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**Scattering Kernel for Phase II Solid Methane** YUNCHANG SHIN, CHRISTOPHER LAVELLE, WILLIAM MICHAEL SNOW, CHEN-YU LIU, DAVID BAXTER, University of Indiana — Methane is one of the few substances that possess free rotor groups even in the solid phase at low temperature. These rotational degrees of freedom allow for efficient energy loss for cold neutrons and CH<sub>4</sub> is therefore a good choice for a low energy neutron moderator. In addition to its use as a cold neutron moderator at LENS, solid methane is planned to be used as a pre moderator for an ultracold neutron (UCN) source at the NC State PULSAR reactor and can also be used as a premoderator for solid O<sub>2</sub> UCN source at LENS. We have developed a simple model for the double differential cross section for solid methane for incident neutron energies from 0.1 meV to 1000 meV and temperatures from 4 K to 20.4 K. In this temperature range the solid methane exists in a phase (called phase II) with partial orientation of the free rotors. We adapted this analytical model due to Ozaki. *et al.*, which describes free and hindered rotor excitations in phase II valid for neutron energies below 6.5 meV, and convoluted it with a phonon model good for energies between 6.5 and 1000 meV. The parameters of the model are consistent with neutron and Raman measurements of the excitations of phase II CH<sub>4</sub>. We present the total cross section and MCNP simulation from the scattering kernel and compare to the measurement of LENS at IUCF.

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