VILLANOVA UNIVERSITY

MECHANICAL ENGINEERING DEPARTMENT

Fall 2024 SEMINAR SERIES

Seminar Date: Friday, November 1, 2024

Lecture: Inertial Confinement Fusion Across Length, Time, and Energy Scales

Speaker: Connor Alexander Williams, PhD
Senior Scientist
Radiation & ICF Target Design
Sandia National Laboratories

Abstract:

In inertial confinement fusion (ICF), a target containing deuterium–tritium fusion fuel is imploded at high velocity through the application of tremendous driving pressures. The target is eventually halted by the rising pressure of the fuel itself, which is heated through the conversion of kinetic energy to thermal energy. The fusion reactions produced in the ~100,000,000 ºC plasma release high-energy alpha particles, which can further heat the fuel and lead to “ignition”, the thermonuclear instability that allows copious amounts of fuel to be fused.

The realization of ignition in the laboratory—recently achieved at the National Ignition Facility—has reawakened interest in ICF as a potential solution to the present energy crisis. This feat has set in motion federal investment plans in inertial fusion energy (IFE) and prompted the formation of a rapidly increasing number of private fusion companies. There exists a profound level of technical diversity among the schemes being pursued both within the private fusion community and across the National Laboratory complex. This diversity indicates that, while there are several core principles that bind (almost) all ICF platforms together, the success of these methods is rather agnostic to the exact manner in which these criteria are met. Instead of forming an absolute hierarchy among these fusion concepts, the differences in the way the fusion targets are imploded, heated, and confined result in specific regimes in which a given technique may particularly excel. These regimes are characterized by explicit relationships that arise between the length, time, and energy scales that appear in the problem of terrestrial fusion. In this talk, we will explore the nuances of laser-, x-ray-, and magnetically driven implosions, and posit the direction future endeavors may lead.

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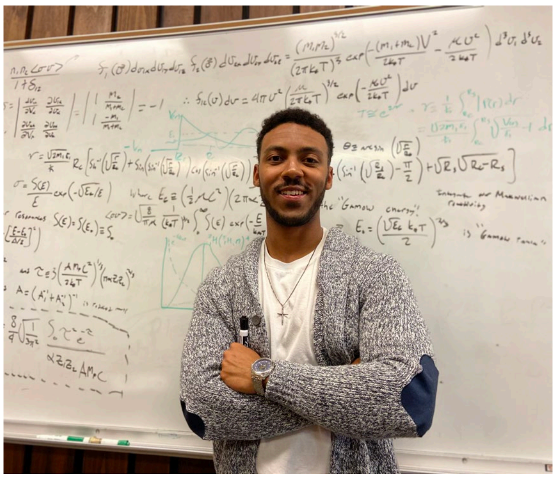
Biography:



Dr. Connor Alexander Williams received his B.S. degree in physics as a Presidential Scholar at Villanova University in 2019 before continuing his studies at the University of Rochester, where he subsequently earned an M.A. in 2021 and Ph.D. in 2023, both in physics. At the University of Rochester, Dr. Williams was awarded the Provost Fellowship, Frank J. Horton Fellowship, and the High-Energy-Density Physics Equity Scholarship. His doctoral research, conducted at the Laboratory for Laser Energetics, investigated ultrahigh-velocity direct-drive inertial confinement fusion (ICF) implosions as a method of generating near-kilojoule yield outputs on the 30-kJ Omega Laser Facility, validated experimentally during his time there. He also helped construct the quasi-analytic "Betti–Williams" model, an inference model that recovers the state of an ICF hot spot at the moment of peak neutron production. This model was crucial to validating the breakthroughs that ultimately netted him a share of the American Physical Society's 2024 John Dawson Award for Excellence in Plasma Physics Research. Dr. Williams is now a senior member of technical staff at Sandia National Laboratories in the Radiation & ICF Target Design organization. His current interests are in designing magnetic direct-drive ICF platforms and studying factors that affect burn efficiency and propagation.

Host: Andrew Lee, PhD