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Some Neutronic Aspects of Solid Methane Moderator System

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Abstract

Beam intensities and pulse characteristics of the cold neutrons emanating from a coupled and a decoupled solid methane moderators were measured. The result suggets the possibility of adopting a coupled solid methane moderator as a KENS cold source. The effects of the cryostat wall and the phase transition of the solid methane on the neutron spectrum are also discussed.

1. Cold Neutron Characteristics for a Coupled and a Decoupled Systems

Based on the program to improve the performance of the KENS target-moderator-reflector assembly[1], some optimization studies on the solid methane moderator have been performed since the last ICANS meeting. As a first step of the measurements, the beam intensity of cold neutrons as well as the pulse characteristics from a coupled and a decoupled solid methane moderators with a graphite reflector were measured using the cold moderator system at Hokkaido linac[2]. Solid methane moderator with a dimension of 25 x 25 x 5 cm^3 was placed in slab geometry to the Pb target and was embeded into a graphite reflector (about 60 x 60 x 60 cm^3) under the condition of with and without Cd decoupler of 0.5 mm thickness. Moderator temperature was kept to 20 K throughout the measurements. The neutron spectra measured by Vanadium scattering for the both coupled and decoupled moderators are plotted in Fig. 1 normalized at the neutron energy above Cd cut-off. Neutron beam intensity obtained from the coupled moderator turned out to be about 35 % higher than that from the decoupled one around λ = 4A.

Pulse shapes of cold neutrons at various energies from the coupled moderator have also been measured by means of the back scattering from a mica crystal. The measured results are summarized in Fig. 2 with previous results obtained for the decoupled one[3]. The results of both cases for E = 5.26 meV are also compared in a linear scale in Fig. 3. In Fig. 4 are demonstrated three time constants; the rise time, the half width and the decay time. Note that the elongations in the time constants for the coupled system are fairly small.

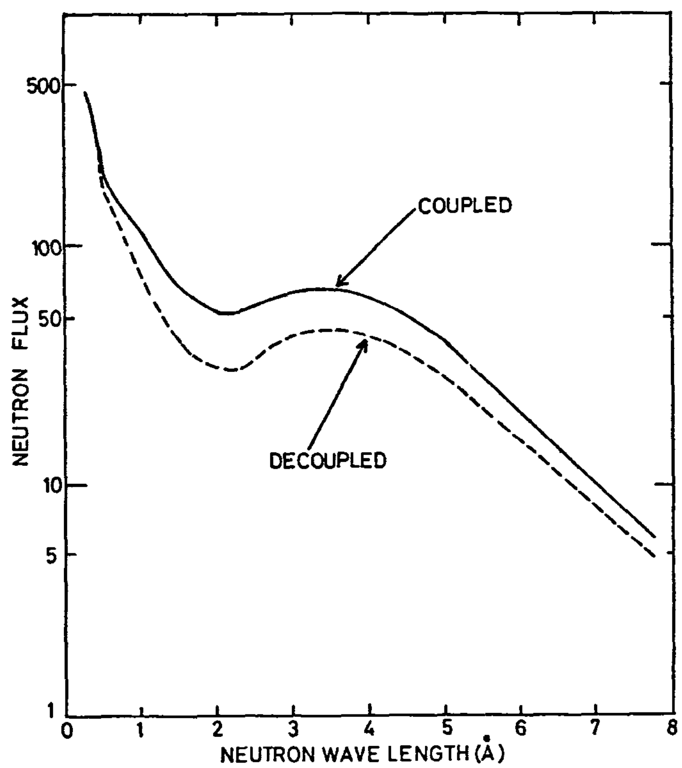


Fig. 1 Time of flight spectra for the coupled and the decoupled moderators

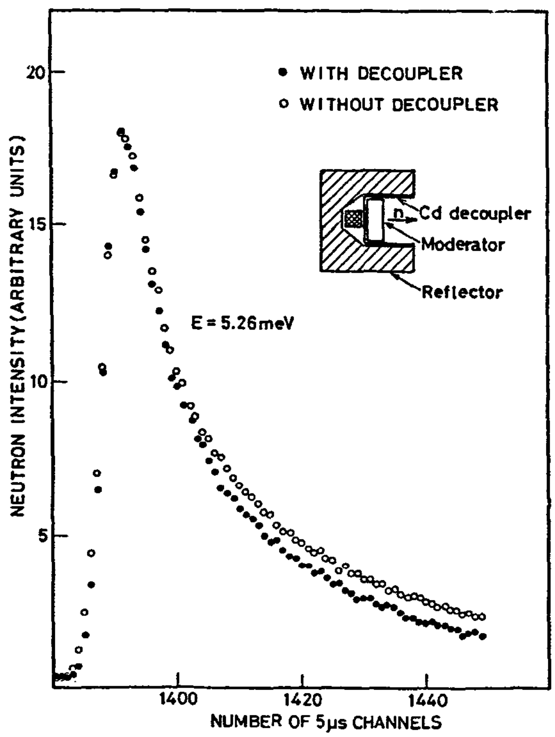


Fig. 3 Time shapes for the coupled and the decoupled moderators at 5.26 meV

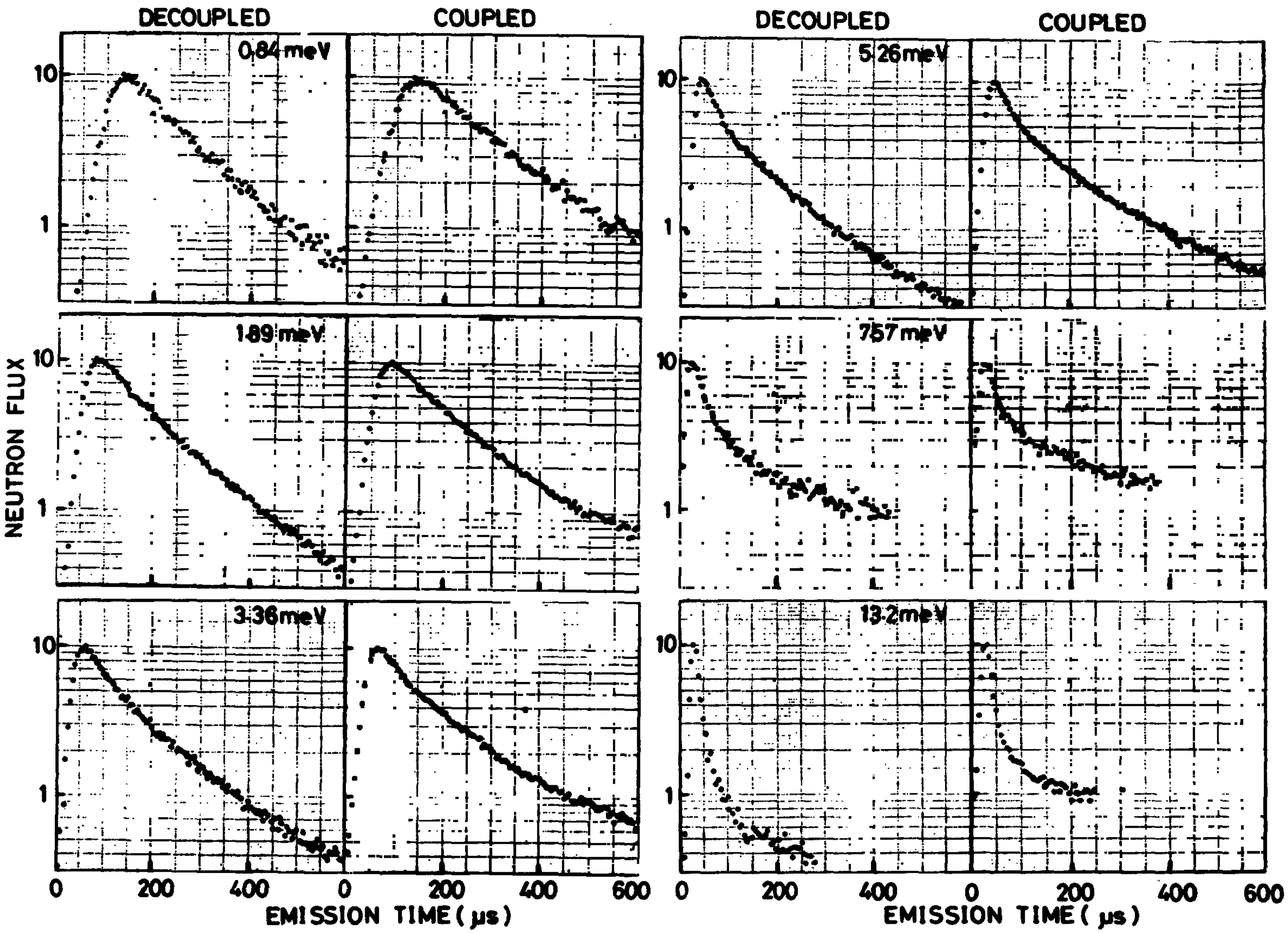


Fig. 2 Pulse shapes of cold neutrons from the coupled and the decoupled moderators

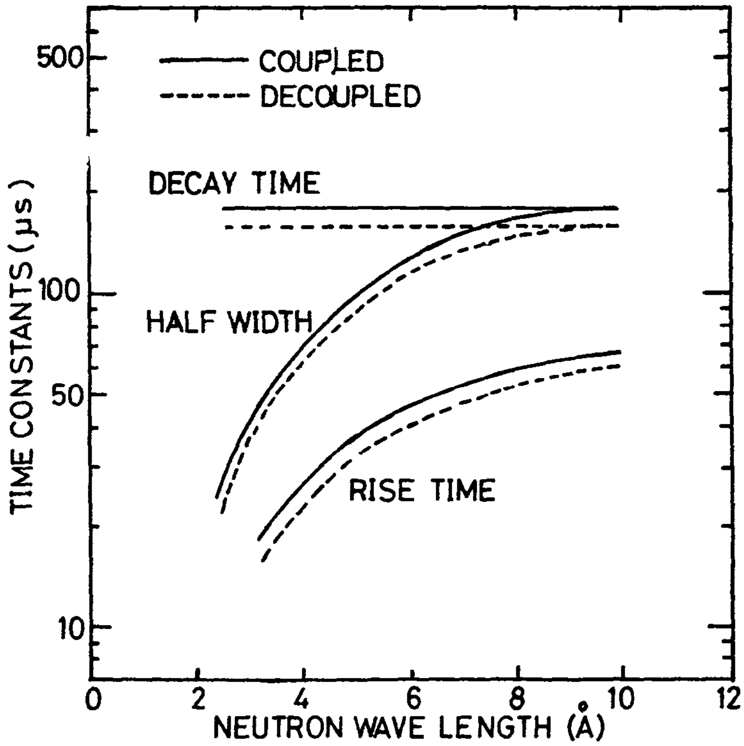


Fig. 4 Three time constants

2. Fine Structure of Cold Neutron Spectra

Fine structure of the neutron spectrum from the cryogenic moderator has been noticed in some laboratories[4)5)]. It has been argued that, in case of solid methane moderator, the fine structure may be related with the phase transition which exists at about 20 K. We have found, however, the measured spectra from the solid methane moderator at various temperatures below and above the transition temperature exhibit quasi-equilibrium spectra as shown in Fig. 5[3)]. The result is consistent with the calculated spectra based on the hindered rotation model which show that the anomalous fine structure becomes appreciable only below about 10 K as shown in Fig. 6.

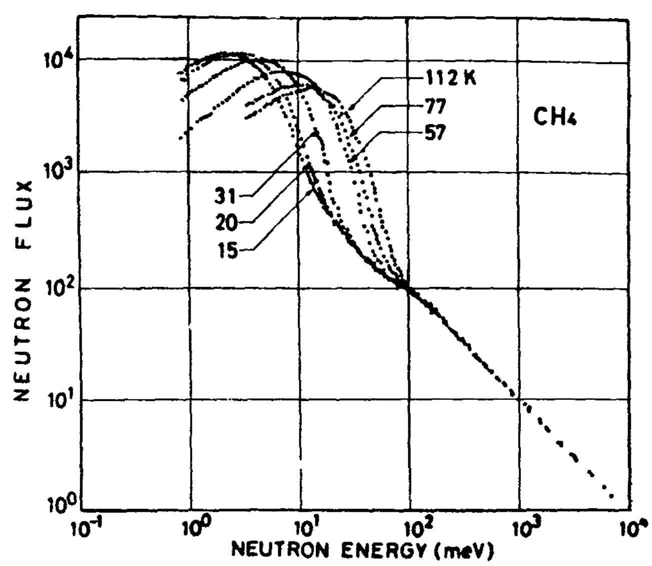


Fig. 5 Energy spectra from the solid methane moderator at various temperatures

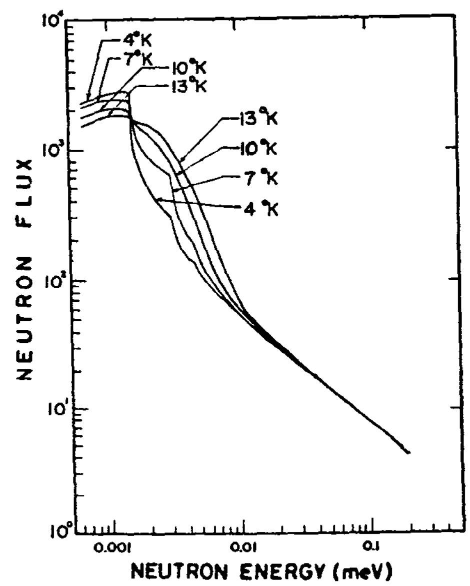
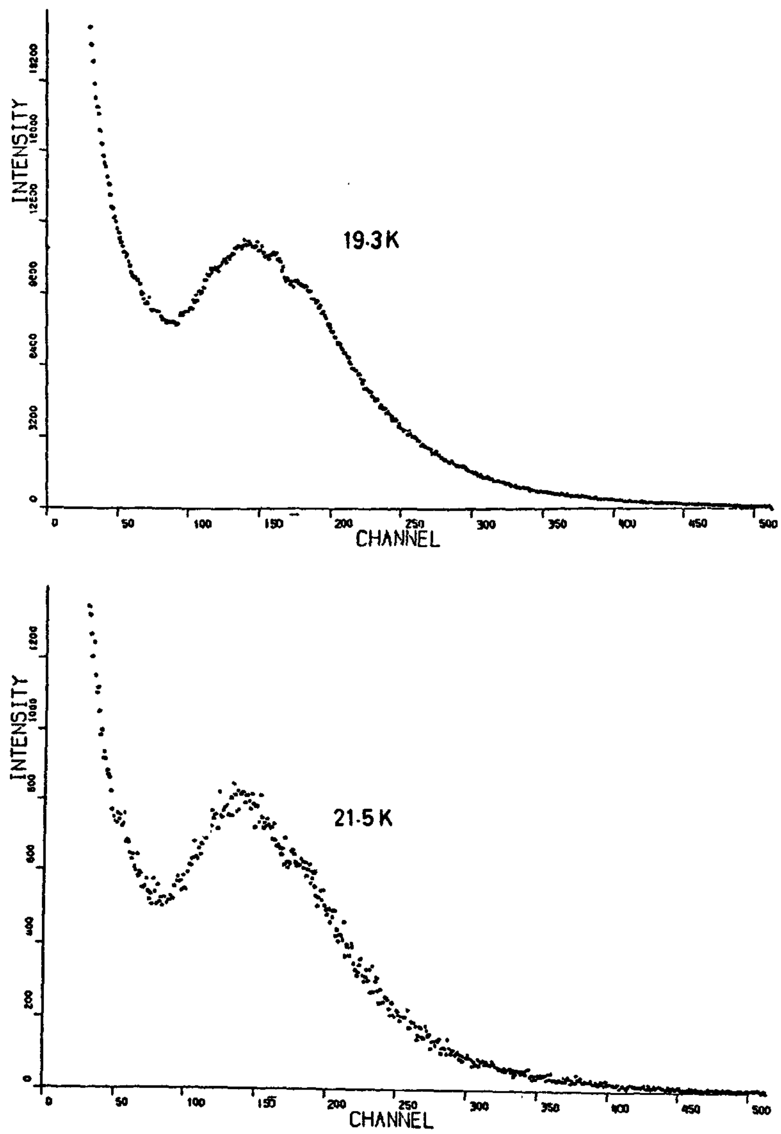


Fig. 6 Calculated energy spectra for solid methane moderator at lower temperatures



As for the cryostat wall effect, some deformations of the neutron spectra have also been reported[4]. A careful measurement of the cold neutron spectrum from the KENS cold moderator demonstrated that the spectrum was contaminated by a fine structure as displayed in Fig. 7. By changing the moderator temperature, from 19.3 K to 21.5 K, no appreciable change of the fine structure was recognized. The fine structure was found to be explained by the total cross section of aluminum; the total thickness of alminum of the moderator cryostat is 11 mm in the view surface. Since we found that the cooling power of our cryostat system is sufficient compared with the energy deposition the fine structure can be reduced to some extent.

Fig. 7 Time of flight spectra for KENS methane moderator

References

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