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Aleksander Chumakov

"Shedding Synchrotron Light on a Puzzle of Glasses"

Vibrational dynamics of glasses remains a point of controversial discussions. In particular, the density of vibrational states (DOS) reveals an excess of states above the Debye model called "boson peak." Despite the fact that this universal feature for all glasses has been known for more than 35 years, the nature of the boson peak is still not understood. The application of nuclear inelastic scattering via synchrotron radiation perhaps provides a clearer, more consistent picture of the subject.

The distinguishing features of nuclear inelastic scattering relative to, e.g., neutron inelastic scattering, are ideal momentum integration and exact scaling of the DOS in absolute units. This allows for reliable comparison to data from other techniques such as Brillouin light scattering. Another strong point is ideal isotope selectivity: the DOS is measured for a single isotope with a specific low-energy nuclear transition. This allows for special "design" of an experiment to study, for instance, the dynamics of only center-of-mass motions.

Recently, we have investigated the transformation of the DOS as a function of several key parameters such as temperature, cooling rate, and density. In all cases the transformation of the DOS is sufficiently well described by a transformation of the continuous medium, in particular, by changes of the macroscopic density and the sound velocity. These results suggest a collective sound-like nature of vibrational dynamics in glasses and cast doubts on microscopic models of glass dynamics.

Further insight can be obtained in combined studies of glass with nuclear inelastic and inelastic neutron scattering. Applying two techniques, we have measured the energy dependence of the characteristic correlation length of atomic motions. The data do not reveal localization of atomic vibrations at the energy of the boson peak. Once again, the results suggest that special features of glass dynamics are related to extended motions and not to local modes.

Aleksandr Chumakov has been a Research Scientist at the European Synchrotron Radiation Facility since 1993, primarily on Nuclear Resonant beamline ID18. He graduated from the Moscow Physical Technical Institute in 1980 with a diploma in plasma physics. From 1980 to 1986 he was a PhD student at the Kurchatov Institute of Atomic Energy (KIAE) in Moscow, writing his Ph.D. thesis on "Suppression of the Inelastic Channel of Nuclear Scattering of Gamma Rays Under Diffraction Conditions." From 1986 to1993 he was a Research Scientist at the KIAE. He has authored or coauthored more than 100 refereed publications, including 14 in *Physical Review Letters*.

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