Resonance or virtual state causing cross-section peaks just above thresholds

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It is a long standing problem to determine its resonance energy and width of the first excited $1/2^+$ state of ^{9}Be, which is closely connected with the problem to clarify whether it is a resonant state or not. From analyses of the scattering length for the ^{8}Be+n scattering and the R-matrix calculations, it has been shown that the first excited $1/2^+$ state is a virtual state. On the other hand, recently the first excited $1/2^+$ state has been discussed as a three-body resonance of $\alpha + \alpha + n$.

Experimentally, the photodisintegration cross section of ^{9}Be+$\gamma \to \alpha + \alpha + n$ in a low energy region has been measured to deduce a production rate of ^{9}Be from the astrophysical point of view. In the low energy region up to $E_\gamma = 6$ MeV, the enhancement of the cross section has been observed at several energy positions corresponding to excited states of ^{9}Be, which are understood to be due to the electro-magnetic dipole transitions. In particular, the first excited $1/2^+$ state is observed as a sharp peak just above the ^{8}Be(0^+)+ n threshold.

Recently, we studied the $1/2^+$ state of ^{9}Be and the photodisintegration cross section applying the complex scaling method to the $\alpha+\alpha+n$ three-cluster model [1]. The results indicate that there is no sharp resonant state corresponding to the distinct peak observed just above the ^{8}Be+n threshold in the photodisintegration cross section of ^{9}Be. However, the recent experimental data of the $1/2^+$ cross section can be well reproduced by the $\alpha + \alpha + n$ three-cluster model calculation. From these results, we discuss that the first excited $1/2^+$ state in ^{9}Be is a ^{8}Be+n virtual state but not resonant one.

Reference

[1] M. Odsuren, Y. Kikuchi, T. Myo, M. Aikawa, and K. Katō, Phys. Rev. C92, 014322 (2015).