Harrison Krantz

Full-stack scientist for comprehensive electro-optical SSA research, instrument development and operation

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Education

PhD Astronomy & Astrophysics 2023 expected	University of Arizona Steward Observatory *Thesis: LEO Satellite Photometric Characterization (see details below)*	*Advisor: Dr. Eric Pearce*
MS Astronomy & Astrophysics 2020	University of Arizona Steward Observatory *Thesis: Chimera High-Speed Photometer (see details below)*	*Advisor: Dr. Eric Pearce*
BS Engineering Physics 2017	Colorado School of Mines *Thesis: Using Stars to Align Steered Laser (see details below)*	*Advisor: Dr. Lawrence Wiencke*
BS Computer Science 2017	Colorado School of Mines	

Skills and Expertise

- Telescope instrument integration and performance characterization
- Electro-optical sensor design and performance modeling
- Observatory design and system optimization
- Small and large observatory operation and troubleshooting
- Observation of Earth satellites (planning, optimization, and execution)
- Cislunar and xGEO space object tracking
- Photometric and spectroscopic data processing
- Interpretation of observational data of Earth satellites
- Software development to support observing and data analysis
- Hardware integration and fabrication: Solidworks, machining, welding, 3D printing, electronics

Significant Projects

LEO Satellite Photometric Characterization
I am characterizing the brightness of new mega-constellation satellites to evaluate their impact on astronomy and inform the community with meaningful information. I developed new observing methodology and software to observe the fast-moving satellites with available facilities. I created a semi-automated software pipeline to process the images and produce calibrated photometric measurements from the ten thousand plus observations. Through an SQL database I correlate the measured brightness with an array of other parameters and present the data with novel all-sky plots which demonstrate the non-intuitive behavior of satellite reflections across the entire range of Sun-satellite-observer geometry. I also created new metrics for communicating the brightness of these satellites in meaningful ways to both the astronomy community and the satellite operators.

IAU Centre for Protection of the Sky (CPS) Collaboration
In conjunction with my study of LEO satellite brightness I work internationally with astronomers and space industry experts to address the impacts on astronomy. As part of the working groups for the SATCON 1 & 2 and Dark and Quiet Skies workshops, I guided others in understanding the behavior of reflecting satellites and significantly contributed to writing the published working group reports. My proposals led to the creation of the IAU CPS, and SatHub sub-group, to continue efforts.

Chimera Simultaneous Thee-Color High-Speed Photometer for SSA
I completed assembly and integration of this instrument on the Kuiper 61 inch telescope in 2018. Since, I have accumulated over 100 nights of observing and iteratively refined the instrument operations and observing methodology. I created software to produce high-fidelity light curves and interpretation to identify distinct signatures for each object (e.g. satellites, rocket bodies, debris). These light curves are vital for supporting multi-phenomology studies, such as our near-IR studies (see below).

Pomenis Astrograph for SSA
I worked on the development of Pomenis and its continual operation and improvement. Pomenis is a versatile wide-field of view astrograph system specifically for SSA and created with low-cost COTS components. Using a combination of available software and new software I created, I automated every aspect of the observing to maximize data production such that Pomenis now plans and executes observations without any human input. I utilize Pomenis for a broad range of projects and as an always-available testbed for quickly implementing and evaluating new ideas. This includes photometry of LEO satellites, all-sky NSB measurements, and SSA observing technique development.

Mobile Observatory Enclosure
I designed and fabricated the unique trailer-based mobile enclosure for Pomenis. Building on prior experience, I designed the mobile enclosure for minimal site infrastructure, easy deployment, and maximum reliability. The self-opening roof is my own design and specifically made to accommodate the peculiar requirements (e.g. maximize the viewable sky while clearing the trailer wheels, stable for travel, etc.). Over 5 years of operations the enclosure has proven reliable with no failures or issues. The mobile enclosure design is patent pending.

Near-IR Photometry and Spectrometry of Satellites
I observe satellites in the near-IR wavelength in our long-term observing campaign with UKIRT. We are developing methods for object discrimination based on broad-band near-IR photometry with supporting spectrometry observations. I interpret the data and tie in the conclusions to improve other aspects of the ongoing project. The existing software (which is for astronomy) did not meet our needs for SSA, so I created a new software suite for processing the images and producing calibrated measurements. In addition to synthesizing the UKIRT photometry and spectrometry, I include light curves from my observations with Chimera, to better interpret the resulting data.

Steered Laser System for Cosmic Ray Simulation
As an undergrad, I worked on the Global Light System prototype. This is a steered high-power UV laser system inside a trailer-based mobile lab which we used to simulate the extensive air showers produced by ultra-high-energy cosmic rays in order to test and characterize cosmic ray observatories. For my thesis I developed a camera system to look through the same optics as the laser system and image star fields to align the laser pointing.

Cosmic Ray Observatory NASA Super Pressure Balloon Flight (EUSO-SPB1)
As an undergrad, I worked on the integration of the EUSO-SPB1 cosmic ray observatory for flight on a NASA super pressure balloon in 2017. In particular, I worked in the lab to characterize the 1-meter Fresnel lenses which made the primary telescope.

Select Publications

Krantz, H., Pearce, E. C., and Block, A., “Characterization of LEO Satellite With All-Sky Photometric Signatures”, in *The Advanced Maui Optical and Space Surveillance Technologies Conference*, 2022.

Pearce, E. C., Krantz, H., *et al.*, “Measurements and Interpretation of Near-IR Spectra of Satellites”, in *The Advanced Maui Optical and Space Surveillance Technologies Conference*, 2022.

Krantz, H., Pearce, E. C., and Block, A., “Characterizing the All-Sky Brightness of Satellite Mega-Constellations and the Impact on Astronomy Research”, in *The Advanced Maui Optical and Space Surveillance Technologies Conference*, 2021.

Pearce, E. C., Krantz, H., Block, A., Sease, B., and Kirshner, M., “Rapid Discrimination of Resident Space Objects Using Near-Infrared Photometry”, in *The Advanced Maui Optical and Space Surveillance Technologies Conference*, 2021.

Krantz, Harrison. 2020. A trailer-based mobile observatory enclosure. US63/107,203 filed 2020-10-29. Patent pending.

Walker, C., Krantz, H., *et al.*, “Impact of Satellite Constellations on Optical Astronomy and Recommendations Toward Mitigations”, vol. 52, no. 2, 2020. doi:10.3847/25c2cfeb.346793b8.

Krantz, H., Pearce, E. C., Avner, L., Durney, O., and Sauve, C., “Chimera: a high-speed three-color photometer for space surveillance and astronomy”, in *Ground-based and Airborne Instrumentation for Astronomy VII*, 2018, vol. 10702. doi:10.1117/12.2312142.

Krantz, H. and Wiencke, L., “Using Stars to Align a Steered Laser System for Cosmic Ray Simulation”, in APS April Meeting, 2016.