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Ion and neutral dynamics in Hall plasma accelerator ionization instabilities[1] ANDREA LUCCA FABRIS, CHRISTOPHER YOUNG, MARK CAPPELLI, Stanford Plasma Physics Laboratory — Hall thrusters, the extensively studied $E \times B$ devices used for space propulsion applications, are rife with instabilities and fluctuations. Many are thought to be fundamentally linked to microscopic processes like electron transport across magnetic field lines and propellant ionization that in turn affect macroscopic properties like device performance and lifetime. One of the strongest oscillatory regimes is the "breathing mode," characterized by a propagating ionization front, time-varying ion acceleration profiles, and quasi-periodic 10-50 kHz current oscillations. Determining the temporal and spatial evolution of plasma properties is critical to achieving a fundamental physical understanding of these processes. We present non-intrusive laser-induced fluorescence measurements of the local ion and neutral velocity distribution functions synchronized with the breathing mode oscillations. Measurements reveal strong ion velocity fluctuations, multiple ion populations arising in narrow time windows throughout the near-field plume, and the periodic population and depopulation of neutral excited states. Analyzing these detailed experimental results in the context of the existing literature clarifies the fundamental physical processes underlying the breathing mode.

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Christopher Young
Stanford Plasma Physics Laboratory

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