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RELAXATION OF EXCITED Pb NUCLEI IN LIQUID Hg (*)

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Résumé. — On a mesuré l'interaction hyperfine de l'état isomérique ($I = 7$; 2 200 keV) de ^{206}Pb , qui était produit et orienté par la réaction $^{204}\text{Hg}(\alpha, 2n)$, dans Hg liquide. La relaxation quadrupolaire était observée dès 235 K à 528 K. Elle est déterminée par la diffusion ionique.

Abstract. — The hyperfine interaction of the $I = 7$ state of ^{206}Pb at 2 200 keV produced and aligned by the reaction $^{204}\text{Hg}(\alpha, 2n)$, was studied in liquid Hg. The quadrupolar relaxation rate, observed between 235 K and 528 K, is dominated by ionic diffusion.

Hyperfine interactions can be studied by perturbed angular correlation methods using isomeric nuclear states, excited and oriented by nuclear reactions. This method differs from NMR measurements on stable isotopes in some important aspects [1, 2] e. g. :

Many more excited states are available offering a choice of moments for a particular study. The production of the orientation is independent of temperature and of the state of the surrounding. It is possible to investigate impurities in extremely low concentration.

We report on the determination of the quadrupole relaxation rate of the 2200 keV state of ^{206}Pb (lifetime $\tau_L = 170 \mu\text{s}$; spin $I = 7$) in liquid Hg; the measurement takes advantage of the aspects mentioned above. The state was populated and oriented by the reaction $^{204}\text{Hg}(\alpha, 2n)$ with a pulsed beam of 24 MeV α -particles from the Karlsruhe cyclotron. The orientation of the state leads to an anisotropic distribution of the decay γ -rays. The dependence of the γ -ray anisotropy on time t , i. e. the relaxation time τ_R , was observed by the spin rotation method [1]. With the chosen experimental conditions, the γ -ray angular distribution $W(t)$ is described by :

$$W(t) = 1 + A_2 \exp(-t/\tau_R) P_2(\cos(\omega t + \varphi)) \quad (1)$$

with the Larmor frequency $\hbar\omega = \mu B/I$ and the anisotropy parameter A_2 .

Figure 1 shows the relaxation rate $1/\tau_R$ as a function of the target temperature between 235 K and 528 K. Due to the extremely small g -factor of the state of

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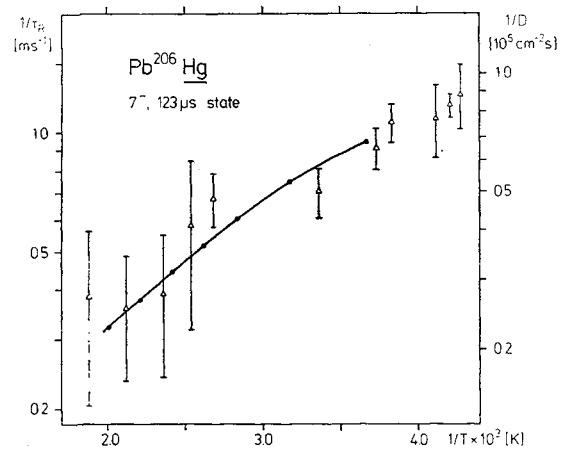


FIG. 1. — Relaxation rate $1/\tau_R$, of excited ^{206}Pb in Hg (experimental points, left scale) and self-diffusion constant D of Hg (full curve, right scale) vs temperature.

^{206}Pb , $g = -0.0217$, the magnetic relaxation rate $1/\tau_m$ can be estimated to be negligible, so that the observed rate is almost purely quadrupolar ($1/\tau_Q$):

$$1/\tau_R = 1/\tau_m + 1/\tau_Q \approx 1/\tau_Q. \quad (2)$$

The extended temperature range as compared to [3] allows a comparison with the temperature dependence of the self diffusion constant D of Hg (Fig. 1). From the close parallelism we conclude that the relaxation time τ_Q is diffusion dominated for PbHg as it is for GeGa [2] and Bi [4]. This is consistent with the theory of Sholl [5], who relates $1/\tau_Q$ to the two- and three particle correlations and assumes that both obey the temperature dependence of the

diffusion. Concerning the magnitude of $1/\tau_Q$ the theory of Sholl [5] and measured data on liquid alloys [6] point to a strong cancellation of the contri-

butions of the two- and three- particle correlations. Calculations are in progress to compare the observed rates τ_Q^{-1} with theoretical predictions.

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