

**UNIVERSITY OF ROCHESTER**

**THESIS DEFENSE**

Tuesday  
18 May 2021

<https://rochester.zoom.us/j/95672512068?pwd=RVZSMkZrU0N0cUJlYVlWbWxkZkZkdz09>

3:00 PM to 4:00 PM  
1500 to 1600 hrs

**Measurements of Non-Maxwellian Electron Distribution Functions Using Angularly Resolved Thomson Scattering**

Avram L. Milder

Electron velocity distribution functions (EVDs) are of fundamental importance in plasma physics, determining the dispersion and damping of waves. Traditionally, Thomson scattering and other diagnostic techniques measure the thermal equilibrium EVD (Maxwellian). This can lead to misinterpretation of plasma conditions, measured by Thomson scattering. To date, by relaxing the assumption on the distribution function, collective Thomson scattering has been used to measure the EVD from a single Gaussian, driven by intense femtosecond laser, in a Maxwellian through electron-electron collisions. To further investigate the EVD, a novel diagnostic technique and instrument were developed where the Thomson scattering spectra was measured as a function of scattering angle. This technique of angularly resolved Thomson scattering allowed direct measurements of the EVD over many orders of magnitude, without the need to assume a shape. With this technique, the non-Maxwellian EVD resulting from inverse Bremsstrahlung heating were measured to have a Maxwellian tail in addition to the super-Gaussian tail. The impact of such an EVD has been shown to be a decrease in laser absorption.

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Prof. Riccardo Betti



Prof. Eric Blackman



Prof. Dustin Froula



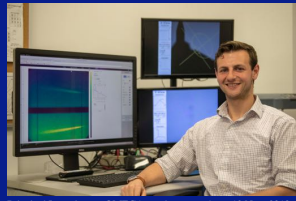
Prof. John Palastro

Dr. Avram L. Milder received his PhD. in Plasma Physics from the University of Rochester's Department of Physics and Astronomy in 2021. He started his physics journey at the University of Massachusetts-Amherst where he earned a Bachelor of Science in Physics and Mathematics. He joined the Plasma & Ultrafast Physics Group at the Laboratory for Laser Energetics after receiving the Frank J. Horton Fellowship in 2017. Dr. Milder published four first authored manuscripts, including two Physical Review Letters and two Physics of Plasmas, presented three invited talks at international conferences, and co-authored 6 more publications, including a Nature Physics and two more Physical Review Letters, while he was a graduate student. His thesis work was performed under the direction of Prof. Dustin Froula.

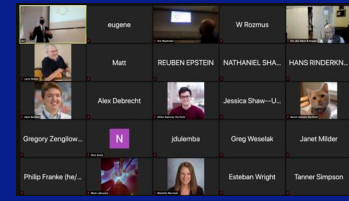
Dr. Milder developed a novel technique that encodes the electron motion to the frequency of scattered light while using collective Thomson scattering to improve the scattering efficiency at velocities where the number of electrons are limited. The conceptual realization that the collective Thomson-scattering spectrum uniquely defines the electron distribution function and that the enhanced scattering from the electron plasma waves provides access to the velocities of the electron distribution function where there are very few particles, allowed several novel measurements, including the effects of ionization on electron distribution functions [A. L. Milder et al., Phys. Rev. Lett. 124, 025001 (2020)], and the effects of non-Maxwellian electron distribution functions on cross-beam energy transfer [D. Turnbull et al., Nat. Physics 15, 181 (2020)], and on laser absorption [A. L. Milder et al., Phys. Rev. Lett. (2021)].



2 Jan. 2018



Principal Investigator, OMEGA gas-jet target shots, 12 Nov. 2019



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**Dr. Avi Milder**  
18 May 2021

Laboratory for  
Laser Energetics  
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Hans Rinderknecht, Dana Edgell, Aaron Hansen, Andrei Maximov, Tanner Simpson, Dillon Ramsey, Avi Milder, John Palastro, Phil Franke, Bill Donaldson, Kathleen Weichman, Dustin Froula, Kyle McMillen, Jess Shaw, Joe Katz