Subbarrier heavy ions fusion enhanced by subbarrier nucleons transfer and subbarrier fusion of nuclei far from the β-stability line

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We discuss a semiclassical model for the description of subbarrier fusion of heavy ions which takes into account the coupling to the low-energy surface vibrational states and to the few-nucleon transfer with arbitrary reaction Q-value. The subbarrier transfer of nucleons during barrier penetration is described by using the WKB approach and does not use special proposal on the low-energy behavior of the transfer coupling. The coupling with the low-energy surface vibrations in the model is considered by using traditional simplified coupled channels approach [2,3]. This model is correct in the case of nucleons transfer with the large positive Q-value. The fusion reactions ^{32}S + ^{100}Mo, ^{36}S + ^{96}Mo, ^{28,30}Si + ^{58,62,64}Ni, ^{28}Si + ^{94,100}Mo, ^{40}Ca+^{90,96}Zr, ^{16,18,20,22,24}O + ^{58}Ni and ^{28}Si + ^{124,126,128,130,132}Sn are analyzed in the framework of this model. The calculated fusion cross section, mean angular momentum and its dispersion for these reactions are good agreed with available experimental data. It is shown that the fusion cross sections and mean angular momentum quantities are significantly enhanced by few-nucleon transfer with large positive Q-value, see fig for example.

This model is applied for the fusion reactions between nuclei near to the neutron drip line and nuclei close to the β-stability line. The neutrons transfer has extremely large positive Q-value and small values of neutrons separation energy for such collision systems. The fusion reactions ^{18,20,22,24}O + ^{58}Ni and ^{28}Si + ^{124,126,128,130,132}Sn are discussed in detail, see fig. It is shown that the subbarrier fusion cross sections and the mean angular momenta are strongly enhanced by neutrons transfer for these reactions. It is found, that the slope of energy dependence of subbarrier fusion cross section is changed due to neutron transfer. The maximums are appeared in the energy dependencies of the both mean angular momentum and its dispersion in the case of neutron transfer with positive Q-value.

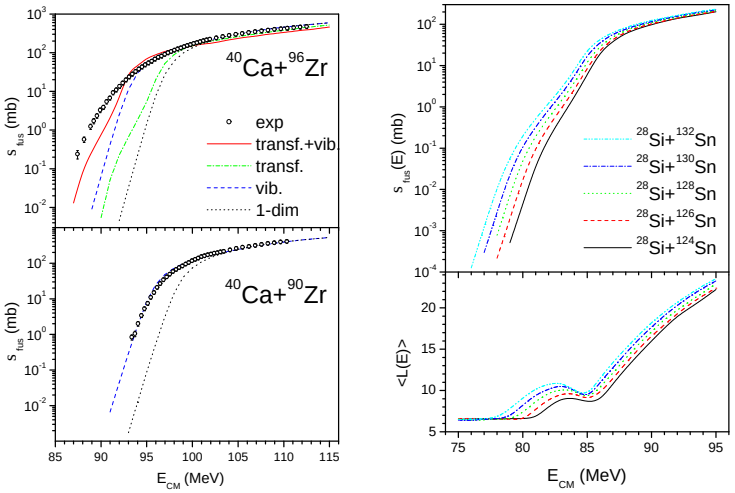

FIG. 1. Left: Fusion cross sections for the reactions ^{40}Ca+^{96}Zr (top) and ^{40}Ca+^{90}Zr (bottom). Experimental data (dots) are taken from [4]. Right: Fusion cross section (top) and mean angular momentum (bottom) for the reactions ^{28}Si+^{124,126,128,130,132}Sn.

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