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Short note

High-spin isomers in ^{183}Os

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Abstract. High-spin states in ^{183}Os have been studied by means of in-beam γ-ray spectroscopy. Two isomers with $I^\pi = (\frac{43}{2}^-)$ and $\frac{43}{2}^+$ have been identified at excitation energies of $E_x = 5.068$ and 5.168 MeV. The half-lives are determined as $T_{1/2} = 27 \pm 3$ and 24 ± 2 ns.

PACS. 21.10.Tg Lifetimes – 23.20.Lv Gamma transitions and level energies – 27.70.+q $150 \le A \le 189$

In a previous study of ^{183}Os [1], Pedersen et al. has pointed out the existence of a $T_{1/2} \sim 30$ ns isomer with spin greater than or equal to $\frac{41}{2}\ \hbar$. However, no detailed decay scheme of the isomer has been reported yet. For further studies of the isomeric decay, a new spectroscopic investigation of ^{183}Os was carried out. High-spin states in ^{183}Os have been populated through the ^{170}Er(^{18}O,5n) reaction at a beam energy of 85 MeV. A 2.0 mg/cm^2 ^{170}Er target enriched to 95.88% with a 10 mg/cm^2 lead backing was bombarded by an ^{18}O beam derived from the 12UD tandem accelerator at University of Tsukuba. Emitted γ rays were detected by an array consisting of nine Compton-suppressed HP Ge detectors positioned at 37° (2 detectors), 79° (2), 101° (2) and 143° (3) with respect to the beam direction. In addition, one Ge detector for low energy photons was placed at an angle of 79°. A total of 2×10^8 γ-γ coincidence events were collected. A partial level scheme of ^{183}Os established by the present data is shown in Fig. 1. The spin assignments are mainly based on DCO ratios, γ-ray decay pattern and/or presence of both cascade and cross-over transitions. For fast $\Delta I = 2$ transitions, E2 assignments are preferably taken than M2, because M2 transition probabilities are normally quite small.

The $K^\pi = \frac{9}{2}^+$ ground state band (gsb) was known from previous work [2] up to the $I^\pi = \frac{41}{2}^+$ level. The present data extend this band to the $I^\pi = \frac{49}{2}^+$ level. The levels form a signature pair of rotational sequences associated with the $\frac{9}{2}^+$[624] Nilsson configuration. The large signature splitting seen in the gsb can be attributed to different band crossings for the two signature sequences, i.e. BC or AD crossings. Two levels, that decay to the $K^\pi = \frac{9}{2}^+$ band members, are found at $E_x = 3067$ and 3786 keV, and can be assigned $I^\pi = \frac{31}{2}^+$ and $\frac{33}{2}^+$. The $E_x = 3786$ keV level is populated by a 99 keV transition of which the total conversion coefficient is deduced to be $\alpha_T = 6.0 \pm 0.7$ from the measured γ-ray intensity balance. Comparison with the calculated values [3] of $\alpha_T = 0.4$(E1), 6.0(M1) and 4.6(E2) supports an M1 assignment for the 99 keV

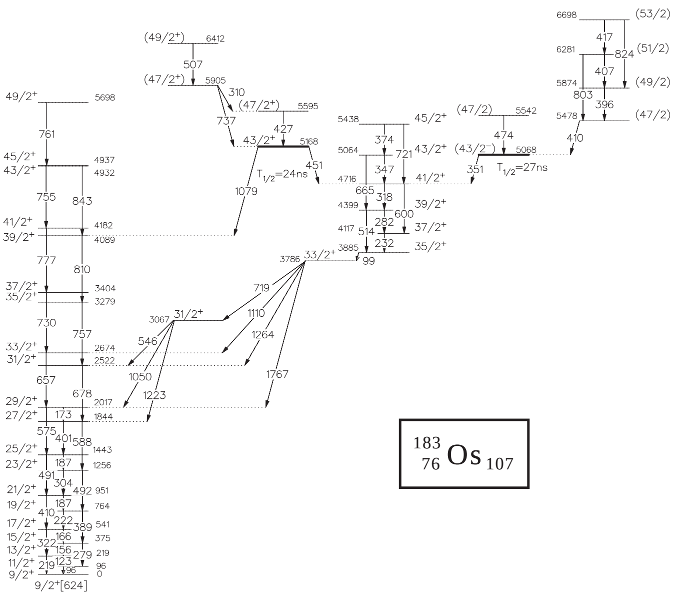

Fig. 1. Proposed level scheme of ^{183}Os

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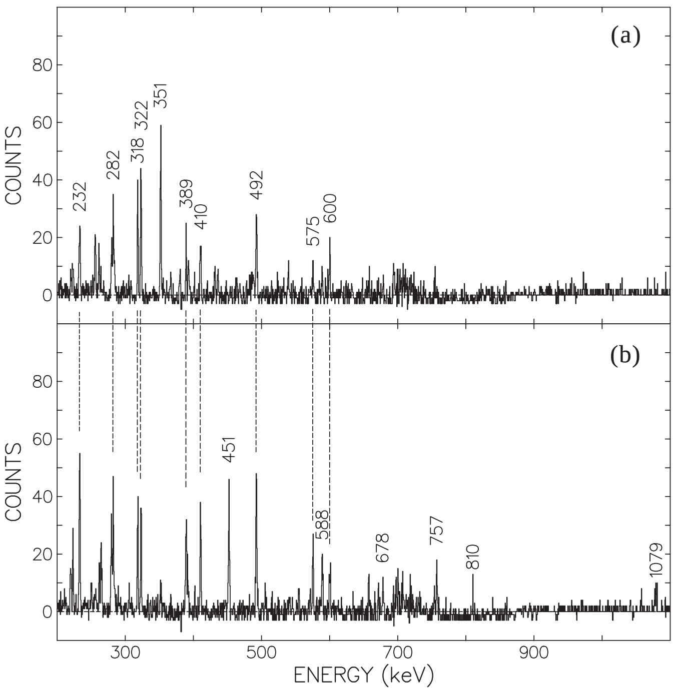

Fig. 2. Delayed coincidence spectra gated on the 396 **a** and 427 **b** keV γ rays, showing transitions below the isomers

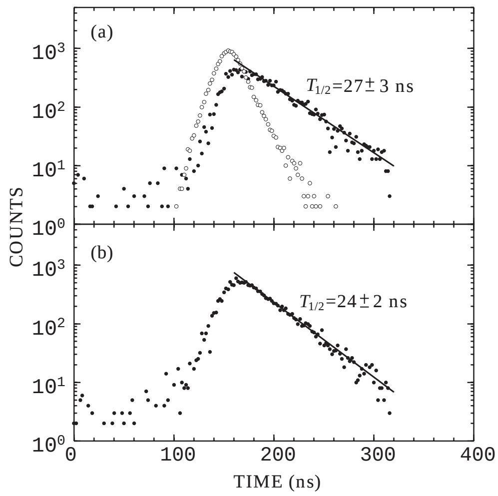

Fig. 3. Time difference spectra between the 396, 407 keV transitions and the 232, 282 318, 351 keV transitions **a**, and between the 310, 427 keV transitions and the 232, 282, 318, 451 keV transitions **b**. The time difference spectrum in prompt coincidence is also shown with *open circles* **a**

transition, resulting in an $I^\pi = \frac{35}{2}^+$ assignment for the $E_x = 3885$ keV level. On top of this level, a new band is constructed with in-band $\Delta I = 1$ and 2 transitions. From analysis of the delayed spectra shown in Figs. 2a and 2b, two isomeric states at $E_x = 5068$ and 5168 keV are found to decay to the $K^\pi = \frac{35}{2}^+$ band via 351 and 451 keV transitions. Alternatively, the $E_x = 5168$ keV level has another decay branch to the $K^\pi = \frac{9}{2}^+$ band member by a 1079 keV transition. From the DCO ratios and/or the measured γ-ray intensity balance, the $E_x = 5068$ and 5168 keV levels are assigned $I^\pi = (\frac{43}{2}^-)$ and $\frac{43}{2}^+$, respectively. Assuming $K = \frac{43}{2}$ for both the isomeric levels, the 351 and 451 keV transitions change the K values by 4 $\hbar$, while the 1079 keV transition takes place with a much larger step of 17 $\hbar$ in the K quantum number. Above the isomers, several γ-ray transitions are also observed.

Half-lives of the two isomers can be analysed with γ-γ time difference spectra shown in Figs. 3a and 3b. By fitting the slopes of the decay curves, the half-lives are determined as $T_{1/2} = 27 \pm 3$ ns for the $K^\pi = \frac{43}{2}^-$ isomer and $T_{1/2} = 24 \pm 2$ ns for the $K^\pi = \frac{43}{2}^+$ isomer. Hence, the hindrance factors, defined as $F = T^\gamma_{1/2}/T^W_{1/2}$ ($T^\gamma_{1/2}$: the partial γ-ray half-life, $T^W_{1/2}$: the Weisskopf estimate), are obtained to be 5.8×10^6 and 1.1×10^5 for the 351 and 451 keV transitions, respectively, which are 3 times K-forbidden. The values are consistent with the systematics [4] in the region. Contrary, the measured hindrance factor of $F = 3.5 \times 10^4$ for the 1079 keV transition is extremely small in spite of the much larger inhibition. This remarkable decay would be explained by γ-softness predicted for the Os isotopes with mass number $A \approx 180$. The fluctuation of the nuclear shape along the γ deformation can introduce significant admixture of the wave functions between low-K and high-K states [5]. Thus, the γ-fluctuation would reduce the K-forbiddenness and hence facilitate such a transition as observed in the $K^\pi = \frac{43}{2}^+$ isomeric decay.

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