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An absorption spectroscopy platform to measure photoionization fronts in the laboratory

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In present day star forming regions, large, young stars introduce ionizing radiation sources to cold gas clouds. This radiation acts to heat the surrounding gas cloud, causing expansion and a rocket effect. The heat wave that propagates through the gas cloud, causing these changes, is driven by the ionizing radiation in the high-energy tail of the stellar emission, which we call a photoionization (PI) front. Photoionization is the dominant source of heating in this kind of front. Recent work shows it is possible to create this type of heat front in the lab with achievable experimental conditions.

Recent experiments using the Omega-60 laser, attempted to observe PI fronts by heating a N gas cell using an about 80 eV soft x-ray source. Ten 1 ns laser pulses stitched together to form an effective 5 ns pulse with an irradiance of 10^{14} W cm^{-2}, which is incident on a thin Au foil to create an about 80 eV x-ray source. This source should drive a PI front in the N gas. We used absorption spectroscopy of a 1% Ar dopant to probe the system 1250 μm from the source at different times using the 2-4 keV emission from a capsule implosion as the absorption source. Here we show the results of that experiment, where we demonstrated a platform for absorption spectroscopy of a relatively high-pressure gas cell. This includes the characterization of the capsule implosion in >2 keV x-ray images, < 600 eV x-ray images, and time resolved flux measurements as well as spectrally from two different angles.

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