The study of exoplanet transits is one of the most accessible ways of discovering life on distant worlds. By studying the spectroscopy of exoplanet atmospheres (something possible only when studying transits or direct detections) scientists can detect chemical signatures for Earth-like life on other planets. To this end, telescopes and new types of detectors have been tested for transient research. Small scale research has already begun, with new larger telescopes coming online in the next few years.

Current generation instruments are able to detect exoplanet transits in large numbers. Once these exoplanets have been identified, follow up measurements can be done to gather more information. With regards to extrasolar terrestrial life, the most important information gleaned from exoplanet transits is atmospheric information. Using primary and secondary transits [1] the spectroscopy of an exoplanet’s atmosphere can be obtained.

A new type of infrared (IR) detector has been tested for use in transient research. Indium Gallium Arsenide (InGaAs) detectors have a few advantages over the Mercury Cadmium Telluride (MerCad) detectors commonly used in IR astronomy. The IR detectors such as the one tested are of particular interest due to their mitigation of limb-darkening effects which plague optical transit work [2]. Many of the bio-signatures of life that can be detected in an exoplanet’s atmosphere are emitted in the IR [3]. The tested InGaAs detector can be mounted on an 18-inch Newtonian telescope and a 12-inch Cassegrain telescope. This configuration is ideal for quick follow-up of transient detections.

The 18-inch (and possibly an array of 18-inch telescopes) will be working with several new telescopes coming online within the next few years. The DDOTI (Deca-Degree Optical-Transient Imager) has been funded, with construction planned to be completed later in 2017 [4]. An IR counterpart, DIRTI (Degree InfraRed Transient Imager), has also been proposed.

Current Telescopes

The current telescopes available for testing and development are an 18-inch JMI telescope and a 12-inch Meade telescope. Both scopes are highly mobile, and so can be used for testing in the city for convenience, or at a dark site for improved data quality. The photometric performance of the InGaAs detector on both telescopes is plotted in Figure 3.

**18-inch JMI:**

The main telescope used for on-sky testing of the InGaAs camera was, an 18 inch Newtonian telescope, f/4.5, with a split ring, equatorial mount produced by JMI. Shown in Figure 2. The size of the InGaAs pixels when mounted on the 18-inch scope are 4 arcseconds per pixel; the entire FWHM of a star can fit within this pixel size, limiting the effects of pixel to pixel variations. The field of view of the camera on the 18-inch scope is about one-third of a degree (≈ 20 arcminutes). The InGaAs detector mounted on the 18-inch telescope can achieve a magnitude of 11.25 in 60 seconds at five sigma confidence levels.

**12-inch Meade:**

A secondary telescope used in testing the InGaAs detector was a 12-inch Meade, shown in Figure 2. This is an f/10 telescope, and can be used with a wedge to switch between ALT/AZ and equatorial mountings. The field of view is 2.7 arcseconds per pixel, with an entire field of view of about 35 arcminutes. Mounted on the 12-inch, the InGaAs detector can achieve a magnitude of 10.4 at 5 sigma in 60 seconds.

Next Generation Telescopes

DDOTI (Deca-Degree Optical-Transiant Imager)

The DDOTI observatory consists of 6.28m telescopes working together on a robotic mount, as shown in Figure 4. Together the scopes cover a sky area of 67 square degrees. DDOTI will reach a magnitude of 19 at a 5 sigma level in 60 seconds; it will be able to image the entire visible sky to this depth every three hours. These specs make DDOTI ideal for transient detection.

DIRTI (Degree InfraRed Transient Imager)

Initial plans with DIRTI involve upgrading DDOTI telescopes by mounting IR detectors in conjunction with optical devices using high efficiency dichroics. Following these preliminary results, a separate IR counterpart to DDOTI could be built.

Conclusions

- Current generation instruments are able to detect exoplanet transits.
- DDOTI, coming online this year, should be able to detect exoplanet transits in the optical at a high rate.
- Using a setup similar to the one in Figure 1, DDOTI or the proposed DIRTI, should be able to measure the spectra of exoplanet atmospheres.
- Bio-signatures in the spectra of exoplanet atmospheres could be the first evidence for life on a different world.
- Heavily funded telescopes coming online in the next few years, such as JWST and LSST, will greatly benefit from having operational follow-up telescopes such as DDOTI and DIRT.

References


Table 1: Additional Information for Collected Data

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Additional information for the data plotted in Figure 3.