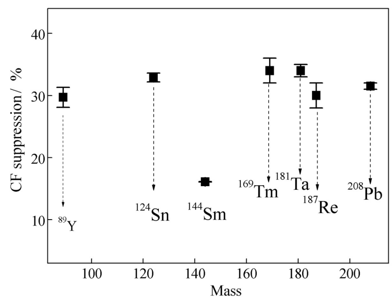

Fig. 1 Mean complete fusion suppression at energies slightly above the Coulomb barrier[2,6].

As shown in Fig. 1, the average ratios for most of the systems in this energy region are between 0.30 and 0.35. The approximate constant after considering the error bars reflects that the ratio is independent on the reaction system. As regards the ^{144}Sm target, the CF suppression is found to be much smaller than the others. One possible explanation is that some events corresponding to ICF were considered as CF in the determination of the cross sections.

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2 - 3 High-spin Level Structure of the Neutron-rich Nucleus ^{91}Y

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The high-spin states of near-spherical nuclei can be constructed by coupling the angular momentums of open shell nucleons. The maximum-spin state of valence space is made by aligning the angular momentums of all valence nucleons. Beyond that, the higher-spin states can be generated by breaking the shell closures. Many studies have been made about such excitation process of nuclei around the quasi-doubly magic nucleus[1−4].

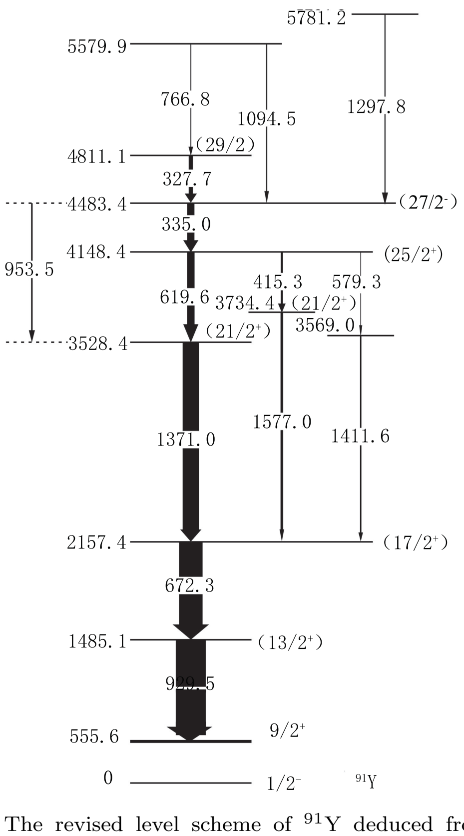

Fig. 1 The revised level scheme of ^{91}Y deduced from the present work.

In this work, high-spin states of ^{91}Y were populated through the ^{82}Se(^{13}C, p3n)^{91}Y reaction. The ^{13}C beam with 44 MeV was provided by the HI-13 Tandem Accelerator of the China Institue of Atomic Energy (CIAE), and the target was 2.11 mg/cm^2 isotopically enriched ^{82}Se on 8.56 mg/cm^2 natural lead backing. The emitted γ rays from the reaction products were detected by an detector array consisting of 2 planar and Compton-suppressed HPGe detectors. The energy and efficiency calibrations were made using the ^{60}Co, ^{133}Ba and ^{152}Eu standard sources and the typical energy resolution was 2.0 ∼ 2.5 keV at full width at half-maximum (FWHM) for the 1 332.5 keV line of ^{60}Co. Events were collected when at least 2 detectors were fired within the prompt 80 ns coincidence time window. Under these conditions, a total 2.5×10^7 coincidence events were recorded and the data were sorted into a symmetrized $E_\gamma - E_\gamma$ matrix for subsequent off-line analysis. Based on the analysis of γ–γ coincidence relationships and anisotropy of angular distribution, a level scheme for ^{91}Y has been proposed and presented in Fig. 1.

The 579.3, 766.8, 953.5, 1 094.5, 1 297.8 and 1 411.9

keV γ rays are newly added into the level scheme compared with that in Ref. [5]. Accepting the $(17/2^+)$ state as the fully-aligned state in the valence space $\pi(p_{1/2}, g_{9/2})^1$ and $\nu(d_{5/2})^2$, one can deduce that the higher-spin states involve the competition of the proton $p_{3/2}(f_{5/2}) \rightarrow p_{1/2}$ and neutron $d_{5/2} \rightarrow g_{7/2}$ particle-hole excitation, which is related to crossing the $Z = 38$ and $N = 56$ sub-shell closures respectively. Analogous to the analysis for ^{92}Zr[6], we propose that based on the $(17/2^+)$ state, the 3 528.4 keV $(21/2^+)$ level is attributed to neutron $(d_{5/2} \rightarrow g_{7/2})$ particle-hole excitation, while the other $(21/2^+)$ state at 3 734.4 keV is naturally ascribable to the proton $(p_{3/2} \rightarrow p_{1/2})$ particle-hole excitation. Therefore the 4 148.4 keV $(25/2^+)$ state is assigned to the $\pi(p_{3/2}^{-1}p_{1/2}g_{9/2})\otimes\nu(d_{5/2}g_{7/2}^{-1})$ configuration, which involves both neutron and proton particle-hole excitation from the $(17/2^+)$ state. Comparing the 619.6 keV (415.3 keV) transition with 1 577.0 keV (1 371.0 keV) transition, one can find that there is a reduction of energy for Z=38 (N=56) as one neutron (proton) is added to the $g_{7/2}$ $(p_{1/2})$ orbital, which is also found in ^{92}Zr[6]. In addition, the $N = 52$ isotones ^{93}Tc and ^{95}Tc are anticipated having the similar property and the detailed analysis is in progress.

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2 - 4 First Isochronous Mass Measurement in Neutron-rich Region at CSRe*

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Mass is one of the fundamental properties of atomic nuclei. Isochronous mass spectrometry (IMS), using a storage ring combined with an in-flight separator, has been shown to be a powerful tool for mass measurement of exotic nuclei[1]. Recently, masses of many proton-rich nuclides were accurately determined at the HIRFL-CSR facility[2]. In this paper, we described the first isochronous mass measurement of neutron-rich nuclides at CSRe.

This experiment was performed at the end of 2011. In the experiment, the primary beam of ^{86}Kr^{28+} ions was accumulated and accelerated to an energy of 460.65 MeV/u in the synchrotron CSRm. The ^{86}Kr^{28+} ions were fast extracted and focused on a ~15 mm thick beryllium target which was placed at the entrance of the RIBLL2 (an in-flight fragment separator). The hot fragments, produced via projectile fragmentation of ^{86}Kr^{28+}, were separated by the RIBLL2 and then injected and stored in the experimental cooler storage ring CSRe. Both RIBLL2 and CSRe were set to a fixed magnetic rigidity of $B\rho = 7.6755$ Tm for optimum transmission of the target ions ^{61}Cr^{24+}. The CSRe was tuned in isochronous mode for the target ions. The energy of the primary beam was chosen such that the isochronous condition $\gamma \approx \gamma_t$ is fulfilled for the target ions, where γ is the Lorentz factor of the ions and γ_t is the so-called transition point of the ring. Other fragments within a $B\rho$-acceptance of about ±0.2% of the RIBLL2-CSRe system were also transmitted and stored. The revolution times of the stored ions were measured by a dedicated time-of-flight detector.

The effects of magnetic instability were carefully corrected by applying the method described in Ref. [3], and the revolution time spectrum was obtained (Fig. 1(a)). Masses of nuclides were calibrated from this spectrum. In particular, the mass excesses of ^{52}Sc, ^{53}Sc and ^{54}Sc were -40492(82), -38928(114) and -34654(540) keV. These values were smaller by 1.8 σ, 2.8 σ, and 1.6 σ than the adjusted values in AME12[4] respectively.