Investigation of interesting spectroscopic features in ^{202}Po around $Z = 82$ shell closure

Sahab Singh[1], D. Choudhury[1], R. Roy[1], B. Maheshwari[1,2], R. Palit[3], P. Dey[3], B. Das[3], A. Kundu[3], Md. S. Laskar[3], D. Negi[3], S. Bhattacharya[4], B.S. Naidu[3], S. Jadhav[3], and A.V. Thomas[3]
[1] *Department of Physics, Indian Institute of Technology, Ropar - 140001, INDIA*
[2] *Department of Physics, University of Zagreb, HR-10000, CROATIA*
[3] *Tata Institute of Fundamental Research, Mumbai - 400005, INDIA and*
[4] *Amity Institute of Nuclear Science and Technology, Noida-201313, India*

Nuclei close to the doubly-magic spherical shell closure at $Z = 82$, exhibit both single-particle excitations at low spins, as well as a variety of collective rotational behavior including super-deformation [1] at high spins, making them spectacular examples of shape coexistence [2]. The even-even $^{200-208}$Po isotopes with 2 protons above the $Z = 82$ shell closure are one of the examples having this typical feature of competition between the 2 quasi-protons and 2 quasi-neutrons [2]. An interesting feature is the existence of several isomeric states due to different neutron-proton configurations, well known among these being the seniority isomers in Pb and Hg isotopes and expected in Po as well [3]. Only two measurements being known for ^{198,200}Po with seniority= 2 isomers, the investigation of ^{202}Po would help in understanding the two-particle case above $Z = 82$ shell closure. Exploring high-seniority isomers would also be a unique finding. Regular structures with oblate deformed states connected by $M1$ transitions, popularly known as shears bands, are well known in Pb, Hg and Bi nuclei ($A = 192$ to 201) since 1990s and are known to be generated by high-K neutron-proton coupling and alignment. The mechanism is now well understood with the tilted axis cranking (TAC) and semiclassical models [4]. No such bands are yet reported in the neighboring Po isotopes. Analogous to ^{200}Pb, an interesting candidate to investigate the existence of such sequences is ^{202}Po to understand the role of the two protons above the shell closure.

High-spin states of ^{202}Po nuclei were populated using the ^{195}Pt(^{12}C, 5n) reaction at a beam energy of 83 MeV produced by the 15-UD BARC-TIFR Pelletron LINAC facility in Mumbai. The de-exciting $\gamma-$rays were detected using a hybrid array of 16 Compton-suppressed HPGe clover detectors at 23°, 40°, 65°, and 90° with respect to the beam direction, coupled with 14 $LaBr_3$(Ce) scintillators. Two- and higher-fold coincidence data were collected using an XIA-based digital data-acquisition system (DDAQ) [5, 6]. After the energy calibration of all the HPGe detectors, the time-stamped coincidence data were sorted by Multi Parameter timestamped based Coincidence Search (MARCOS) code, developed at TIFR, Mumbai [5]. The $\gamma-\gamma$ matrices and $\gamma-\gamma-\gamma$ cubes were formed with 100 and 300 ns time windows and analysed by DAMM and RADWARE software packages [7, 8]. The spin and parities of the excited states were obtained by determining the multipolarities of the $\gamma-$ray transitions by Directional Correlation of $\gamma-$ray de-exciting Oriented states (DCO ratio method) and integrated polarization directional correlation from the oriented nuclei (IPDCO) method [9, 10]. The previously known level scheme [2] of ^{202}Po has been confirmed and further extended up-to a spin of 27 with the addition of around 50 new γ-ray transitions. Several dipole band structures have been observed at high spin. Detailed review of the analysis and results will be discussed during the presentation.

[1] R.V.F. Janssenns and T.L. Khoo, Ann. Rev. Nucl. Part. Sci. **41** (1991) 321.
[2] B. Fant *et al.*, Phys.Scripta **41**,652(1990).
[3] B. Maheshwari *et al.*, Nucl. Phys. A **1014** (2021) 122277.
[4] H Hubel *et al.*, Prog. Part. Nucl. Phys. **28** (1992) 427; R.M. Clark and A.O. Macchiavelli, Annu. Rev. Nucl. Part. Sci. **50** (2000) 1; A.K. Jain and D. Choudhury, Pramana **75** (2010) 51.
[5] R. Palit *et al.*, Nucl. Instrum. Methods Phys. Res. A **680** (2012) 90.

[6] H. Tan *et al.*, in Nuclear Science Symposium Conference Record 2008 (IEEE, Washington, DC, 2008)
[7] Computer code DAMM: MILNER PACKAGE, the Oak Ridge analysis software (private communication).
[8] D.C. Radford, NIMA **361** (1995) 306.
[9] A. Kramer-Flecken *et al.*, Nucl. Instrum. Methods A 275 (1989) 333.
[10] K. Starosta *et al.*, NIM A 423 (1999) 16.