Virtual School on SANS and Neutron Reflectometry Held by NIST

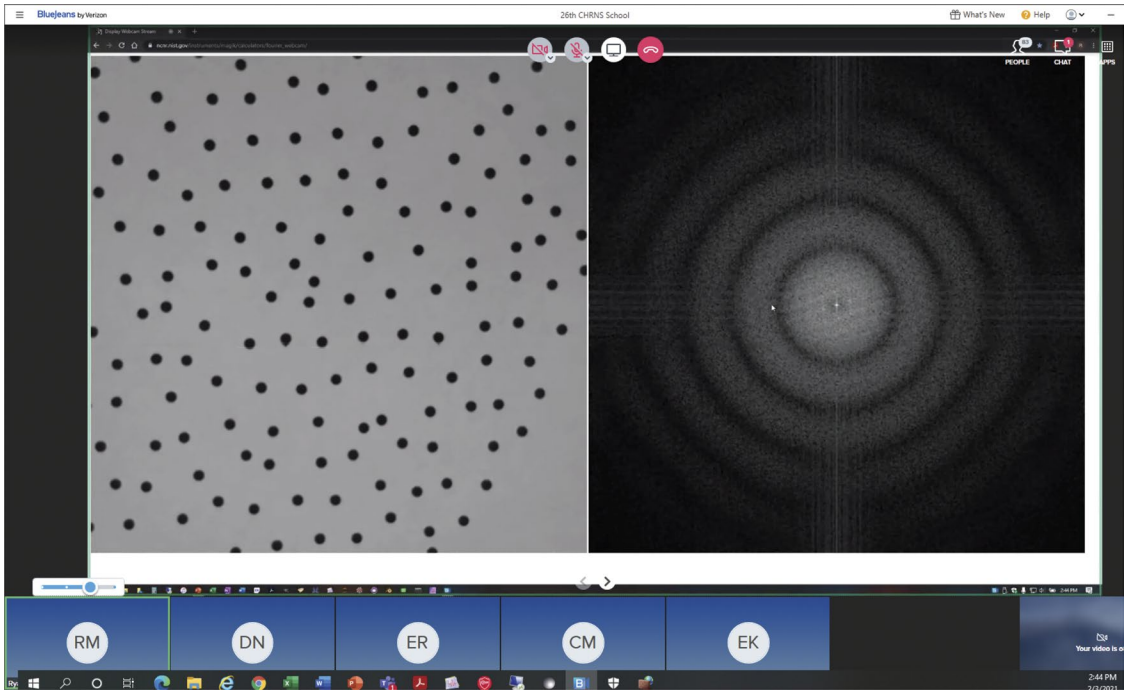

Figure 1. Ryan Murphy described scattering during a plenary lecture with an online program written by Brian Maranville that calculates the Fourier transform (right panel); an image taken from the users' camera (left panel). This program is available at: https://pages.nist.gov/reflectometry-calculators/fourier_webcam/.

The 26th Center for High Resolution Neutron Scattering (CHRNS) School on Methods and Applications of Small Angle Neutron Scattering and Neutron Reflectometry, originally planned for June 1–5, 2020, was held virtually February 3–19, 2021. This school is devoted to methods and applications of small angle neutron scattering (SANS) and neutron reflectometry (NR). In alternate years, the CHRNS school covers Neutron Spectroscopy. CHRNS is a national user facility jointly funded by the NIST Center for Neutron Research (NCNR) and the National Science Foundation (NSF), which develops and operates state-of-the-art neutron scattering instrumentation with broad applications in materials research for use by the general scientific community and supports numerous education and outreach activities.

This school was attended by 36 students affiliated with North American universities and US industry located in 22 US states, the District of Columbia and Mexico. Students came from a diverse set of backgrounds including Chemical Engineering, Materials Science and Engineering, Chemistry, Physics, Biochemistry, Biomolecular Engineering, Energy, Mechanical Engineering, Aerospace & Nuclear Engineering, Polymer Science and Electrical and Computer Engineering.

The school content is tailored to those with little or no previous experience with neutron scattering methods. The combination of introductory lectures and personalized training in scattering techniques provides participants with a unique opportunity to learn and apply neutron scattering in the context of current research topics. Plenary lectures on SANS and NR were given in sessions by Ryan Murphy and Chuck Majkrzak, respectively, followed by a lecture on the reactor and cold sources by Robert Williams (Figure 1).

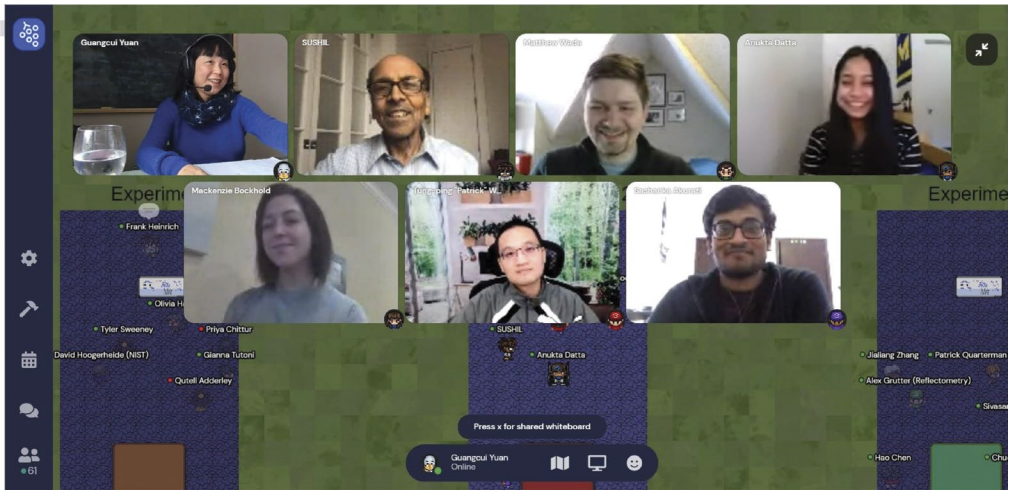

Figure 2. Instructors Guangcui Yuan and Sushil Satija teaching small groups A and E during a polymer Neutron Reflectometry experiment. Parts of the Neutron Reflectometry room are seen in the background (image credit: Guangcui Yuan).

The school featured hands-on data analysis which simulated the work of a researcher after collecting neutron data. Students were asked to choose one of four SANS experiments and one of three NR experiments based on the experiment descriptions made available (along with lectures and other course materials) on the NCNR website (https://www.nist.gov/ncnr/chrns/education-and-outreach/chrns-summer-school-neutron-scattering). Studying both techniques allowed students to expand their horizons into techniques they may not have considered and helped them to develop a greater understanding of both SANS and NR by comparing the similarities and differences of these two methods. Parallel lectures on SANS (given by John Barker and Yun Liu) and on NR (given by David Hoogerheide, Brian Maranville, Frank Heinrich and Brian Kirby) preceded the 3-day session of hands on experiments for student doing those techniques. Halfway through the school, the students switched techniques, attended the other set of parallel lectures, and then worked on their second set of experiments (Figure 2). The titles and presenters of the SANS and NR experiments are as follows:

Neutron Reflectivity Investigation of the Role of pH in the Structure of a Solid Supported Bilayer – David Hoogerheide and Frank Heinrich

Neutron Reflectivity Investigation of the Propagation of a Liquid Polymer across a Glassy Interface – Guangcui Yuan and Sushil Satija

Unexpected Coupling in Magnetic Metal/Insulator Hybrid Systems – Brian Kirby

Time-Resolved SANS: Lipids, Surfactants, and Foams – Kathleen Weigandt and Elizabeth Kelly

Small Angle Neutron Scattering Studies of Lysozyme Solutions – Susan Krueger and Susana Teixeira

Measuring Complex Fluids with RheoVSANS – Ryan Murphy and Peter Gilbert

Using Polarization Analyzed SANS to Investigate Magnetic Nanoparticles – Kathryn Krycka and Julie Borchers

This year the school had many unique features due to its virtual venue. To foster communication during the hands-on tutorial sessions, students were divided into "small groups" of three which were led by one or more instructors. Screen sharing permitted the instructors to demonstrate data reduction and fitting and to check the students' work. These small groups stayed together for both the NR and SANS experiments. While the lectures were held via a conventional video-conference platform, the students' poster sessions, coffee hours and small-group tutorial sessions were held in GatherTown (Figure 2),* an online plat-

*Certain commercial equipment, instruments, materials, suppliers, or software are identified in this paper to foster understanding. Such identification does not imply recommendation or endorsement by the National Institute of Standards and Technology, nor does it imply that the materials or equipment identified are necessarily the best available for the purpose.

form that allows participants to move their avatars around a virtual conference center and initiates a video conference between avatars that get within range of each other, providing an atmosphere for the school more like an in-person setting. A social event held on February 1 allowed the students to meet each other and the staff while trying out the GatherTown platform. Instead of the typical 40 plus hour week, this school was run for 3.5 hours per day on seven consecutive Mondays, Wednesdays and Fridays (omitting a holiday) so that the students could tend to their other studies and have time between events to review material.

As a final project, the students were required to write a pedagogical beam time proposal on a subject of their choice, either related to their own research or based on one of the school experiments that they did. Advice on how to write a good proposal was given in a plenary lecture by Yamali Hernandez. The student beam time proposals were then submitted through the NCNR Information Management System and reviewed in the same manner as real ones, giving students the same experience as researchers. The best SANS and NR proposals were awarded certificates and coffee mugs featuring SANS data from the NCNR. Runners-up were also named and given certificates.

Based on the evaluation forms they filled out, the students thought that the length and schedule of the school suited the virtual format. They pointed out some technical issues with running the analysis software and meeting software simultaneously. They also gave the lecturers and instructors very high ratings and rated 9.5 out of 10 on how well they would recommend this school to other graduate students interested in pursuing SANS and/or NR.

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