Abstract Submitted
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Dynamical Systems Analysis of Thermoacoustics Stacks[1] ROBERT STODDARD, Utah Valley University, DON MCLAUGHLIN, University of New Mexico, BONNIE ANDERSEN, Utah Valley University — Thermoacoutics is the science of interconversion between disorganized heat energy and organized sound energy. The effect was observed centuries ago with ceremonial rice cookers in China and may be easily observed by heating a wire mesh in a pipe. Time series gas pressures may be measured with a piezoelectric sensor embedded in the resonator of a thermoacoustic engine. The emergent resonant frequency of the sound produced depends on the working fluid and dimensions of the apparatus. A plot of time series data reveals an initial region of random pressure variation followed by a region of growing pressure amplitude together with interspersed regions of random and chaotic motion. Thermoacoustics has traditionally been modeled using fluid dynamics and acoustics theory. The purpose of the research reported here is to explore modeling thermoacoustics phenomena using the analysis tools of dynamical systems theory. This approach is capable of describing various regions of organized and disorganized behavior and produces mathematical models designed to describe observed data. The time series data suggest a sigmoid growth curve moderated by a periodic oscillation model. We have assumed a simple logistic growth curve having a single adjustable parameter (representing growth rate) multiplied by a simple sine curve having an observed resonant frequency of 2.28 kHz. It is found that a nonlinear least squares fit of the logistic/sine model parameters reproduces the observed behavior of the various regions reasonably well.

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