

# A customizable wide field-of-view multiband imager for lunar atmospheric Studies

Supriya Chakrabarti, Sunip Mukherjee, Timothy Cook, and Jeffrey Baumgardner\*

LoCSST, University of Massachusetts Lowell, 600 Suffolk Street, Lowell, MA 01854, USA

\*CSP, Boston University, 725 Commonwealth Ave, Boston, MA 02215, USA

Supriya\_Chakrabarti@uml.edu

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## Background

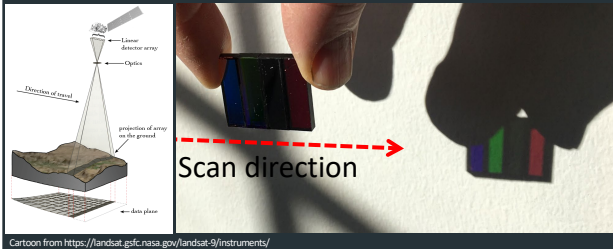
Ground based observations have long demonstrated the presence of Sodium and Potassium in lunar atmosphere. At times lunar Sodium has been observed to extend beyond the Earth's orbit. They were also observed by LADEE ([https://www.nasa.gov/mission\\_pages/ladee/main/index.htm](https://www.nasa.gov/mission_pages/ladee/main/index.htm)). Our versatile imager can be used to monitor and study the morphology of Sodium and Potassium in lunar exosphere from a small package.

## The instrument

The instrument is small ( $10 \times 10 \times 6.2 \text{ cm}^3$ ), has a mass of 1.2 Kg and consumes 6 W (see an annotated photograph in the middle panel on right). This multi-channel imager uses a CCD detector and has an angular resolution of  $0.1^\circ$  and a field of view of  $35^\circ \times 25^\circ$ . This large field of view is shared by a mosaic of interference filters that selects emission features of interest. The prototype imager has been validated in the laboratory as well as aboard a high-altitude balloon for Sodium and Potassium resonance emissions at 589 nm and 770 nm, respectively. Two other channels simultaneously monitor background signals.

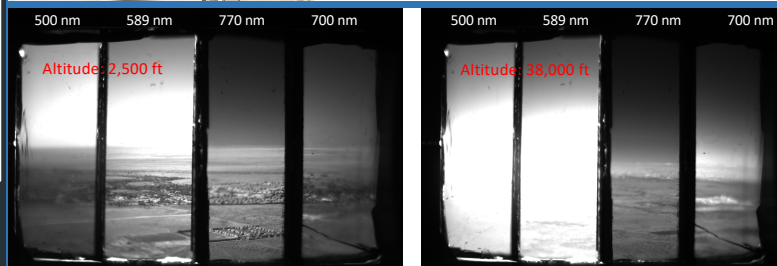
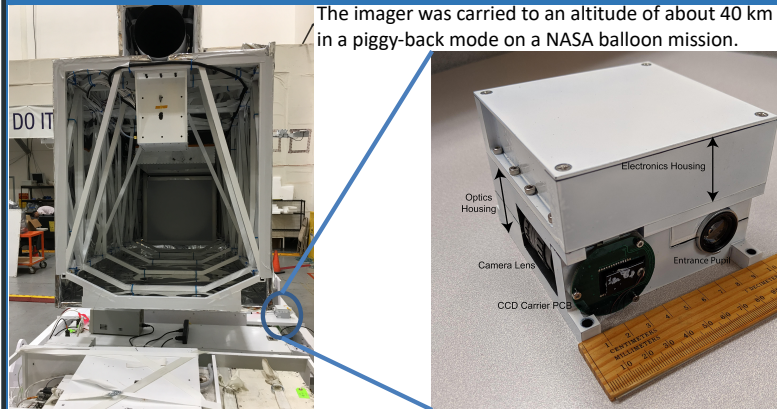
## Principle of operation

For imaging scenes in four wavelength bands, the prototype instrument uses the push-broom technique (shown in the cartoon below). The four-filter mosaic used in this instrument is shown in the photograph below). By selecting different numbers of filters and their passbands, the imager can be optimized for a wide range of applications.



Interested in collaborations?  
Contact: [supriya\\_chakrabarti@uml.edu](mailto:supriya_chakrabarti@uml.edu)

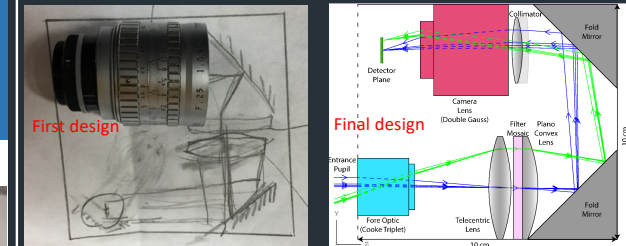
We have developed a multi-channel instrument to image potassium and sodium in lunar atmosphere. It was validated on a NASA high-altitude balloon and can be easily tailored to many other applications.



Flight data from two altitudes – 760 m (2,500 ft, left) and 11,580 m (38,000 ft, right).

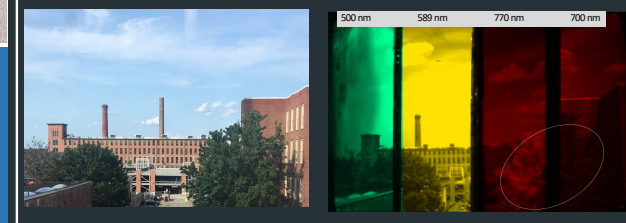
## The Design

The key design criterion for this instrument was CUBESat compatibility ([https://static1.squarespace.com/static/5418c831e4b0fadecac1baed/56e9b62337013b6c063a655a/1458157095454/cds\\_rev13\\_final2.pdf](https://static1.squarespace.com/static/5418c831e4b0fadecac1baed/56e9b62337013b6c063a655a/1458157095454/cds_rev13_final2.pdf)). This, and the need for the use of COTS parts, required careful packaging of available optical components. The design underwent several changes (see below) to incorporate available optics and detector.



## Performance

The imager has undergone several laboratory tests to characterize its performance and demonstrated that besides meeting the Size, weight and power requirements, it can observe lunar Sodium emissions (typically ~40 Rayleighs) with 100 seconds exposures. During daytime laboratory tests, a tree appears brighter in 770 nm channel than 700 nm (see elliptical region highlighted in the right panel, below). With built-in automatic exposure control, it has also observed star trails at night.



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