Survey of half-life, spin, parity measurements of nuclear levels, for A=1-260

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Introduction

This work aims to review the quantum of work done in terms of measurement of half-life values, spin, and parity of excited states. This survey can give experimentalists an idea of areas of a nuclear chart which are well studied and those that need more attention.

Data collection

The online site https://www.nndc.bnl.gov/ [1] has data of nuclear energy level, spin, parity, half-life, etc values available separately for each nucleus in pdf and ENSDF (text) format.

A computer code was written (using language C++) to retrieve the half-life, spin and parity values, of excited states from the ENSDF (text format) files. The code filtered out the required information from Evaluated Nuclear Structure Data Files (ENSDF) of adopted data sets of each nucleus. For each nucleus, factor P_H, P_S, and P_P were determined.

The quantity P_H (P_S or P_P) is defined as 100 x number of energy levels with half-life (spin or parity) value measured / total number of observed energy levels in that nuclei.

Data analysis

On the NNDC website [1], data is available for approximately 3250 nuclei (as per information available in march 2019) Out of these 3250, there are 2218 nuclei whose at least ground state and two excited states (or more) are observed experimentally. This paper deals with only those 2218 nuclei.

SPIN: There are 485 nuclei where absolutely no confirmed spin value is known, not even for ground state.

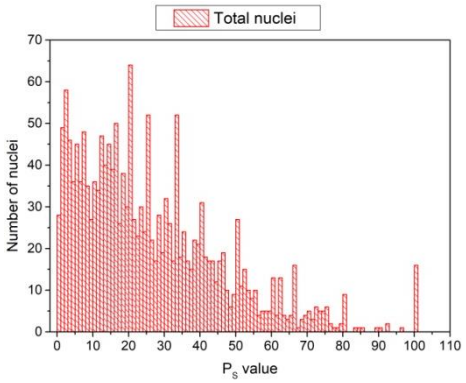

Fig. 1: Distribution of P_S values of all 1733 Nuclei

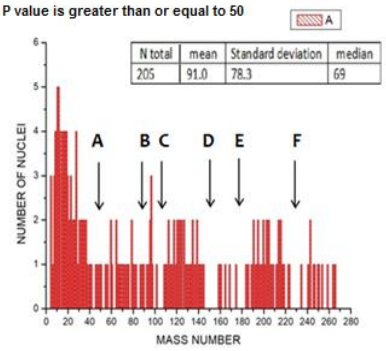

Fig. 2: shows the distribution of the mass number of nuclei which have $P_H \geq 50$

Distribution of the P_S value for the remaining total set of nuclei (1733) is shown in

Figure 1. From this figure it can be seen that the median value of P_S is at 21.2 and the mean value is 26.6, which implies that for 50% of the only 21% of energy levels have confirmed spin values known.

The number of nuclei which have P_S value is less than 3 is 135 and P_S value greater than 50 is 234 that means only in 234 nuclei more than 50% of energy levels are assigned spin value.

PARITY: There are 486 nuclei where absolutely no confirmed parity value is known, not even for ground state. After removing these nuclei from consideration, the distribution of P_P value for remaining 1732 nuclei has median value is at 30.2 and mean value is 32.7.

The number of nuclei which have P_P value is less than 3 is 63 and P_P value greater than 50 is 366 that means only in 366 nuclei more than 50% of energy levels are assigned parity value.

HALF-LIFE: There are only three nuclei where not even ground state half-life value is known. The distribution of P_H value with remaining 2215 nuclei has median is at 11.1 and mean is 18.6. which means that for 50% of the nuclei (1108) only 11.1% of energy levels have confirmed Half-life values known.

The number of nuclei which have P_H value is less than 3 is 243 and P_H value greater than 50 is 205 that means only in 205 nuclei more than 50% of energy levels have their half-life values measured. Total distribution of P_H can be seen in Figure 3.

Figure 2. Shows the distribution of Mass number for nuclei whose P_H value is greater than 50. From figure 2, it can be seen that the peak of the distribution is in the low A region where as there are six different regions labelled A-F (A=50, B=90, C=105, D=150, E=180, F=230) where the half-life value measurement is distinctly low (P_H <50)

Conclusion

From the survey it can be observed that there is a very small quantum of measurements in terms of spin, half-life and parity values in the Nuclear experiments. A lot is desired in terms of the experimental measurements which can boost the physics information on nucleon-nucleon interaction in a nucleus. The data from this survey, presented in the symposium, can be a guide to future experiments in Nuclear Physics.

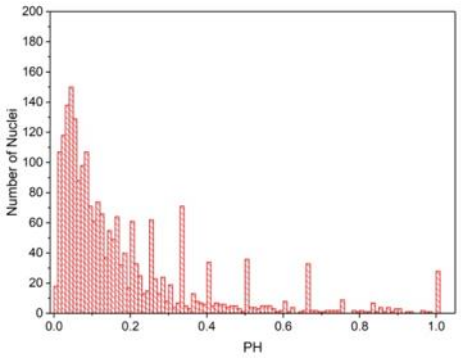

Figure 3 Distribution of P_H

Table 1 Statistical data of histograms studied for the Spin, Parity and Half-Life part.

	Number of Nuclei		
	Spin	**Parity**	**Half-Life**
Distribution of Atomic number of $P = 0$	485	486	3
All Nuclei	1733	1732	2215
Distribution of Atomic number of Nuclei with $P < 3$	135	63	243
Distribution of Atomic number of Nuclei with $P \geq 50$	234	366	205

The detailed results from the present analysis will be presented during the symposium.

Acknowledgement

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References

[1] https://www.nndc.bnl.gov/