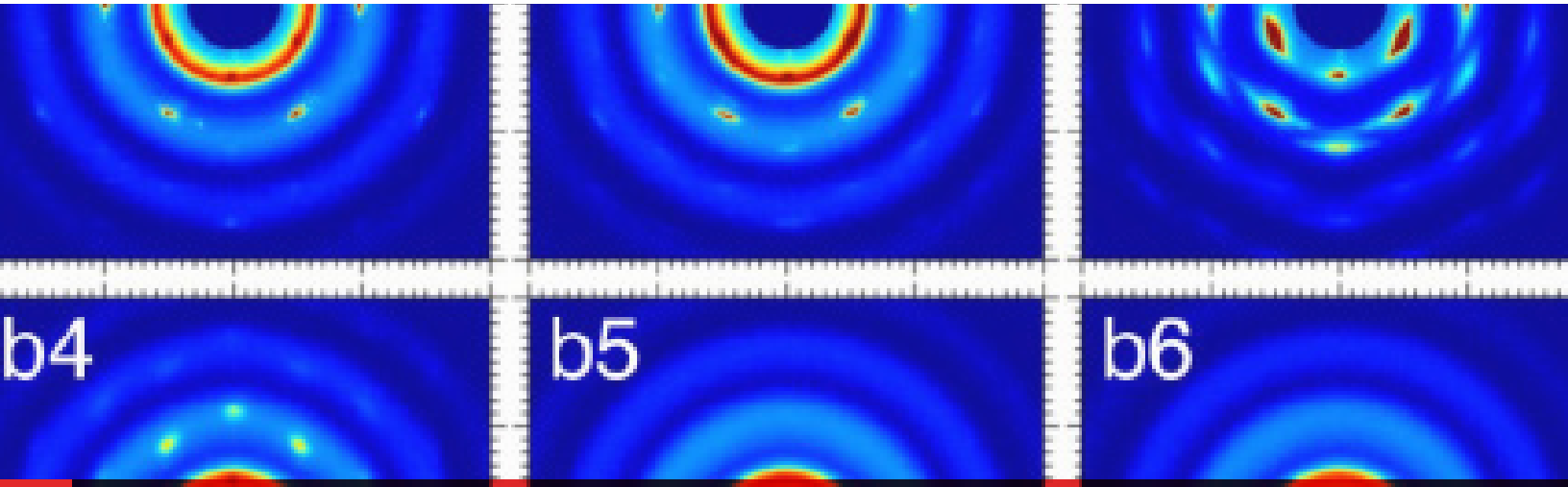
Argonne NATIONAL LABORATORY



STUDIES OF UNCONVENTIONAL THICKENING COULD IMPACT **CHEMICAL AND BIOMEDICAL SYSTEMS**

THE IMPETUS

What do paint, dishwasher detergent and blood have in common? All are composed of particles suspended in a carrier liquid, flow when stirred or forced, but remain thick at rest. This behavior in complex fluids is called shear thinning: their viscosity decreases during mixing and increases at rest. But certain fluids, when the mixing speed increases, can pass through the region of shear thinning and move into a region where viscosity increases dramatically. This effect, known as shear thickening, has been under investigation for several decades as engineers sought to solve complex production problems caused by the phenomenon.

THE WORK

When fluids are mixed at low speeds, the suspended particles form ordered layers that can slide easily across each other, facilitating flow — but when exposed to high speeds, the layers become disordered and stumble over one another, hindering flow. This change in the type of flow is called “order-to-disorder transition.”

An Argonne National Laboratory team of nanoscientists and physicists has unraveled this mystery by studying a shear-thickening fluid with in situ X-ray characterization.

Using the rheometry small-angle X-ray scattering technique at Argonne’s Advanced Photon Source, a U.S. Department of Energy (DOE) Office of Science user facility, and co-managed with Argonne’s Center for Nanoscale Materials, another DOE Office of Science user facility, Argonne researchers measured how the nanoparticles flowed in response to an applied force in real time.

THE IMPACT

- The highly uniform suspensions created by the team allowed separation of the two phenomena: order-to-disorder transition and normal shear thickening. Until now, they had been indistinguishable in other experiments. These behaviors are driven by two separate, independent mechanisms.
- Researchers are now seeking to understand the mechanism that really contributes to shear thickening. These studies could lead to applications in three-dimensional printing, the chemical industry and the biomedical field.

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