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STAFF FELLOWS
AT ORNL

Fehmi Yasin

Alvin M. Weinberg Fellow

Where and when did you earn your PhD?

I earned my PhD in June 2019 from the University of Oregon. My research was conducted in Prof. Benjamin McMorran's electron physics laboratory.

What was the subject of your dissertation?

My dissertation focused on the development of a new kind of electron interferometer within a scanning transmission electron microscope (STEM) capable of quantitatively measuring the full specimen transmission function, amplitude and phase.

What was your dissertation's major contribution to your field?

The ability to measure the amplitude and phase of electrostatic and magnetic materials is critical for characterizing materials and functional devices at atomic resolution. My research team used sinusoidal gratings microfabricated out of cheap, commercially available silicon nitride membranes as amplitude-dividing electron beam-splitters to decrease the coherence requirements of the electron source and enable interferometric imaging in any commercially available STEM. These gratings are easily installable in the condenser aperture slots, and their large size guarantees a large overlap area of interference fringes at the detector, which in turn allows for higher signal-to-noise and lower beam doses, which may lead to future development of this technique for biological imaging.

Who is your ORNL mentor, and which group and division are you working in?

My mentor is Dr. Andrew R. Lupini, Scanning Transmission Electron Microscopy group leader in the Center for Nanophase Materials Sciences, in which I am working.

What will your fellowship research focus on?

I aim to expand ORNL's world-class electron microscopy to include magnetic imaging at temperatures ranging from room temperature down to liquid helium temperatures. I will focus on imaging quantum materials that host emergent, topologically nontrivial real-space spin textures such as magnetic skyrmions, as well as their dynamics under external stimuli such as electric and thermal currents.

What is your project's expected contribution to your field?

Topological spin textures have been heralded as next-generation information carriers in future spintronics devices due to their low energy manipulation, long lifetimes, and topological protection. They are also responsible for the so-called topological Hall effect (THE), an effect seen in transport measurements of magnetic devices in which the application of an external magnetic field normal to the device along with an electric current applied longitudinally across the device results in an emergent transverse electric field. I plan on developing a first-of-its-kind in-situ experimental setup in a helium-cooled Lorentz STEM, capable of measuring the THE quantitatively while simultaneously imaging the real-space magnetic textures to reveal the role of topology in transport measurements.

What are your research interests?

I am interested in using electron microscopy to help solve material science's biggest mysteries as well as to identify new materials hosting properties that may help improve the quality of life of all humans in the future. This includes (S)TEM and electron interferometry technique development, in-situ electron microscopy imaging at cryogenic temperatures, transport measurements, focused ion beam fabrication of novel device geometries, and simulation techniques for both electron optical imaging and micromagnetics. I am also very interested in continuing to learn various experimental techniques that are complimentary to electron microscopy and crucial to solving the puzzles at hand.

What led you to science and your specific discipline?

My honors physics teacher Christopher Kappelmeier at High Point High School in Sussex, New Jersey, encouraged me to pursue physics as a career even though I was not a particularly promising student in a course where memorizing kinematic equations was the key to success. A year later, in calculus-based AP physics, I thrived in an environment where we derived the equations. The exhilaration of grappling with physics problems as a team of people that all care about finding the solution stays with me even today.

What did you do before coming to ORNL?

Prior to ORNL, I was a postdoctoral researcher in Dr. Xiuzhen Yu's Electronic States Microscopy Research Team at the Center for Emergent Matter Science at RIKEN in Japan. There, my research focused on imaging novel spin textures using Lorentz (S)TEM techniques. We discovered a spin texture that exhibits a topological charge varying from skyrmionic on the surfaces to antiskyrmionic in the bulk in a palladium-doped schreibersite with uniaxial anisotropy. We were able to image the Bloch point quadrupole linking these topologically nontrivial states in three dimensions using holographic vector field electron tomography.

Could you share an interesting fact or two about yourself?

I have been a part of several choirs and a cappella groups throughout my life and really enjoy karaoke. I used to be a downhill ski racer and still love skiing whenever I get the chance.

What nonscience topic or activity is important to you and why?

Ancient human practices such as growing food in a garden and fermenting foods into edible staples such as sauerkraut and miso are very important to me, and I endeavor to learn as many of these practices as I can and share them with my community so that this knowledge lives on and may contribute to a more sustainable society.