On electric Quadrupole Transition between rotational states of $^{188-192}$Os

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Introduction

There has been a long-standing debate on the nature of the spectra characterizing Osmium isotopes. Some groups consider these nuclei as being γ – soft [1, 2, 3] while others as γ – rigid asymmetric rotor [4, 5]. The equilibrium values of the asymmetric parameter γ, predicted by Lender in ref. 3 are 20^0, 20^0, 25^0 while Faessler in ref. 5 are 19^0, 22^0, 25^0 respectively for ^{188}Os, ^{190}Os, ^{192}Os. The basic parameter that distinguish the rigid rotor from γ – soft nuclei are –
$\Delta E_1[= E3_1^+ - (E2_1^+ + E2_2^+)] = 0$ and
$\Delta E_2[= E3_1^+ - (2E2_1^+ + E4_1^+)] = 0$.
The modulus of $|\Delta E_1|$ and $|\Delta E_2|$ for $^{188-192}$Os are given as $|\Delta E_1|$ = 2, 11, 5 and $|\Delta E_2|$ = 2, 171, 302 respectively. Recently the triaxiality is associated with the odd – even staggering (OES) in γ – band considering the sign of $S(4)$ and $S(6)$ which is negative in γ – soft while positive in γ – rigid [6, 7].

We have calculated these $S(4)$ and $S(6)$ signtures of γ-rigid and γ – soft nuclei and found their values to be positive in all these nuclei under consideration and are tabulated in table – I.

Table – I

The values of staggering indices $S(4)$ and $S(6)$ in $^{188-192}$Os nuclei

Nucl.	^{188}Os	^{190}Os	^{192}Os
S(4)	0.120	0.0096	0.055
S(6)	0.185	0.112	0.470

This observation supports our point of view underlying in the study of these nuclei in the present work. We keep in mind that the energies obtained for various rotational levels in rigid rotor model are too large and as such to bring them down the correction due to centrifugal stretching or the coriolis antipairing effect at large γ deformation with increasing angular momentum are necessary. These corrections were introduced by generalizing the variable moment of inertia by Faessler [5] or by introducing Lipas correction [8, 9] however the values of the quadrupole transitions between various rotational levels remains unaltered due to the correction applied [10]. Another parameter that comes in support of the present study is $\beta A^{2/3}$. According to Mayer – ter – vehn $\beta A^{2/3} < 4$ in vibrational nuclei and $\beta A^{2/3} > 7$ in well deformed nuclei and $4 < \beta A^{2/3} < 7$ is recommended fit for nuclei to be considered as asymmetric rotors [11]. In another approach these nuclei were taken as ideal triaxial liquid drop having γ = 30^0 and the liquid drop Hamiltonian written in intrinsic frame was separated into two terms describing the β and γ – variables. The potential in β consists of a centrifugal term and a sextic potential while the differential equation for γ as that for the Mathiew function [12] and the Osmium nuclei were treated in this Sextic Mathiew Approach (SMA).

In the present work, we evaluate the B (E2) values for $^{188-192}$Os nuclei between different rotational energy states using rigid triaxial rotor model [4, 5] and list them along with the corresponding theoretical values obtained from SMA. These values are compared with the experimental data. The theoretical values of SMA and the experimental values are taken from the ref. 12 (Table – II). The values which deviate by more than a factor of two are underlined in table – II.

Table –II

Some B (E2) values for $^{188-192}$Os obtained in present work and compared with the Corresponding SMA and experimental data

B(E2) in e^2b^2	^{188}**Os**			^{190}**Os**			^{192}**Os**		
$J_i \to J_j$	Exp	Present	SMA	Exp	Present	SMA	Exp	Present	SMA
$2_1^+ \to 0_1^+$	0.502	0.466	0.502	0.468	0.0440	0.468	0.424	0.407	0.424
$4_1^+ \to 2_1^+$	0.776	0.687	0.722	0.623	0.640	0.684	0.497	0.576	0.632
$6_1^+ \to 4_1^+$	0.843	0.808	0.945	0.679	0.774	0.912	0.660	0.725	0.858
$8_1^+ \to 6_1^+$	0.927	0.903	1.103	0.814	0.866	1.079	0.754	0.801	1.030
$10_1^+ \to 8_1^+$	1.191	0.958	1.232	0.754	0.924	1.218	0.688	0.848	1.175
$4_2^+ \to 2_2^+$	0.352	0.245	0.302	0.389	0.236	0.291	0.298	0.184	0.261
$6_2^+ \to 4_2^+$	0.466	0.456	0.392	0.520	0.433	0.384	0.336	0.343	0.352
$8_2^+ \to 6_2^+$	0.382	0.542	0.593	0.398	0.520	0.590	0.314	0.419	0.549
$2_2^+ \to 0_1^+$	0.047	0.033	**0.005**	0.039	0.028	**0.001**	0.037	0.017	**0.006**
$2_2^+ \to 2_1^+$	0.150	0.165	0.150	0.227	0.243	0.227	0.303	0.369	0.303
$2_2^+ \to 4_1^+$	0.029	0.014	**0.000**	0.007	0.016	**0.000**	0.024	0.016	**0.000**
$4_2^+ \to 2_1^+$	0.009	0.0095	**0.003**	0.005	0.004	**0.001**	0.002	**0.008**	0.004
$4_2^+ \to 4_1^+$	0.134	0.142	**0.031**	0.227	0.174	**0.050**	0.203	0.131	**0.068**
$4_2^+ \to 6_1^+$	0.036	0.024	**0.000**	0.048	**0.0168**	**0.000**	0.018	**0.005**	**0.000**
$6_2^+ \to 4_1^+$	0.001	**0.004**	0.002	0.003	0.0046	**0.001**	0.000	0.000	**0.002**
$6_2^+ \to 6_1^+$	0.164	0.083	**0.018**	0.238	**0.067**	**0.030**	0.171	**0.055**	**0.042**

The minimum numbers of underlined values are observed in the present work and this encourages our point of view of considering these osmium nuclei as asymmetric rigid rotor. The model employed in the present work is well known because of its extreme simplicity and clearness. This allows one to use it when there is no need for the description of a great number of details of the nuclear spectrum and restricts only on low lying rotational bands.

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