# If it wiggles, it must be jellyfish swimming -- or atoms moving in glass

July 3 2007

The scientist who first compared the movements of atoms in glass to the wiggling of jellyfish in water has won the top award in the field of glass science.

Himanshu Jain, director of the International Materials Institute for New Functionalities in Glass (IMI) at Lehigh University in Bethlehem, Pa., received the Otto Schott Research Award on Monday, July 2, at the International Congress on Glass in Strasbourg, France.

The biennial award, which carries a cash prize of 25,000 Euros, is the most valuable prize for glass research. Jain, a professor of materials science and engineering at Lehigh, is sharing the award with Walter Kob of the University of Montpellier in France.

Jain is being cited for "outstanding work towards advancing fundamental understanding of the movements of atoms inside glass."

The Donors' Association for the Promotion of Science in Germany, which administers the Schott award, also noted Jain's research into unique light-induced phenomena in glass, his studies of the corrosion of glass in nuclear environments, and his work with sensors, infrared optics, waveguides, photolithography, nanolithography and other photonic applications of glass.

Jain was taking a boat ride to the Isle of Skye off Scotland's west coast 20 years ago when he first conceived of the connection between jellyfish and atoms in glass.

Watching the hundreds of jellyfish in the Sea of the Hebrides, Jain couldn't help noticing what many before had observed – that the invertebrates were not swimming but wiggling as they drifted in the water.

The fluctuations of the jellyfish caused Jain to wonder anew at the movements of atoms in glass. When the temperature of a glass is lowered to 4 degrees Kelvin, or near absolute zero, he says, these atomic movements slow from a lively hop to a virtual standstill.

When he returned from Scotland, Jain thought more deeply about the nuclear-spin relaxation studies that he had conducted with colleagues in Germany and the dielectric measurements of super-cold glass that his former adviser had recently reported. Observing the super-cold glass in the lab, he detected a weak signal with unique characteristics, indicating that some atomic movement was still occurring.

"What we saw at this extremely low temperature was clearly something different," says Jain. "We proposed that a group of atoms was sitting in one place but wiggling like a jellyfish, which does not swim but instead has small fluctuations of movement."

Jain initially called the phenomenon the "jellyfish" fluctuations for the AC (alternating current) conductivity of ionic solids at low frequency and low temperature.

He later coined the term "jellyfish fluctuations of atoms in solids."

His theory met with resistance but has since gained acceptance and is described today in some textbooks on materials and their behaviors.

Jain’s studies of the movements of atoms in glass have been conducted in Germany and the U.S. He and his colleagues first measured the AC conductivity of atoms in super-cold glass over a long period of time – 1 second, an eon in the life of an atom. The group then took the same measurements at room temperature over a much shorter period of time – about one one-billionth of a second, a snapshot of too short a duration for the atoms to begin their typical hopping movements.

In both instances – under the low frequencies prevailing at low temperatures over a long duration and under the high microwave frequencies prevailing at room temperature over a short duration – Jain and his group at Lehigh discovered the same type of fluctuation of atoms.

“We noticed a ubiquitous phenomenon and came up with the idea that the fluctuation, or wiggling behavior, was the work of a group of atoms and not just that of one atom.

“For one atom to hop requires a lot of energy that is not available at 4 degrees K. On the other hand, for a group of atoms to wiggle does not require much energy. That small amount of movement is sufficient to generate easily observable electrical conductivity,” such as the occasional electric signal from super-cold glass.

Jain’s jellyfish model, which has been validated in computer simulations, represents a fundamentally new perspective. It also has important applications, Jain says, to cell phones, satellites and other devices that contain glass and rely on microwave frequencies.

The Donors’ Association also commended Jain for the breadth of his international collaborations. Jain has worked with engineers and scientists and even dentists in Germany, France, the Czech Republic, India, Ukraine, Japan, Greece, Portugal, Egypt, China, the UK and the

U.S.

The Otto Schott Research Award has been presented since 1991, biennially and alternating with the Carl Zeiss Research Award, to recognize excellent scientific research and to encourage cooperation between science and industry. Both awards are administered by the Donors' Association for the Promotion of Science in Germany.

The award is named for Friedrich Otto Schott (1851-1935), a German chemist who invented borosilicate glass, which is known for its high tolerance to heat, chemicals and sudden temperature changes.

Source: Lehigh University