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Short note

Study of very neutron deficient nuclei ^{178}Pt and ^{181}Au

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Abstract. The ^{178}Pt and ^{181}Au nuclei have been studied with the (230 MeV) ^{46}Ti + ^{142}Nd fusion-evaporation reaction; γ-rays, evaporated particles and recoiling nuclei have been detected by the γ-array GASP + the Si ball ISIS + the recoil mass spectrometer RMS. The newly observed structures in ^{178}Pt and ^{181}Au are most probably built on the proton and quasi-proton $h_{9/2}$ and $i_{13/2}$ configurations.

PACS. 23.20.Lv Gamma transitions and level energies – 25.70.Jj Fusion and fusion-fission reactions – 27.70.+q $150 \leq A \leq 189$

Coexistence of spherical, prolate and oblate shapes is predicted for the very neutron deficient nuclei belonging to the region extended between platinum and lead [1–3].

Experimental information on nuclei from this region is still limited due to difficulties in obtaining the desired nucleus *via* conventional heavy ion induced fusion-evaporation reactions. In fact, the dominant role of fission at energies above the Coulomb barrier, with respect to particle evaporation channels, demands for application of very sensitive γ radiation arrays in conjunction with selective devices such as recoil spectrometers and charged particle detectors.

In the present study the reaction ^{46}Ti+^{142}Nd was used. The titanium beam was delivered by the Legnaro XTU Tandem at an energy of 230 MeV. The target consited of a 0.5 mg/cm^2 ^{142}Nd foil. The emitted γ-rays were detected by the GASP array [4] while charged particles were detected using the silicon ball ISIS [5], and recoiling nuclei were selected with the RMS spectrometer [6] and registered in coincidence with prompt γ rays.

According to the statistical model predictions provided by the PACE code [7], in the chosen reaction ∼90% of the produced compound nuclei undergo fission. Indeed, the observed raw γ spectrum contained a huge continuous background related to the decay of the fission fragments. However, γ-recoil coincidences and triple γ-γ-particle coincidences allowed a good separation of γ-rays emitted from the evaporation residues. These data provided new information on the structure of the ^{178}Pt nucleus and confirmed the recently proposed level scheme of ^{181}Au [8]. For both nuclei, the collected statistics was not sufficient to derive DCO ratios, therefore spin and parity assignments are based on systematics (^{180}Pt and ^{176}Os for ^{178}Pt and odd-A Au isotopes for ^{181}Au). The relative intensities of the γ-transitions correspond to the width of the arrows in the level schemes. The γ-ray energy precision is ± 0.2 keV except for the side band transitions of ^{178}Pt where it becomes ± 0.5 keV.

The ^{178}Pt nucleus was populated *via* $2\alpha 2n$ evaporation with a yield of about 0.5% of the total cross section. Gamma rays depopulating the excited states in this nucleus were selected by coincidence with two α particles. The resulting γ-γ spectrum in coincidence with the known transitions from ^{178}Pt is shown in Fig. 1.

As shown in the level scheme of ^{178}Pt (see Fig. 2), apart from the known ground state band [9], we observe a new excited band resembling the negative parity structure known in ^{180}Pt [10] and ^{176}Os [11]. Such a level sequence may be interpreted as a decoupled two quasiparticle $\pi h_{9/2}$

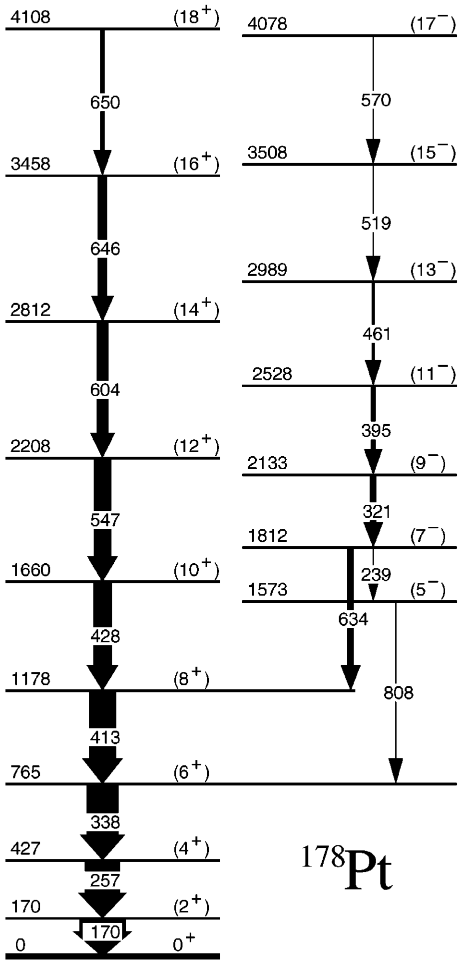

Fig. 1. Spectrum of γ-rays emitted from ^{178}Pt obtained by summing gates on the 170 keV, 257 keV, 338 keV and 413 keV γ-transitions in coincidence with two α particles

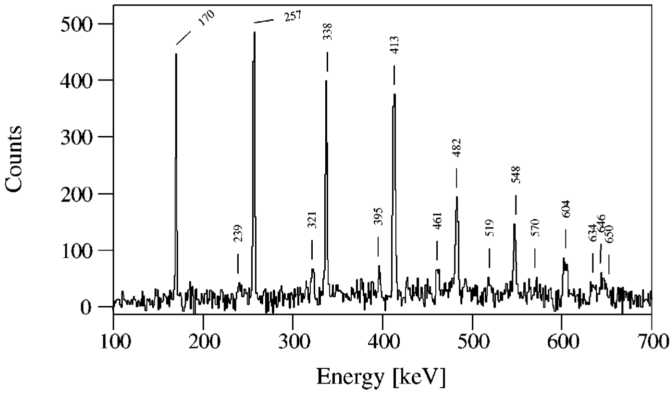

Fig. 2. Level scheme of ^{178}Pt obtained from the present study. Spin assignment is based on the comparison with the structure of heavier even-A Pt and Os isotopes

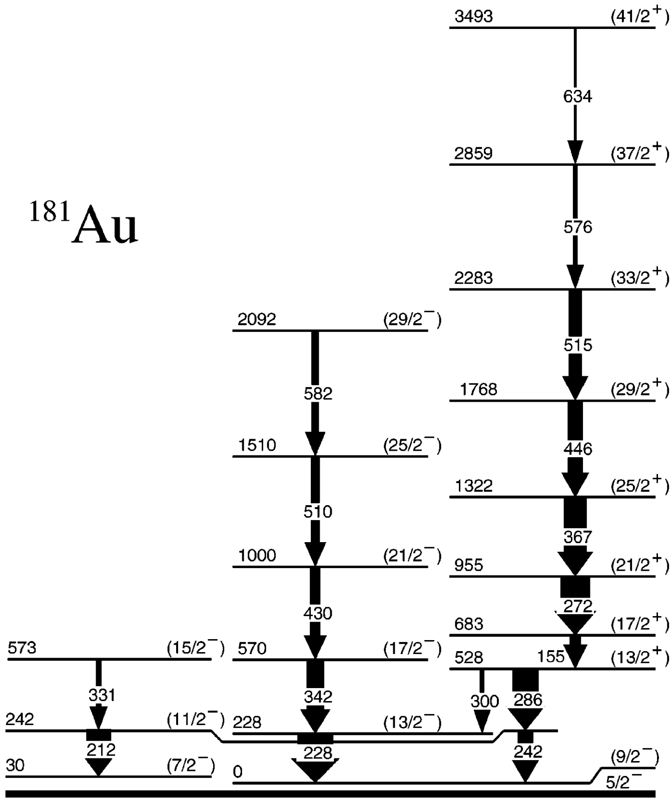

Fig. 3. Level scheme of ^{181}Au obtained from the present study. Excitation energies refer to the lowest observed J^{π}=(9/2$^-$) state

rotational band with an admixture of octupole vibration at low spin.

The level scheme of ^{181}Au, which arises in the $\alpha p2n$ evaporation channel, is presented in Fig. 3. It has been obtained from the analysis of γ spectra measured in coincidence with one proton and one α particle (Fig. 4).

The mass spectrum measured with the RMS in coincidence with these γ-rays allowed an unambigous mass determination. By similarity with the neighboring ^{183}Au and ^{185}Au nuclei [12,13], we have placed the lowest J^{π}=(9/2$^-$) level very close to the ground state. The proposed energy difference of 30 keV between the J^{π}=(9/2$^-$) and the J^{π}=(7/2$^-$) levels is confirmed by the radioactive decay of ^{181}Hg [14] where a 30 keV transition is observed. As already mentioned, our data partly confirm the data of Ref. 8 where a more suited reaction allowed to extend the ^{181}Au level scheme up to E = 6 MeV and I = 27. The level scheme consists of two rotational bands, similar to known structures in ^{183,185}Au [15,13], built on the levels with J^{π}=(9/2$^-$) and J^{π}=(13/2$^+$). The negative parity K^{π}=9/2$^-$ band results from the proton $h_{9/2}$ configuration. Two transitions belonging to the unfavored $\pi h_{9/2}$ band were also identified. The positive parity band with K^{π}=13/2$^+$ arises most likely from the $\pi i_{13/2}$ configuration.

Present results show that carefully selecting γ-rays from the decay of an evaporation residue and using Ge arrays in conjunction with ancillary detectors, one is able to extract relevant information on very weakly populated nuclei. Both the currently studied ^{178}Pt and ^{181}Au exhibit features typical of their neighboring nuclei, and have been interpreted in terms of the particle-rotor model.

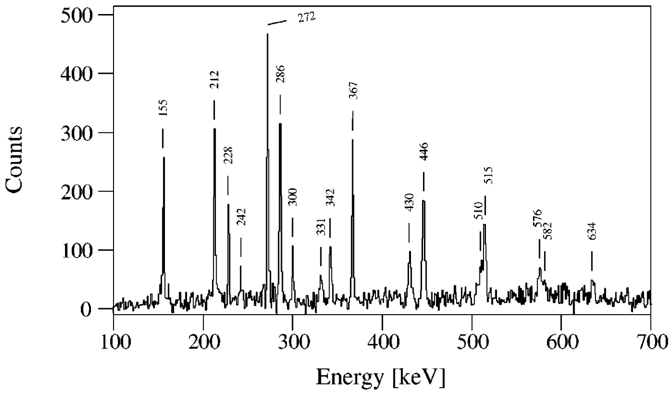

Fig. 4. Spectrum of γ-rays emitted from ^{181}Au obtained by summing gates on the 155 keV, 212 keV, 228 keV, 242 keV, 272 keV, 286 keV and 342 keV γ-transitions in coincidence with one α and one proton

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References

1. J.L. Wood et al.: Phys. Rep. 215 No. 3 & 4, 101 (1992)
2. W. Nazarewicz et al.: Phys. Lett. **B**305, 195 (1993)
3. B. Cederwall et al.: Z. Physik **A**337, 283 (1990)
4. D. Bazzacco: Proc. of Int. Conf. on Nuclear Structure at High Angular Momentum, Ottawa, Canada, 1992 (Report no. AECL 10613), Vol. 2, p. 376
5. E. Farnea et al.: Report No. LNL-INFN 095/95, 189 (1994)
6. P. Spolaore et al.: Nucl. Instr. and Meth. **A**238, 381 (1985)
7. A. Gavron: Phys.Rev. **C**21, 230 (1980)
8. L.L. Riedinger, W.F. Mueller et al.:, Workshop II on the Science and Operation of Gammasphere at ATLAS, Argonne, May 9-10, 1997, Transparency Report
9. G.D. Dracoulis et al.: J. Phys. **G**12, L97 (1986)
10. M.J.A. De Voigt et al.: Nucl. Phys. **A**507, 472 (1990)
11. G.D. Dracoulis et al.: Nucl. Phys. **A**383, 119 (1982)
12. M.I. Macias-Marques et al.:Nucl. Phys. **A**427, 205 (1984)
13. A.L. Larabee et al.: Phys. Lett. **B**169, 21 (1986)
14. J. Sauvage: Nucl. Phys. **A**540, 83 (1992)
15. M.P. Carpenter: private communication