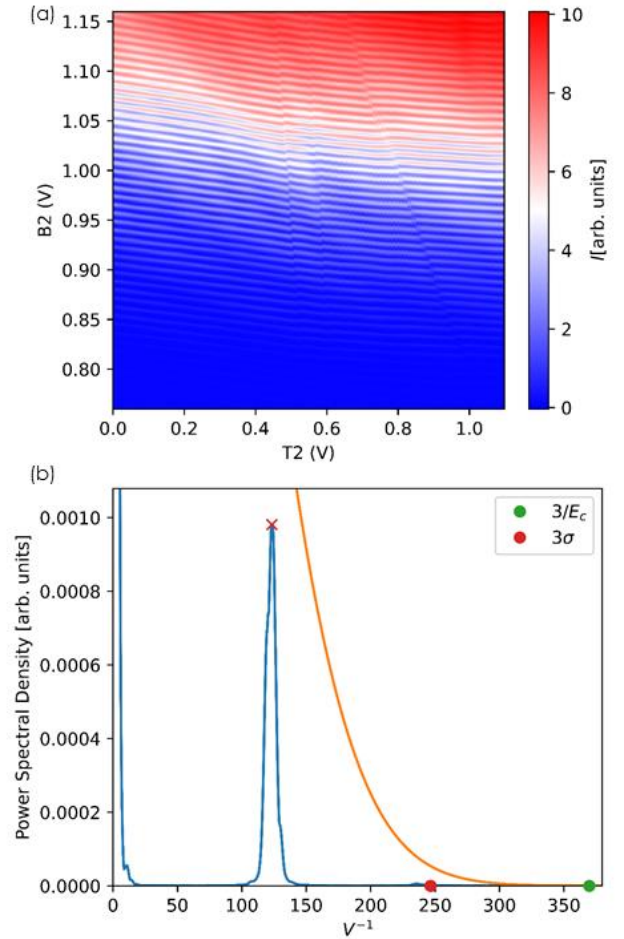
Figures

Figure 1: (a) Charge stability diagram, (b) corresponding PSD (blue) and embedding gaussian (orange) with possible thresholds (red and green dots).
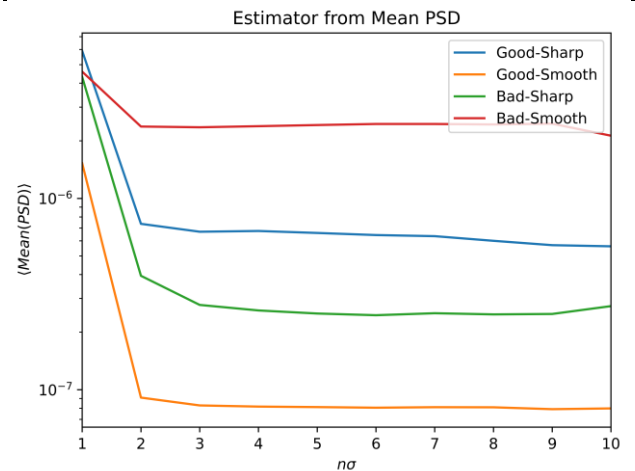

Figure 2: Estimator as a function of threshold calculated from the standard deviation of embedding Gaussian as in Fig.1(b)