

Abstract Submitted
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Origin of Viscosity in Water by Inelastic X-ray Scattering¹

TAKESHI EGAMI, University of Tennessee/Oak Ridge National Laboratory, TAKUYA IWASHITA, Oita University, BIN WU, University of Tennessee, WEI-REN CHEN, Oak Ridge National Laboratory, ALFRED BARON, Riken SPring-8 — Atomic collision and caging are the principal origin of viscosity in the hard-sphere model, whereas the role of the attractive force is unclear. We proposed earlier through simulation that excitations to change the local topology of atomic connectivity are the origin of viscosity, and at temperatures above the cooperative crossover temperature, T_A , the time-scale of bond cutting, τ_{LC} , is equal to the Maxwell relaxation time, τ_M (PRL 110, 205504). To prove this idea by experiment we carried out an inelastic x-ray scattering experiment on water at room temperature. The dynamic structure factor $S(Q, E)$ was determined over a wide range of Q (momentum exchange) up to 9.5 \AA^{-1} and E (energy exchange) up to 100 meV, and was double-Fourier-transformed into the van Hove function (vHf) $g(r, t)$. Because hydrogen is almost invisible to x-rays the vHf is dominated by the O-O, thus molecular, correlation. The vHf clearly showed the switching action between the first and second O-O neighbors, and that the time-scale to cut the hydrogen bond, τ_{LC} , is about 0.4 ps. This time-scale is close to τ_M (~ 0.34 ps), strongly supporting the equality $\tau_M = \tau_{LC}$ as suggested by simulation.

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