High pressure ^{111}Cd – TDPAC spectroscopy of $YbAl_2$ compound

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The first measurements of perturbed γ - γ angular correlation (PAC) were done in the early 1950's, but the interest in the interaction between electric field gradients (EFG) eq and nuclear quadrupole moments Q has increased only recently.

The EFG is an impotent guiding concept for the description of the electronic structure of solids. From the time-differential perturbed angular correlation (TDPAC) measurement of the 173-247 keV γ cascade, and knowing electric quadrupole moment Q of the 5/2 intermediate level in ^{111}Cd, we can extract the EFG eq acting on the probe nucleus.

The physical properties of $YbAl_2$ exhibit typical signatures of non-integer valence, i.e. the Yb valence is directly related to the number of $4f$ holes n_h (or to the number of 5d-band electrons n_d=n_h) by υ=2+n_h. Recently, the Yb valence in $YbAl_2$ has been investigated by resonant inelastic x-ray emission[1]. It was found that the Yb valence increases from 2.25 at normal pressure to 2.8 at 80 kbar. Thus, there is an opportunity to examine the EFG in relation to the valence of Yb ions in YbAl2 by the high-pressure TDPAC spectroscopy. The effect of high pressure on the EFG, present on ^{111}Cd impurity nuclei in $YbAl_2$ compound, has been measured by using a TDPAC installation[2]. The pressure range was up to 80 kbar.

As a result, linear dependence between the quadrupole frequency $\nu_Q = e^2qQ/h$ and the number of 5d-band electrons n_d (valence υ=2+n_d) has been found. This linear dependence can be expressed by ν_Q = 7,5(10 n_d – 1) MHz.

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