Title : Ground-based experiments and space-flight missions for space exploration with students

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At University of Massachusetts Lowell we have developed a multifaceted experimental research program for space exploration. They range from new ground-based instruments to study the upper atmosphere and ionosphere to spaceflight technology maturation experiment for direct imaging of exoplanetary systems.

Two ground-based instruments we have developed include a full-waveform lidar operating simultaneously in two NIR bands to characterize forest structures and the only hyperspectral imager capable of ground-based observation of auroral emissions during sunlit hours.

Our PICTURE-series of sounding rocket and high-altitude balloon missions have systematically matured key technologies necessary for imaging and characterizing exoplanetary system in reflected visible light. Already we demonstrated a planet-star contrast of $1x10^{-6}$ and a pointing stability of 1 milli arcseconds, which is comparable to James Webb Space Telescope. Ours are the only experiments that have demonstrated these key technologies on sky.

At the same time, we have designed and flight demonstrated a compact, wide-field multispectral camera that can be easily reconfigured to meet different measurement objectives. It has flown twice aboard high-altitude balloons. Also, as a hands-on educational initiative, our undergraduate students developed and flown a 16-element X-band phased array for retrodirective beam forming and steering aboard a 3U CubeSat. It provided over 100 undergraduate students opportunities to design, construct, integrate, test and launch UMass Lowell's first satellite.

During the first quarter of 2025, we will deploy the hyperspectral imager in Kiruna, Sweden to support a sounding rocket mission followed by a one-year auroral observation. We will also launch a repackaged multichannel camera aboard a 45-day balloon mission to study upper atmospheric processes. Finally, we will complete the development of a new format nanosatellite suitable for education and research. All these experiments and systems will be built and tested at our newly developed space instrumentation facility.

In this presentation I will provide an overview of these activities.