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Analysis of Gravitational wave using multi-window NHA method

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Gravitational waves caused by neutron stars, black holes, the early universe and supernova explosion have become a new method to observe the universe. And the gravitational wave has been successfully detected for the first time using LIGO detector, named GW150914.
About the real data of detector, the plural line noises are appearing bigger than the gravitational wave greatly, without the notch filter to analyze and observe the gravitational wave signal in detail becomes necessary. Among the various techniques, we proposed and tried to use the Non-Harmonic Analysis (NHA) which improved the frequency resolution dramatically to analyze the gravitational wave since NHA can minimize the influence of the window length. For the model signal of gravitational wave, we compared and verified the analysis accuracy of NHA with other techniques in the time-frequency domain. Using the actual LIGO measured data to verify the analytical precision of gravitational wave signal which near the line noise by NHA. And NHA provides a higher-resolution analysis than other previous methods, even the information of small gravitational wave signal which be covered by the large power supply noise, it can be captured and visualized to the limit by NHA without doing the notch filter.
Moreover, for improving the analytical precision, we proposed a new time-frequency analysis method named Multiwindow NHA based on NHA method, which perform the band division in frequency domain and provide the optimal analysis window length for each band to perform NHA. Therefore, the advantages of NHA are not only retained, but also can use multiple analysis window lengths in the entire frequency domain, and the time resolution and frequency resolution can be achieved simultaneously.
Multiwindow NHA was used to analysis the actual GW150914 signal, and verified its validity and accuracy with state-of-the-art methods. Consequently, multiwindow NHA can be utilized to represent GW signals from the low to high frequency range accurately based on the high time-frequency resolution and analytical precision, and the influence of noise can be suppressed more effectively than if state-of-the-art methods were used.

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