# Spatio-temporal Analysis of Nucleate Pool Boiling: Identification of Nucleation Sites using Nonorthogonal Empirical Functions (NEFs).

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## Abstract

The analysis of spatio-temporal data and the physical understanding of the systems generating them are often limited by the available techniques. These limitations are especially evident in nucleate boiling. This paper investigates the analysis of a sequence of temperature fields obtained from a pool nucleate boiling experiment. Spatio-temporal data for the wall temperature in pool nucleate boiling of water on a thin, horizontal, stainless steel plate were obtained by liquid crystal thermography and high speed video recording A previous analysis provided examples of the thermal conditions for activation of individual nucleation sites, for the heat transfer mechanisms during bubble growth and for the consequent interactions between adjacent sites. Principal component analysis (PCA) is shown to provide a reconstruction of the temperature fields that is accurate in the root mean square sense but which obscures information about the underlying physics, such as positions of the nucleation sites. In contrast, a new approach using non-orthogonal empirical functions (NEFs) encodes the relevant physical constraints (e.g., each NEF has a radially symmetrical form as suggested by the pattern of cooling during bubble growth). NEFs provide an efficient identification of the positions of active sites in successive frames; they are better suited to the analysis of non-stationary dynamics than PCA and allow for information compression.