References

[1] Z. Y. Zhang, Z. G. Gan, M. H. Huang, et al., Atom. Ener. Sci. Tech., 45(2011)1262.
[2] S. Hofmann, G. Munzenberg, Rev. Mod. Phys., 72(2000)733.

2 - 3 Dynamics Aspect of Subbarrier Fusion Reaction in Light Heavy Ion Systems

Huang Meirong, Zhou Feng, Wada Roy, Liu Xingquan, Lin Weiping, Zhao Minghui, Wang Jiansong
Chen Zhiqiang, Ma Chunwang, Yang Yanyun, Wang Qi, Ma Junbing, Han Jianlong, Ma Peng
Jin Shilun, Bai Zhen, Hu Qiang, Jin Lei, Chen Jiangbo and Li Yong

Nuclear fusion reactions near the Coulomb barrier are strongly affected by thestructure of the interacting nuclei, especially with weakly bound neutrons[1]. Some theoretical calculations predict that the fusion cross section is enhanced over well-bound nuclei because of the larger spatial extent of halo nucleons[2]. On the other hand halo nuclei can easily break up in the field of the other nucleus, due to their low binding energies. Experimentally this is still a hot debate because of experimental difficulties.

Another interest we propose here is the influence of the cluster structure in the fusion mechanism. Recent calculations, using an antisymmetrized molecular dynamics model(AMD), indicate that light nuclei exhibit variety of distinct cluster structures[3-6]. The cluster structures are predicted even for nuclei with $Z \sim N$ of Li and Be[4] (where Z and N are the charge and neutron number in a nucleus, respectively). When nuclei with a well-developed cluster structure are involved in fusion reactions near the barrier, it will be reflected on the fusion cross section. In this report we present the calculated results in the study of the fusion reactions of the ^{7}Li $+^{12}$C system near the Coulomb barrier using AMD simulations.

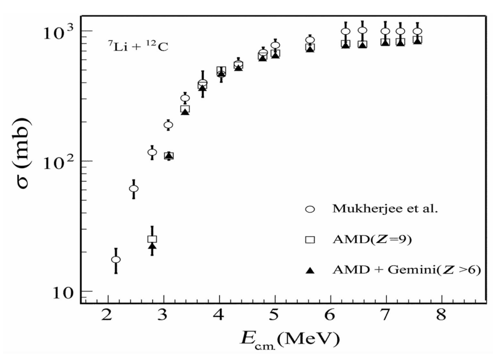

Fig. 1 Fusion cross section for the ^{7}Li $+^{12}$C. Circles represent experimental results and taken from Ref. [8].

The AMD calculations were performed up to times ranging from 3000 fm/c at lower energies to 1000 fm/c at higher energy side and clusterized at the end of the calculation, using a coalescence technique in phase space. Even after such a relatively long time, most clusters were in an excited state. In order to compare the simulated results to those of the experiments, the excited fragments were cooled down using the statistical decay code, GEMINI[7]. These events are referred to as the AMD + GEMINI events hereafter, whereas the events without the GEMINI calculation are called the primary events and referred to as the AMD events. The occurrence of the fusion reactions in the AMD + GEMINI events is defined here by the emission of the fragments with $Z>6$ in a given event.

In Fig. 1 the calculated fusion cross sections, indicated by closed triangles, are compared to those of the experiments (open circles). The experimental data are taken from Ref. [8]. The experimental data are reproduced well within the experimental errors above $E_{cm}>3$ MeV in the absolute scale. The absolute cross sections predicted by the AMD simulations were calculated using the number of events generated in the given impact parameter range. At $E_{cm}\leqslant 3$ MeV the AMD simulation underestimated the fusion cross sections. In this energy range, the tunneling effect through the Coulomb barrier becomes important and in the present AMD formulation, this process is not incorporated. In the figure the formation cross sections of ^{19}F in the primary AMD events are also plotted by open square symbols.

In summary, the fusion cross section of the ^{7}Li $+^{12}$C reaction was studied using the AMD and GEMINI codes. The AMD+GEMINI simulation reproduced the experimental total fusion cross sections reasonably well at $E_{cm}>3$ MeV but under estimated it below that energy.

References

[1] L. F. Canto, et al., Nucl. Phys., A424(2006)1.
[2] N. Takigawa, et al., Phys. Rev., C47(1993)R2470.
[3] Y. Kaneda-En'yo, et al., Phys. Rev., C52(1995)628.
[4] Y. Kaneda-En'yo, et al., Phys. Rev., C52(1995)647.
[5] Y. Kanada-En'yo, et al., Phys. Rev., C60(1999)064304.
[6] Naoya Furutachi, Masaaki Kimura, et al., Theor. Phys., 122(2009)865.
[7] R. J. Charity, et al., Nucl. Phys., A483(1988)371.
[8] A. Mukherjee, et al., Nucl. Phys., A596(1996)299.

2 - 4 Fluorescence Emission from CsI(Tl) Crystal Induced by High-energy Carbon Ions and X-rays

Lei Yu, Zhao Yongtao, Cheng Rui, Sun Yuanbo, Zhou Xianming, Wang Xing
Wang Yuyu, Li Songlin and Xiao Guoqing

The thallium activated caesium iodide (CsI(Tl)) scintillationcrystalshave the advantages of high light output, little afterglow, sufficient stopping power, large detection area, and low cost. Theyhave been applied in many large solid angle detection arrays. The spatial, temporal or energy- information of the particles are probed generally by detecting the photons induced by the particles. The information is precious for both nuclear and material physics. However, there is a general lack of experimental data on spectra components and mechanism of the fluorescence emission induced by different kind of particles.

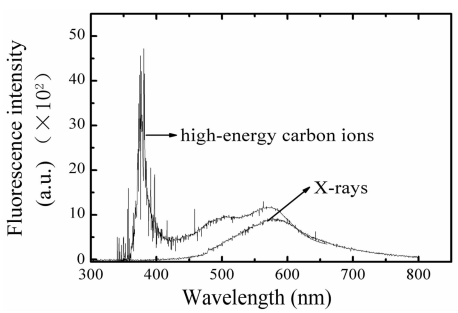

Fig. 1 The fluorescence emissionspectra of the CsI(Tl) crystal induced by high-energy carbon ions and X-rays.

In this work, the fluorescence emission spectra from ultraviolet to visible band were measured when high energy carbon ions passing through a thin plate of CsI(Tl) crystal (CaesiumIodide doped with Thallium). The experiments were carried out at the Cooling Storage Ring of the Heavy Ion ResearchFacility at Lanzhou (HIRFL), while the sample plate was cut from the center of a big bulk of CsI(Tl) crystal made in the Institute of Modern Physics, Chinese Academy of Sciences.

Fig. 1 shows that the fluorescence emissionspectra of the CsI(Tl) crystal induced by high-energy carbon ions and hard X-rays. It is found that the visible band is centered at around 570 nmwas observed in excitation of the high-energy carbon ions and X-rays. However, the ultraviolet-band (around 377 nm) emission, which is attributed to the electronic transitions from trigonal and tetragonal Jahn-Teller minima of the triplet relaxed excited state of Tl^+[1], is a characteristicemission from the high-energy carbon ions. The intensity of the band is very high, and the peak is very sharp (with a full width at half maximum (FWHM) of about 12 nm, which is about five times lower than that of the visible-band emission). Due to that the ionization density induced by high energy heavy ions is muchlarger than that induced by X-rays or γ-rays, the characteristic emission from 0.15 mol% Tl-dopedCsI(Tl)) crystal could be observed[2,3]. Simultaneously, this is also the reason that the characteristic emission with central wavelength around 500 nm from the very low fraction of the crystal defects was observed as well in case of heavy ion impacting.

That the ultraviolet-band (around 377 nm) emission is only observed in the excitation of high energy ions is very important for the CsI(Tl)) scintillation as a particle detector. It can help to accurately detect the spatial, temporal or energy information of high energy particles by only obtaining the ultraviolet-band emission.

References

[1] V. Nagirnyi, S. Zazubovich, V Zepelin, et al., Chem. Phys. Lett., 227(1994)533.