Probing optimal reaction energy for synthesis of element 119 from $^{51}V+^{248}Cm$ reaction with quasielastic barrier distribution measurement†

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At RIKEN, there is a search for element 119 using a ^{51}V + ^{248}Cm hot fusion reaction. The optimal reaction energy of this reaction system is unknown owing to wide variations in theoretical predictions. A method has been developed to estimate the optimal energy from the quasielastic (QE) barrier distribution.[1)] In this study, the QE barrier distribution of the ^{51}V + ^{248}Cm reaction was measured using the gas-filled recoil ion separator GARIS-III at the recently upgraded facility, SRILAC,[2)] and the optimal reaction energy for synthesizing element 119 from the ^{51}V + ^{248}Cm reaction was estimated.

The experimental excitation function of the QE backscattering cross section σ_{QE} relative to the Rutherford cross section $\sigma_{\mathrm{Ruth.}}$, denoted as $R(E)$, for the ^{51}V + ^{248}Cm reaction is shown in Fig. 1(a) with the single- and coupled-channel calculations. Figure 1(b) shows the barrier distribution, $D(E)$, derived from the energy derivative of Fig. 1. Both the experimental trends of $R(E)$ and $D(E)$ are explained by the coupled-channel calculation, indicating a significant effect of the rotational excitation of the deformed ^{248}Cm.

Aiming to estimate the optimal energy for element-119 synthesis, the average Coulomb barrier height, B_0, for the ^{51}V + ^{248}Cm reaction was derived from the present data to be 225.6(2) MeV (closed arrow in Fig. 1). The side-collision energy, B_{side}, which is considered to be favorable for forming a compound nucleus, was also determined to be 233.0(2) MeV (open arrow) by considering the deformation of ^{248}Cm. By evaluating the relation between B_{side} and the optimal energy for maximizing the evaporation-residue cross section in the ^{48}Ca + ^{248}Cm system, the optimal energy for the ^{248}Cm(^{51}V, 3;4n)$^{296;295}$119 reaction was estimated to be 234.8 ± 1.8 MeV. Using this deduced reaction energy, an experiment for the synthesis of element 119 at RIKEN is currently underway.

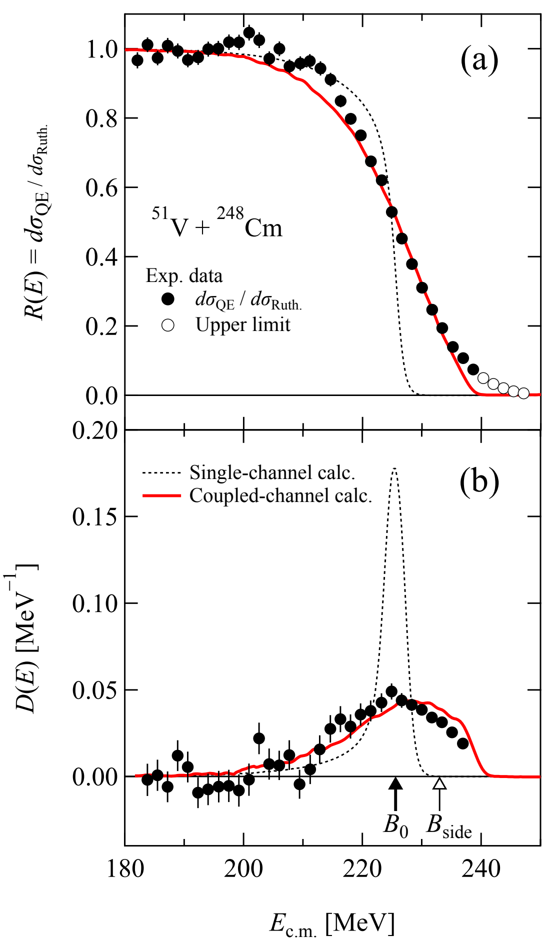

Fig. 1. (a) $R(E)$ and (b) $D(E)$ as a function of the center-of-mass energy $E_{\mathrm{c.m.}}$. The dashed and solid lines represent the single- and coupled-channel calculations, respectively.

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