Introduction Hilbert-Huang Transform
An adaptive data analysis method

Data analysis is indispensable to every science and engineering endeavor. The existing methods of data analysis, either the probability theory or the spectral analysis, are all developed by mathematicians or based on their rigorous mathematical rules. As a result, the bases are all *a priori* determined. And to conform to the rigorous mathematical rules, we are forced to live in a pseudo-real world in which all processes are idealized to conform to mathematician's conditions and requirements. There is always a conflict between reality and the ideal world, which was summarized succinctly by Einstein: ' As far as the laws of mathematics refer to reality, they are not certain; and as far as they are certain, they do not refer to reality.' As research becomes increasingly sophistic, the inadequacies of the traditional data analysis methods have become glaringly clear. For scientific research, the *a priori* basis approach would never work well. To accommodate the needs of scientific, rather than mathematical, data analysis, we have to face the reality of nonstationarity and nonlinearity in the data. The only viable way is to break away from the traditional limitations and establish a new paradigm in adaptive data analysis method. In this course, we will discuss the following topics:

1. Adaptive decomposition method: the Empirical Mode Decomposition
    - Spline functions
    - Stoppage criteria
    - End effects
    - Ensemble EMD

2. The Instantaneous frequency
    - Instantaneous frequency for nonlinear systems
    - The Teager Energy operator
    - Generalized zero-crossing
    - Hilbert Transform
    - Quadrature

3. The time-frequency spectral analysis
    - Wigner-Ville
    - Wavelet analysis
    - Hilbert spectral analysis

4. Generalization of the adaptive method to higher dimensional spaces
    - Bi-dimensional EMD
    - Multi-dimensional EEMD

5. Applications with examples drawing from science and engineering problems

The students should have a priori knowledge of Calculus and Fourier analysis.