Escaping the Uncertainty Principle: The Hilbert–Huang Transform

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Abstract

Time and frequency domain analyses provide different ways of extracting information from a physical signal. However, traditional data analysis methods, such as the Fourier transform, are defined for linear and/or stationary time series, and encounter limitations imposed by the Heisenberg uncertainty principle. It is in this context that we present the Hilbert–Huang transform, an adaptive method that decomposes a signal into a finite number of components of decreasing frequency ranges, leading to a description of the data in terms of physically meaningful instantaneous frequencies. In this talk, we provide an overview of the Hilbert spectral analysis, and the empirical mode decomposition of a signal into intrinsic mode functions. We highlight the domain of applicability of this procedure and its effectiveness by applying it to the analysis of junk radiation from binary black hole simulations. This demonstrates efficacy of the Hilbert–Huang transform as a valuable tool for isolating and characterizing high-frequency bursts in physical data.