Project PANOPTES

A citizen science project to discover transiting exoplanets

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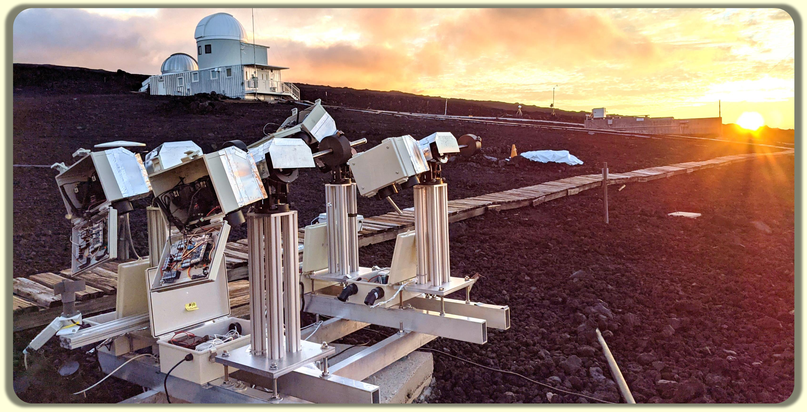
PANOPTES is an open-source citizen science project consisting of a network of automated robotic telescopes that work on a survey mode of the night sky to detect transiting exoplanets.

Build & Operation

The PANOPTES units are designed to be low-cost and easy to build with readily available off-the-shelf hardware. The units can be controlled remotely with fully automated operations, from checking the weather prior to each observation to uploading the captured images to the cloud for data processing. Once the raw images are pushed to the cloud, the PANOPTES data processing pipeline handles storing raw data, processing intermediate data and storing data products.

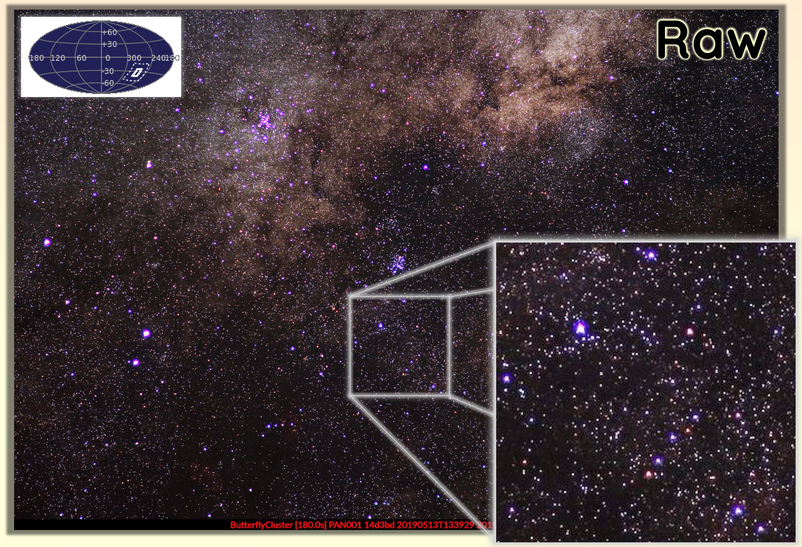


PANOPTES units under deployment at Mauna Loa Observatory, Hawaii

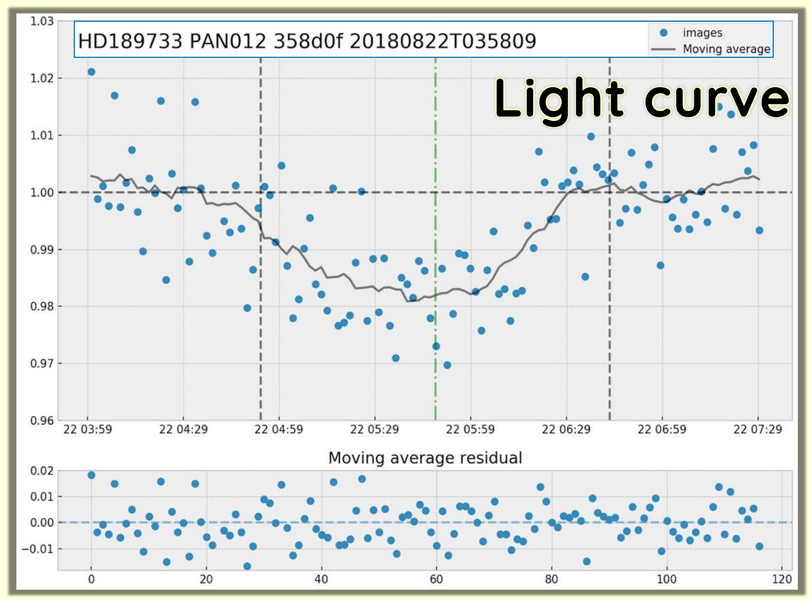
Data Collection

PANOPTES units use commercial Canon DSLR cameras with a medium telephoto lens to carry out wide-field imaging. A typical PANOPTES exposure time per image is 120 seconds taking around 27 images per hour per camera, which doubles to 54 images per hour for the 2 cameras on a unit. Each raw FITS frame has a size of ~20 megabytes. This translates to ~1 GB of raw image frames per hour per PANOPTES unit. The images are uploaded to Google Cloud Storage for permanent storage and follow-up data processing.

Data Processing:



A single exposure of 180s centered on the Butterfly cluster, taken by unit PAN001. PANOPTES will image ~100,000 stars simultaneously per frame of an observation. The magnified inset image shows the dense star field and the image quality.



Transit light curve of HD189733 taken by PANOPTES unit PAN012

Challenges

Since PANOPTES units carry out wide-field imaging, it allows PANOPTES to image a large area of the sky at a reduced precision to produce a catalog of candidate transiting exoplanets that would have the potential for follow-up studies with large telescopes for exoplanet characterization. However, DSLRs are not designed for traditional photometry and hence their Bayer arrays do not directly correspond to the standard astronomical filter bands. The real challenge is the complex interaction between Bayer color array and the star images, yielding large errors with conventional photometry approaches.

We have resolved this issue with a custom algorithm, now yielding percent-level photometric precision on individual frames.

Goals

We are currently working on creating a standard magnitude system for PANOPTES photometry, that will allow us to combine the light curves from different observations and from different units around the world, to produce a more continuous light curve. While the focus of Project PANOPTES is to find transiting exoplanets, the units can play a significant role in observing transient events, variable stars, comets, or be used for wide-field astrophotography.

One of our immediate goals is to create the standard magnitude system for PANOPTES photometry and upload our observations of variable stars and exoplanets to the AAVSO International Database and the AAVSO Exoplanet Database, respectively.

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As a citizen science project, we are always looking for volunteers to join us to take the project and its science goals forward.

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