Investigation of Frequency Evolution of Gravitational Waves From Core Collapse Supernova by Hilbert-Huang Transform

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The next generation Gravitational Wave (GW) detectors are expecting to detect GWs from Core Collapse Supernova (CCSN). Numerical studies show two processes related to the GWs from CCSN; Oscillation of Proto Neutron Star (PNS) (Eigen modes) and Standing Accretion Shock Instability (SASI mode). The physical properties of PNS can be estimated by the analysis of GWs with the approach of the asteroseismology. For which, time evolution of frequencies of eigen modes should be separately identified on the time-frequency representation. However, the conventional method such as Short Time Fourier Transformation (STFT) is not effective due to their low-resolution nature. As the solution, Hilbert Huang Transformation (HHT) is applied. This research consists of two objectives; Comparison of resolution of STFT and HHT and Investigating the ability of HHT to identify the frequency trending. In this research there are two time series models, Time Independent (TI) and Time Dependent (TD), have been considered for the analysis instead of the time series of GWs from CCSN. To perform the analysis, both STFT and HHT are applied on TI and TD time series separately under three different Signal to Noise Ratios (SNR); 5,10 and 20. In the HHT analysis, both Empirical Mode Decomposition (EMD) and Ensemble Empirical Mode Decompositions (EEMD) have been used. According to the results obtained by the analysis, it has been concluded that the resolution of the HHT is higher than that of to the STFT. In the HHT analysis, it has been compared the theoretical frequency trending of the TI and TD models with the Instantaneous Frequency (IF) trending obtained by the HHT analysis. And also, HHT map has also been generated to identify the frequency trending. According HHT results,it has been concluded that HHT is effective to identify the different mode frequencies to estimate the physical properties.

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