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## VERY NEUTRON-DEFICIENT POLONIUM ISOTOPES PRODUCED THROUGH $^{20}\text{Ne}$ INDUCED REACTIONS

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**Résumé.** — Les isotopes de polonium les plus déficients en neutrons ont été produits par réactions  $^{182}\text{W}(^{20}\text{Ne}, xn)$ . Les caractéristiques de désintégration de l'isotope  $^{194}\text{Po}$  ont été complétées. Les isotopes de masses 193 et 192 ont été identifiés et un état isomérique pourrait être attribué à l'isotope  $^{193}\text{Po}$ .

**Abstract.** — Neutron deficient polonium isotopes have been produced through  $^{182}\text{W}(^{20}\text{Ne}, xn)$  reactions. The characteristics of disintegration of  $^{194}\text{Po}$  have been reviewed. Isotopes with masses 193 and 192 have been identified ; an isomeric state could be attributed to  $^{193}\text{Po}$ .

**1. Introduction.** — Neutron deficient isotopes of Po were studied some years ago by several authors [1-4]. The highest polonium isotope,  $^{194}\text{Po}$ , produced by the reaction  $^{185}\text{Re}(^{19}\text{F}, 10n)^{194}\text{Po}$ , was identified by A. Siivola. Due to the large number of emitted neutrons and to the fission competition along the evaporation chain, the cross-section for the production of  $^{193}\text{Po}$  by the reaction ( $^{19}\text{F}, 11n$ ) was very low and a few counts were observed in the alpha spectra [1] at an energy around 6.98 MeV. This  $\alpha$  activity was *tentatively assigned* to the mass 193.

The present work confirms the results of A. Siivola [1] and W. Treytl and K. Valli [2] through mass 194 and presents results for the new isotopes  $^{193}\text{Po}$ ,  $^{193m}\text{Po}$ , and  $^{192}\text{Po}$ .

$^{193}\text{Po}$  and  $^{193m}\text{Po}$  have been clearly identified and their half lives have been measured : the half life has been measured for  $^{194}\text{Po}$  as well.

$^{192}\text{Po}$  was produced at a very low rate and the half life was not measured.

**2. Experimental procedure.** —  $^{20}\text{Ne}$  ions were delivered by the accelerator Alice at an energy of 10 MeV/amu. The bombarding energy at the enriched target of  $^{182}\text{W}$  (2 mg/cm<sup>2</sup>) was calculated with the aid of Northcliffe's tables [5]. The helium jet technique was used in combination with  $\alpha$  spectroscopy to collect and to detect the products. The capillary tube was only 10 cm long to allow the detection of very

short half lives. In order to reduce the background of the Si detector to a very low level the  $\alpha$  spectra were recorded between the beam bursts. This method was very useful in obtaining very clean spectra and high sensitivity. The half-life measurements were obtained by cycling the accelerator and the multichannel analyser in multispectrum mode.

The mass assignments are based on the measured excitation functions of the ( $^{20}\text{Ne}, xn$ ) reactions and on a comparison with the ( $^{20}\text{Ne}, pxn$ ) reactions leading to known Bi nuclides.

**3. Experimental results.** — The excitation functions of the reactions  $^{182}\text{W}(^{20}\text{Ne}, xn)\text{Po}^{202-x}$  have been measured for  $4 < x < 9$  [6] and those of  $^{182}\text{W}(^{20}\text{Ne}, pxn)\text{Bi}^{202-x}$  for  $6 < x < 10$ . It appears from the two sets of curves that the excitation functions for ( $^{20}\text{Ne}, pxn$ ) are located at the same energy as those for ( $^{20}\text{Ne}, (x + 1)n$ ), for each  $x$ .

Figure 1 shows the  $\alpha$  spectrum recorded at a bombarding energy of 182 MeV. The following mass assignments were made :

$$^{194}\text{Po} \quad E_\alpha = 6.84 \text{ MeV}, \quad T_{1/2} = 700 \pm 100 \text{ ms}.$$

From the behaviour of the excitation functions of the reactions ( $^{20}\text{Ne}, xn$ ) the  $\alpha$ -ray at 6.84 MeV is attributed to  $^{194}\text{Po}$ . This assignment is in agreement with the

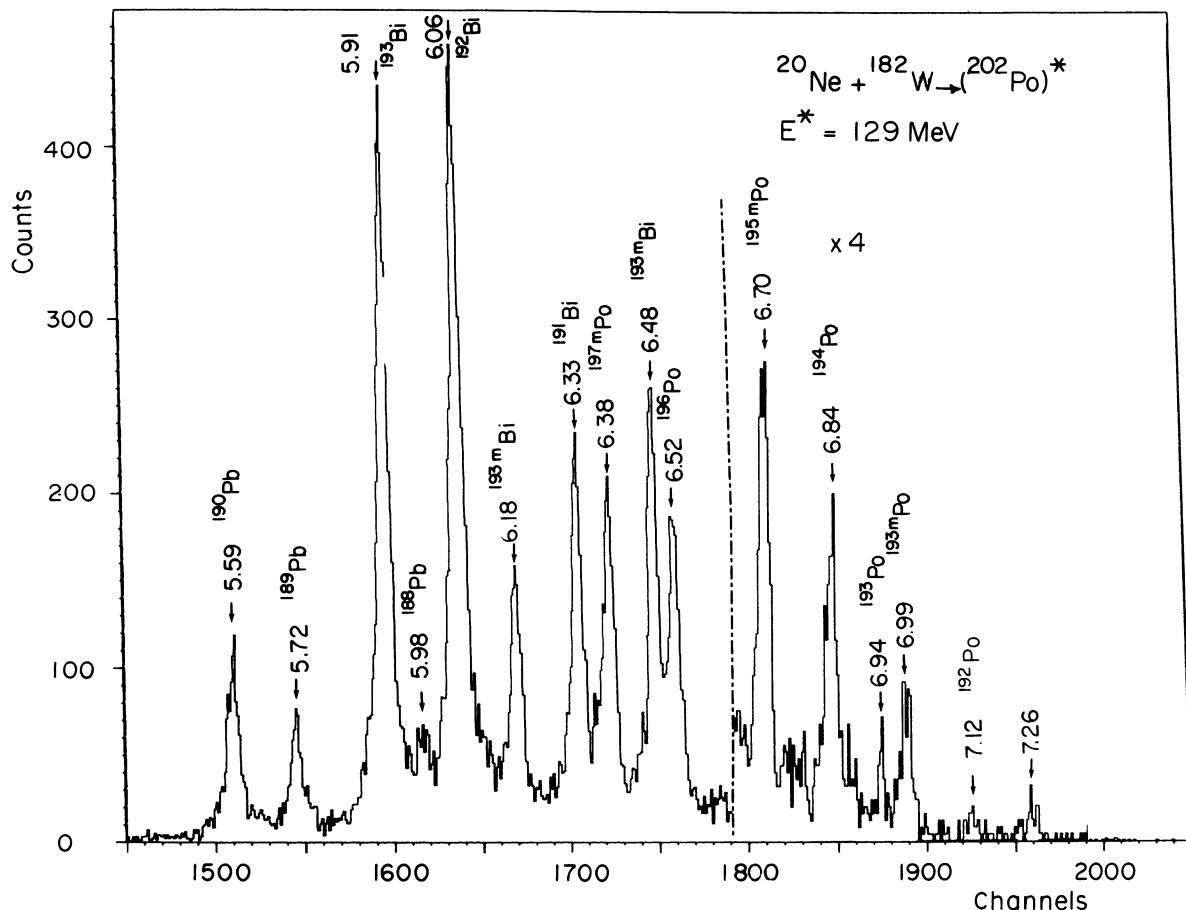


FIG. 1. — Alpha spectrum obtained during a 10 min. bombardment of  $^{182}\text{W}$  by  $^{20}\text{Ne}$  ions at 182 MeV.

results of previous work [1-2]. The half life has been measured accurately.

$$^{193}\text{Po} \quad E_\alpha = 6.94 \text{ MeV}, \quad T_{1/2} = 450 \pm 150 \text{ ms},$$

$$^{193\text{m}}\text{Po} \quad E_\alpha = 6.995 \text{ MeV}, \quad T_{1/2} = 420 \pm 100 \text{ ms}.$$

The two new alpha rays at 6.995 MeV and 6.94 MeV attributed to  $^{193\text{m}}\text{Po}$  and  $^{193}\text{Po}$  are clearly seen in figure 1. These two rays were observed at an energy above 105 MeV as indicated by the excitation functions presented in figure 2. In this figure, the excitation functions of the reaction  $^{182}\text{W}(^{20}\text{Ne}, p8n)^{193}\text{Bi}$  measured by the well known alpha rays of 5.91 and 6.48 MeV of  $^{193}\text{Bi}$  and  $^{193\text{m}}\text{Bi}$  are also shown. Comparison of the excitation function for the emission of 9 nucleons with those obtained for the two new alpha rays (lower part of the figure) indicates that they are due to mass 193. Since isomeric states are observed for all odd masses of polonium and since the measured alpha energies of the two states of  $^{193}\text{Po}$  are in very good agreement with the  $\alpha$  systematics of the light Po isotopes we postulate the existence of the isomeric states  $^{193}\text{Po}$  and  $^{193\text{m}}\text{Po}$ .

$$^{192}\text{Po} \quad E_\alpha = 7.12 \text{ MeV}, \quad T_{1/2} : \text{short}.$$

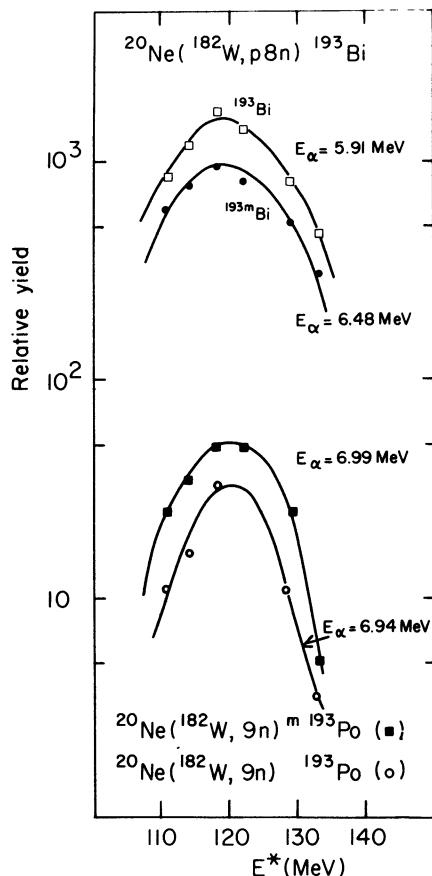


FIG. 2. — Excitation functions for the reactions →  $^{182}\text{W}(^{20}\text{Ne}, p8n)^{193}\text{Bi}$  and  $^{182}\text{W}(^{20}\text{Ne}, 9n)^{193}\text{Po}$ .

The alpha activity observed at an energy of 7.12 MeV is attributed to mass 192. Because of the low intensity the half life has not been measured.

In order to reach the lightest Po isotopes and to confirm this last mass assignment, further experiments are necessary. In particular the system  $^{20}\text{Ne} + ^{180}\text{W}$  seems to be very interesting for this purpose since

one would be able in principle to reach  $^{191}\text{Po}$  and  $^{190}\text{Po}$ . The  $\alpha$  peak at 7.26 MeV, which can be seen in figure 1, could be due to  $^{191}\text{Po}$ .

Thanks are due to Dr. Roulet for having given us a thick target of  $^{182}\text{W}$ . We are also very grateful to the staff and operating crews of Alice for their efficient cooperation.

#### References

- [1] SIIVOLA, A., *Nucl. Phys. A* **101** (1967) 129.
  - [2] TREYTL, W., VALLI, K., *Nucl. Phys. A* **97** (1967) 405.
  - [3] LE BEYEC, Y., LEFORT, M., *Nucl. Phys. A* **99** (1967) 131.
  - [4] HORNSHØJ, P., WILSKY, K., HANSEN, P. G., LINDAHL, A., NIELSEN, O. B., *Nucl. Phys. A* **163** (1971) 277.
  - [5] NORTHCLIFFE, L. C. and SCHILLING, R. F., *Nucl. Data A* **7** (1970) 233.
  - [6] LAGARDE, B., LE BEYEC, Y., to be published, in preparation.
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