2 - 1 Research Progress of Nuclear Structure Research Group

Liu Minliang

The Group of Nuclear Structure Research at IMP has been working in the fields of nuclear structure, nuclear reaction and nucleon-nucleon interactions both experimentally and theoretically. The progresses of such researches in 2014 are given briefly as follows.

We have devoted much effort to the shape coexistence and evolution along the Pt isotope chain. The studied nuclei include the $^{185,187-189}$Pt published before the 2014 year. High-spin states of ^{190}Pt have been investigated by means of the ^{176}Yb (^{18}O, 4n) reaction at a beam energy of 88 MeV. We point out that the yrast line undergoes the transition from the spherical vibration to deformed rotation. The results are published in Physical Review C of 2014 year[1].

As regards the nuclear reaction, our attention is paid to the fusion cross sections of weakly bound nuclei. We have performed the experiments by using an activation technique for the fusion of ^{9}Be + ^{169}Tm, ^{9}Be + ^{187}Re and ^{9}Be + ^{181}Ta systems at the sector-focusing cyclotron of the Heavy Ion Research Facility in Lanzhou (HIRFL), while the experiment for ^{7}Li + ^{186}W is carried out at the HI-13 tandem accelerator of the China Institute of Atomic Energy (CIAE). The results for ^{9}Be + ^{181}Ta are published in Physical Review C of 2014 year[2].

Finally, we turn to the nucleon-nucleon interaction. It is well known that the evolution of nuclear structure is dominated by the proton-neutron interaction rather than the like-nucleon interactions. The proton-neutron interaction includes the spin-isospin dependent central and tensor components. In ^{92}Zr, we identify three high-spin states dominated by the central force, tensor force and combinations of central and tensor force, respectively[3].

References

[1] G. S. Li, M. L. Liu, X. H. Zhou, et al., Phys. Rev. C, 89(2014)054303

[2] N. T. Zhang, Y. D. Fang, P. R. S. Gomes, et al., Phys. Rev. C, 90(2014)024621

[3] Z. G. Wang, M. L. Liu, Y. H. Zhang, et al., Phys. Rev. C, 89(2014)044308

2 - 2 Complete and Incomplete Fusion of ^{9}Be + ^{169}Tm, ^{187}Re at Near-barrier Energies

Fang Yongde, Zhang Ningtao, Li Guangshun, Liu Minliang, Wang Jianguo, Guo Song, Qiang Yunhua, Zhou Xiaohong, Zhang Yuhu, Lei Xiangguo, Zheng Yong, Gao Bingshui, He Xiaofeng, Wang Kailong and Ding Bing

Fusion cross sections with weakly bound nuclei have been a subject of great interest in the last few years[1,2]. In this field, the basic question is whether complete fusion (CF) is enhanced or suppressed due to diffused density and high probability of breakup. The answer to this question depends on the energy regime (above or below Coulomb barrier) and on different target mass regions. Therefore, one important approach to investigate this subject is to study the systematic behavior of the CF suppression as a function of the target mass or charge.

For fusion induced by ^{9}Be, there are some reported works on the CF on different targets, ranging from ^{89}Y to ^{209}Bi[2], but the suppression factor of the CF at near barrier energies does not follow a systematic behavior. For lighter targets, like ^{27}Al and ^{64}Zn [3,4] and for ^{238}U[5], only total fusion (TF) cross sections were measured. In order to contribute to the investigation of the fusion of ^{9}Be, we performed experiments to measure complete and incomplete fusion (ICF) of ^{9}Be on the ^{187}Re and ^{169}Tm targets at energies close to the Coulomb barrier.

The experiments were performed at the sector-focusing cyclotron of the Heavy Ion Research Facility in Lanzhou (HIRFL). The cross sections of reaction products formed in the fusion of ^{9}Be +^{169}Tm and ^{9}Be +^{187}Re systems were measured by using an activation technique. The technique used is based on two main steps: The first step consists of the irradiation of ^{169}Tm and ^{187}Re targets; The second step consists of the offline detection of the rays emitted after the electron-capture decay of the evaporation residues. Finally, the CF and ICF cross sections have been measured in the energy range of 32.1∼48.0 MeV and 34.2∼49.1 MeV for ^{9}Be +^{169}Tm and ^{9}Be +^{187}Re systems, respectively. See Ref. [6] for experimental details.