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Obituary

Muhammad Arif (1954–2018)

Muhammad Arif died after an extended illness on November 27, 2018 at the age of 64. Arif, as he was always called, was born in Madaripur, Bangladesh, as the first of four children. He attended Dacca University, graduating in 1978 with an MSc degree in Physics. Subsequently, he received a scholarship to study physics in the United States at Ohio University, where he earned his MS degree. He received a PhD in Physics at the University of Missouri in 1986 in the then nascent field of neutron interferometry as a student of Prof. Samuel A. Werner. While at Missouri, Arif made many important contributions to the neutron interferometric measurements, including the Aharonov-Casher effect [1], the null Fizeau effect on neutrons in moving matter [2], the coherent scattering length of ^{235}U [3], and gravitationally induced quantum interference over a full rotation [4]. The first two of these were made in collaboration with the Australian Group from Melbourne University as part of a long-term collaboration with Prof. Werner's Group in Columbia, Missouri.

After leaving Missouri, Arif joined the National Institute of Standards and Technology in 1988 as a National Research Council postdoctoral fellow doing precision X-ray work in Richard Deslattes' Quantum Metrology Group, where he worked on a facility comparing precision measurements of the lattice spacing of silicon to other crystals through a lattice spacing difference method developed at NIST [5]. Upon completion of his postdoc, Arif joined the Neutron Physics Group at NIST, where his primary research focus

was the construction of a state-of-the-art neutron interferometry station [6], which was done in collaboration with Geoffrey Greene in the first guide hall of what is now the NIST Center for Neutron Research. Arif helped to pioneer neutron interferometry at NIST in a variety of areas, including tests of quantum entanglement, coherence restoration in quantum information, and matter-wave optics. Arif played a leading role in the creation of the NIST Neutron Interferometry and Optics Facility (NIOF), which was completed in 1992. The scientific output of the NIOF spans many aspects of physics. This facility was used to significantly improve the uncertainty in measurements of the neutron scattering length of silicon and a number of low-mass isotopes. His design of these experiments was a tour de force requiring precise measurements of parameters such as isotopic purity, pressure, thickness and neutron wavelength. The accurate measurements of the coherent scattering length of low-mass isotopes by neutron interferometry is a critical test of NN potential models of the nucleus [7].

His vision for neutron imaging resulted in the first neutron imaging facility to be built at NIST. The NIST Neutron Imaging Facility began in 2003 [8] and was significantly upgraded later in 2006 [9] through a partnership with the U.S. Department of Energy and General Motors. This partnership made it possible to create an optimized in situ fuel cell testing laboratory on the neutron imaging beam line, which made a huge impact in the fuel-cell community [10]. For the first time, researchers had a way to peer inside a fuel cell and see where the water was forming. Prior to this fuel cell, researchers would flash freeze fuel cells in operation with liquid nitrogen and then dissect the fuel cell in a freezer to observe the water distribution. It was said that 5 years of freeze testing could be performed in 1 week at a neutron imaging facility. Many were shocked that they had made so many mistakes in the design of their fuel cells, and the neutron images showed them exactly where they made the mistakes. In addition to the imaging of fuel cells, the neutron imaging technique was used to look inside a myriad of other systems, such as oil shales, lithium-ion batteries, and heat pipes. The success of the thermal neutron imaging facility paved the way to a second cold-neutron imaging facility in 2015 [11]. The neutron imaging program realized a series of important technical advances that recently culminated in a new record resolution for neutron imaging of 1.5 microns [12].

Arif became leader of the Neutron Physics Group in 2003 and remained in that position until his illness forced him to give it up in 2017. He received numerous accolades during his career and was the recipient of notable awards including a Department of Commerce Gold Medal Award, two NIST Bronze Medal Awards, the Arthur S. Flemming Award, an R&D 100 Award, and a Department of Energy R&D Award. He was elected a Fellow of the American Physical Society and of the Washington Academy of Sciences, and in 2014 became a NIST Fellow.

Arif's passions in life extended beyond physics. Above all things, he loved spending time with his family, especially his daughter. He also enjoyed being in nature and traveling to many destinations, visiting over 25 countries in his lifetime. Among his favorite places to visit were Switzerland, Japan, and Hawaii. His extensive knowledge made him an excellent partner in conversation and a trusted source of guidance in matters beyond science. Those who knew him well respected his nuanced perspectives on current events and his pragmatic approach to problem solving. He had a love of gardening, kayaking, studying airplanes, dining out, tinkering with technology, all things Star Wars and elephants. He will be remembered by friends and colleagues for his gentle personality, infectious sense of humor, and good will towards others. Arif is survived by his daughter Sabrina, wife Mary, mother, and two brothers and a sister.

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