deformation, bandbacking and possible configuration mixing.

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2 - 3 High Spin Level Scheme of ^{95}Tc

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High spin level structure of ^{95}Tc was reinvestigated via the ^{90}Zr(^{12}C, αp2n)^{95}Tc fusion-evaporation reaction using the incident beam energy of 78 MeV ^{12}C provided by the SFC of the Institute of Modern Physics (IMP), Chinese Academy of Sciences (CAS). The target was 1.82 mg/cm^2 ^{90}Zr on 8.23 mg/cm^2 natural lead backing. The emitted γ rays from the reaction products were detected by an multidetector array consisting of 15 HPGe detectors of which 8 HPGe detectors have Anti-Compton shieds, 7 Clover detectors placed in a plane perpendicular to the beam and 3 LaBr$_3$ detectors at 30° against the beam. The energy and efficiency calibrations were made using ^{60}Co, ^{133}Ba, and ^{152}Eu standard sources and the typical energy resolution is 2.0 to 2.5 keV at full width at half-maximum (FWHM) for a 1 332.5 keV γ ray of ^{60}Co. Events have been collected when at least two detectors are fired within the prompt coincidence time window of 100 ns. Under these conditions, a total of 3.5×10^6 coincidence events were recorded and the data were sorted into a symmetrized E_γ–E_γ matrix for subsequent off-line analysis.

In order to obtain angular distribution information of the emitted γ rays, two asymmetric coincidence matrices were constructed using the γ rays detected at all angles (as y axis) against those observed at 30° (or 150°) and 90° angles (as x axis), respectively. The ADO (γ-ray angular distribution from oriented nuclei) ratio[1] is defined as

$$R_{\mathrm{ADO}}(\gamma)=\frac{I_\gamma(30^\circ)}{I_\gamma(90^\circ)}=\frac{N_\gamma(30^\circ)/\epsilon_\gamma(30^\circ)}{N_\gamma(90^\circ)/\epsilon_\gamma(90^\circ)},$$

where I_γ is the intensity of γ ray in the respective angular obtained by the number N_γ and efficiency ϵ_γ. By setting gates on the y-axis with all the detectors, the γ ray intensities $I_\gamma(30^\circ)$ and $I_\gamma(90^\circ)$ were extracted from the coincidence spectra regardless of the multipole character of the gating transition. As shown in Fig. 1 stretched quadrupole transitions were adopted if $R_{\mathrm{ADO}}(\gamma)$ values were significantly larger than 0.9, and dipole transitions were assumed if $R_{\mathrm{ADO}}(\gamma)$'s were less than 0.9[2].

The use of Clover detectors facilitate linear polarization measurement which is crucial to determine the level parity from the electromagnetic nature of deexciting γ ray[3]. We also built two additional asymmetric coincidence matrices by the polarization-directional correlation from oriented nuclei (PDCO) method[4]. The so-called vertical PDCO matrix contained the events in which one of the γ rays was scattered inside the Clover detector in the direction perpendicular to the emission plane (those events were put on the x axis), whereas a coincident γ ray was registered in any detector (those events were put on the y axis). Again, the other, so-called horizontal PDCO matrix, contained the events in which one of the γ rays was scattered in the direction parallel to the emission plane (those events were put on the x axis), whereas a coincident γ ray was registered in any detector (those events were put on the y axis)[4]. By setting gates on the y-axis with all the detectors, the scattering γ ray numbers $N_\perp$ and $N_\parallel$ were extracted from the coincidence spectra regardless of the multipole character of the gating transition. In the experiment an asymmetry of Compton-scattered polarized photons was calculated from the expression[4,5]

$$A=\frac{(aN_\perp-N_\parallel)}{(aN_\perp+N_\parallel)},$$

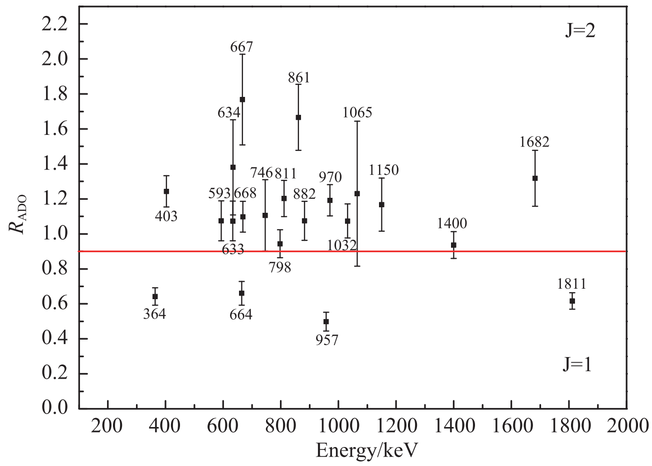

Fig. 1 (color online) ADO ratios against energies of γ rays in ^{95}Tc. The red line with $R_{\mathrm{ADO}}=0.9$ has been drawn to differ the $J=2$ quadupole and $J=1$ dipole transitions. The quoted errors include the error due to background subtraction, fitting, and efficiency correction.

where a denotes the correction due to the asymmetry in response of the Clover segments. This correction term was defined as

$$a=\frac{N_{\parallel}(unpolarized)}{N_{\perp}(unpolarized)}$$

and was determined as a function of energy[4,5]. The value varies from 0.89 to 1.05 by using the ^{133}Ba and ^{152}Eu radioactive source. As shown in Fig. 2, the positive PDCO value would imply an electric nature, while one can expect a negative value for the magnetic transition.

According to the measured intensities of γ rays, $\gamma-\gamma$ coincidences, R_{ADO} ratios and PDCO values, we have constructed a new level scheme in Fig. 3. The present level scheme significantly differs from the previous work[6] by the level spins and parties. This is mainly due to the additional linear polarization measurements by adding the Clover detectors in identifying the electromagnetic nature of γ rays and assigning relatively reliable spins and parties.

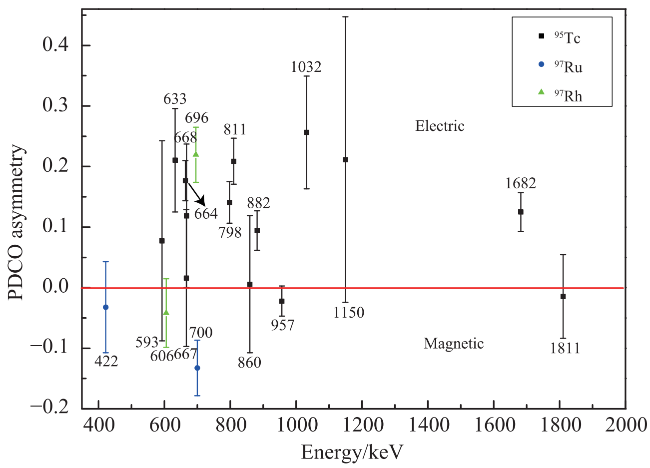

Fig. 2 (color online) PDCO values against energies of γ rays in ^{95}Tc (square), ^{97}Ru (sphere) and ^{97}Rh (triangle). The red line with PDCO zero has been drawn to differ the electric and magnetic transitions. The quoted errors are due to background subtraction, fitting, and efficiency correction.

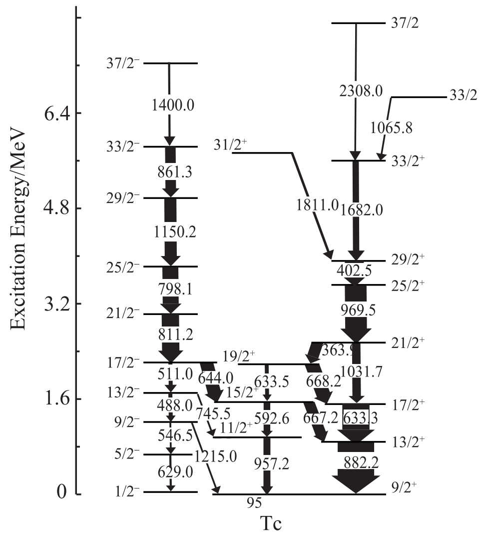

Fig. 3 Level scheme of ^{95}Tc.

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2 - 4 Research Progress in the CSRe Fine Nuclear Spectroscopy Group

Zhang Yuhu and Wang Meng

The research group of CSRe fine nuclear spectroscopy has been working on the precision mass measurements of short lived nuclei based on the isochronous mass spectrometry. The research activities are mainly focused on two aspects. One is the improvements of detection techniques and data analysis methods, the other is the investigations on nuclear structures and nuclear astrophysics based on the new mass values from the experiments.

We have installed two time-of-flight detectors in the straight section of CSRe in order to measure the velocity of stored ions in the ring. The distance between the ultra-thin foils of two ToF detectors has been measured using a laser range-finder Leica Nova MS60 Multi-Station. On the other hand, un-synchronicity of the timing signals from the two ToF detectors is also measured. These two parameters are crucial in the precise determination of ion's velocity. Test experiments have been performed using ^{40}Ar and ^{58}Ni primary beams and great efforts are devoting to develop a new method to deduce the ion's velocity using the experimental data of two-ToF isochronous mass spectrometry.

Concerning the conventional IMS experiments using ^{58}Ni, ^{112}Sn primary beams and single ToF detector, main parts of the data analysis has been completed yielding new mass values which are shown in Table 1 together with those in AME12[1] for comparisons. Most of our ME values are compiled in the latest atomic-mass evaluations 2016[2]. Based on the new mass values, some issues in the studies of nuclear structures and nuclear astrophysics have been addressed in Refs. [3-7].

Table 1 Mass excesses (ME) measured in CSRe together with those in AME12[1].

Nuclide	ME_{CSRe}/keV	ME_{AME12}/keV	Nuclide	ME_{CSRe}/keV	ME_{AME12}/keV
^{27}P	−685(42)	−722(26)	^{45}V	−31 885(10)	−31 885.3(9)
^{29}S	−3 094(13)	−3 160(50)	^{47}Cr	−34 565(10)	−34 561(7)
^{44g}V	−23 827(20)	−24 120(180)	^{49}Mn	−37 607(14)	−37 620.3(24)
^{44m}V	−23 541(19)	−23 850(210)	^{51}Fe	−40 198(14)	−40 202(9)
^{46}Cr	−29 471(11)	−29 474(20)	^{79}Y	−57 803(80)	−58 360(450)
^{48}Mn	−29 299(7)	−29 320(170)	^{81}Zr	−57 524(92)	−58 400(160)
^{50}Fe	−34 477(6)	−34 490(60)	^{82}Zr	−63 632(10)	−63 940(200)
^{52g}Co	−34 361(8)	−33 990(200)	^{83}Nb	−57 613(162)	−58 410(300)
^{52m}Co	−33 974(10)	−33 610(220)	^{84}Nb	−61 219(12)	−61 020(300)
^{54}Ni	−39 278(4)	−39 220(50)	^{80}Zr	−54 176(250)#	−55 520(1490)
^{56}Cu	−38 643(15)	−38 240(200)	^{84}Mo	−53 958(250)#	−54 500(400)

extrapolated in this work

In collaboration with the RIB physics group, an in-ring reaction for ^{58}Ni(p, p)^{58}Ni in inverse kinematics was performed successfully at the 90° laboratory angle with an internal gas-jet target at CSRe. This opens opportunities for low momentum transfer reaction studies on giant resonances, which play an important role in defining the equation of state for nuclear matter.

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