PURDUE UNIVERSITY | Nuclear Engineering
COLLEGE OF ENGINEERING

Nuclear Engineering Seminar

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Applied nuclear physics for nuclear security: from Schrödinger to New START

Abstract

Nearly three decades after the end of the Cold War, nuclear security remains a pressing global issue. The upcoming 2021 expiration of the New START treaty presents a possible new era without numerical limits on US and Russian deployed nuclear warheads, and tensions with North Korea are unpredictable and incendiary. While these perils of nuclear technology are readily apparent, nuclear engineering and applied nuclear physics can also offer valuable new directions in addressing these modern nuclear security problems.

I will first discuss how applied nuclear physics can address a paradox at the core of nuclear arms control: how can an independent inspector verify that a warhead presented for dismantlement is indeed a genuine nuclear warhead without revealing any sensitive information in the process? The physical cryptographic measurement protocol recently developed at MIT presents one possible solution, exploiting the photonuclear interaction known as nuclear resonance fluorescence (NRF) to make isotope- and geometry-sensitive measurements of candidate nuclear warheads without relying on electronics or software to protect sensitive information. I will then examine potential future applications of nuclear engineering to nuclear security, considering both security-enabling nuclear technology development and physics-based analysis of burgeoning nuclear technologies. In addition, I will discuss possibilities for pure nuclear physics studies and the development of computational techniques that may stem naturally from these applied physics goals. I will then conclude with an outlook for modern nuclear security and the role of applied nuclear physics research in maintaining it.

Jayson Vavrek completed his B.Sc. in physics at the University of Alberta, Canada in 2014, and his S.M. in nuclear science and engineering at MIT in 2016. He is currently a Ph.D. student in the Department of Nuclear Science and Engineering at MIT, where his research focuses on applied physics and computational techniques for nuclear treaty verification. This includes the use of nuclear resonance fluorescence (NRF) as an isotope-sensitive warhead verification technique, as well as the development, verification, and validation of the G4NRF code for simulating NRF in Geant4. He also collaborates with Lawrence Livermore National Laboratory on absolute NRF cross section measurements at the HIgS facility for both scientific and nonproliferation applications.

He has authored seven journal publications and proceedings (six first-author), including two articles in Proceedings of the National Academy of Sciences USA.

He has also won several awards, including Best Student Presentation at both the 2018 ANS Advances in Nuclear Nonproliferation Technology and Policy Conference and the 2017 CVT Workshop, as well as Canada's Governor General's Academic Bronze Medal in 2010.