Study of the damping process of the giant resonance by means of the wavelet analysis of fluctuating strength functions

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Giant resonances excited at a high energy region are damped through the coupling with a huge dimensional background states. It is well known that the total width of the strength function can be understood by the doorway damping picture. The total width, however, characterizes the only beginning of whole damping process and the rest of the damping process, which finally leads to the chaotic compound states, is still remained to be explained.

Recent development of a high resolution experiment can give strength functions with a fine structure with smaller energy scales than the total width which is needed for studying the damping mechanism in detail \cite{1}. Then, it is strongly desired to develop a new measure for the fluctuation analysis of the strength function, which can detect physical quantities which characterize the damping process \cite{2}. We proposed the spacing distribution of the wavelet transform modulus maxima (WTMM) based on the wavelet transform as such a new measure \cite{3}. The wavelet transform is defined as

\[ g(E_x, \delta E) = \frac{1}{\delta E} \int S(E) \Psi(\frac{E_x - E}{\delta E}) dE, \]  

where the strength function \( S(E) \) is multiplied by the wavelet function \( \Psi(E) \) located at the energy position \( E_x \) with the energy scale \( \delta E \). The WTMM is defined as the values of \( E_x \) which give the maxima of the wavelet transform as a function of \( E_x \) with a value of \( \delta E \) fixed \cite{4}. The spacing distribution of the WTMM can be seen as the nearest "level" spacing distribution of the coarse grained effective energy spectrum at the energy scale \( \delta E \). Thus, it is expected that the information about the fluctuation properties of the strength function can be obtained by studying how the behavior of the spacing distribution of the WTMM changes as the energy scale \( \delta E \).

We applied this new measure to the strength function obtained by the realistic theoretical calculation for the giant quadrupole resonance in \(^{40}\text{Ca}\) and \(^{208}\text{Pb}\). For \(^{40}\text{Ca}\), the estimated value of the spreading width associated with the doorway states is in good agreement with the actual value. It is also found that for \(^{208}\text{Pb}\) the property of the fluctuation is almost same as that of the Gaussian orthogonal ensemble theory, which is consistent with the result obtained by means of the local scaling dimension \cite{2}. This indicates the effectiveness of the spacing distribution of the WTMM as the analysis measure of the fluctuation.

\begin{thebibliography}{99}
\bibitem{3} K. Suzuno, Master Thesis, Tokyo Metropolitan University (2007).
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