New Stellar Science in Ground-Based Follow-up of TESS Data
Shared Skies Partnership: Universities of Louisville and Southern Queensland

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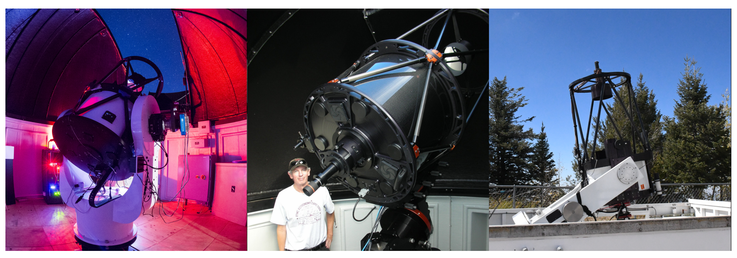
The Observatories

The University of Louisville and the University of Southern Queensland collaborate to provide assisted remote observing for research and student training. Founded in 2006, our Shared Skies Partnership offers unique opportunities for timely observations of extrasolar planet transits, stellar variability, and other transient events with facilities at Moore Observatory in Kentucky, Mt. Lemmon in Arizona, and Mt. Kent in Queensland.

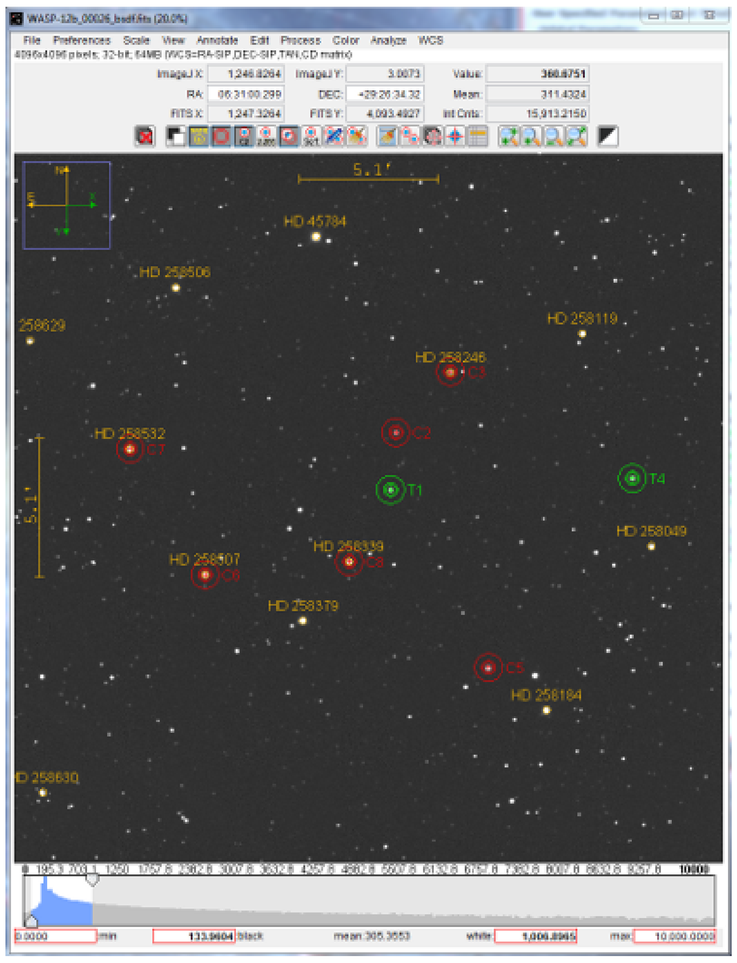
Moore MORC | CDK20N | Azari 20



Mt. Kent CDK700 | CDK20S | Mt. Lemmon ULMT

These 0.7, 0.6, and 0.5 meter telescopes typically have fields of view of 0.5° with sampling less 0.5″, and guiding on science images using precision on-axis encoders with cadences up to a few minutes. Precision tracking minimizes effects of differential pixel sensitivity and yields photometric precision limited by photon statistics. MORC, Azari, and ULMT are RC Optical Systems Ritchie-Chrétien telescopes. The others by Planewave Instruments have corrected Dall-Kirkham optics.

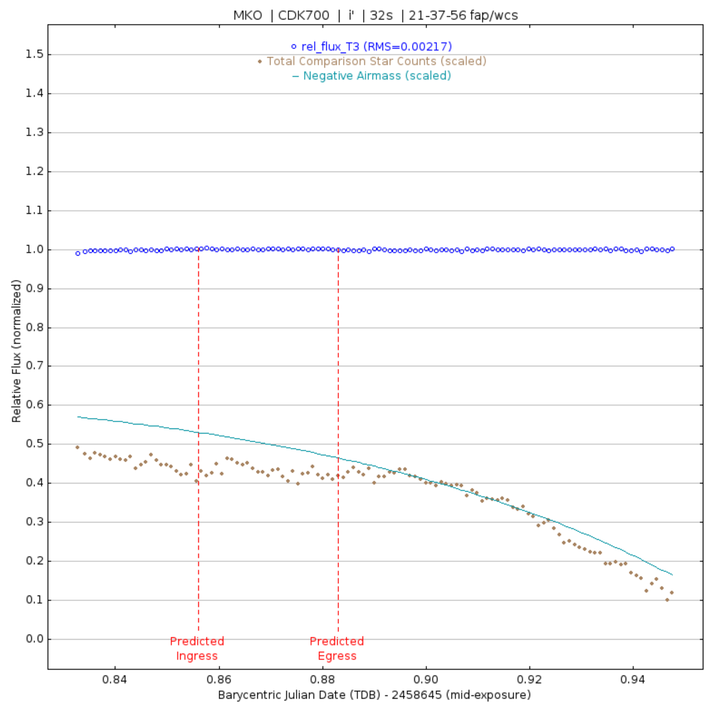
Software and Analysis



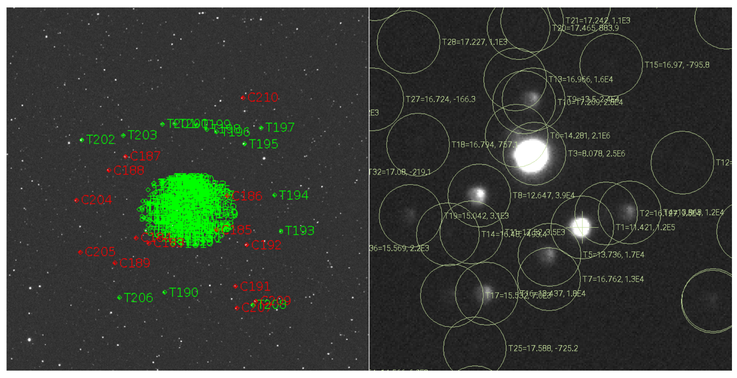
AstroImageJ
www.astro.louisville.edu/software/astroimagej

Multiprocessing and GPU cluster computing with Julia promises to enable fast complex analysis, while daily interactive processing is done with Python utilities to supplement AstroImageJ. See www.astro.louisville.edu/software/alsvid.

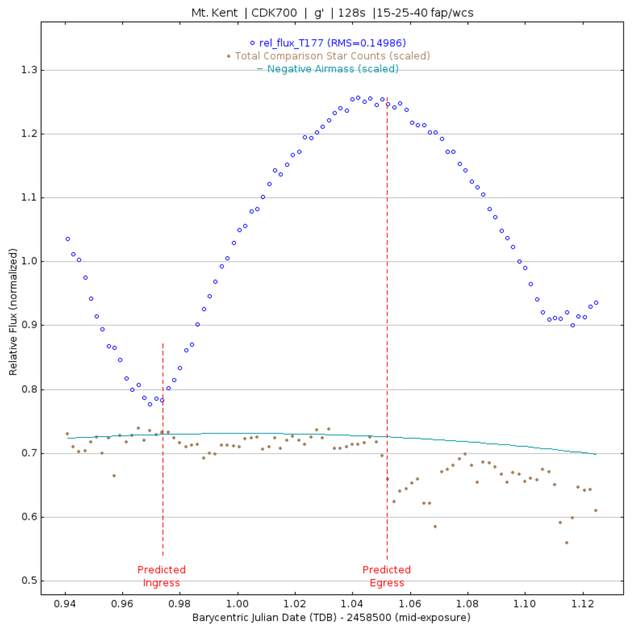
TESS Followup



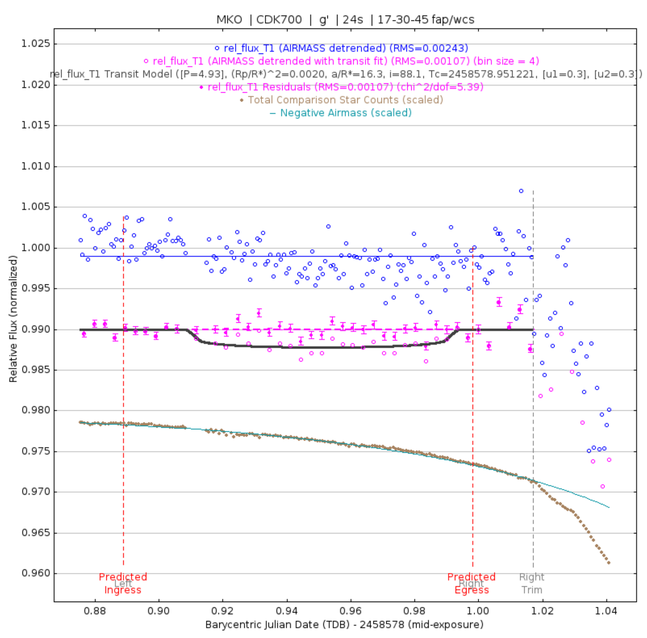
AstroImageJ offers monitoring of photometric quality and analyses of transits in progress so that data can be optimized in real time.



An on-line tool provides apertures for stars in the Gaia catalog that are within 2.5 arcminutes of the target and bright enough to mimic a transit signal if they are variable or eclipsing binary stars. See www.astro.louisville.edu/gaia$_{to}$aij.

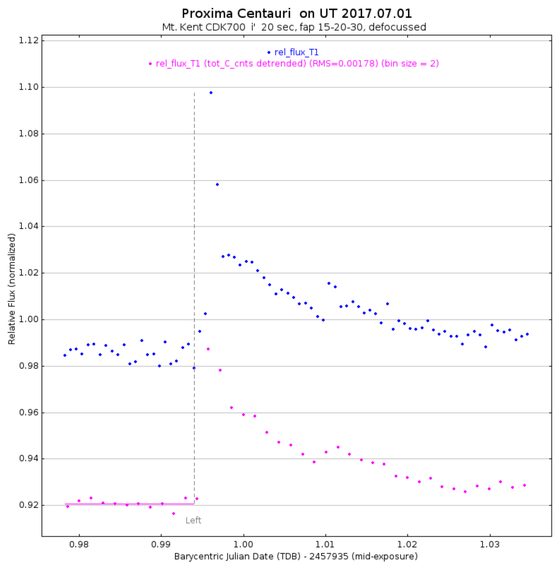


Ground-based followup can find nearby eclipsing binary stars, or confirm their absence, even when the target transit is shallow.

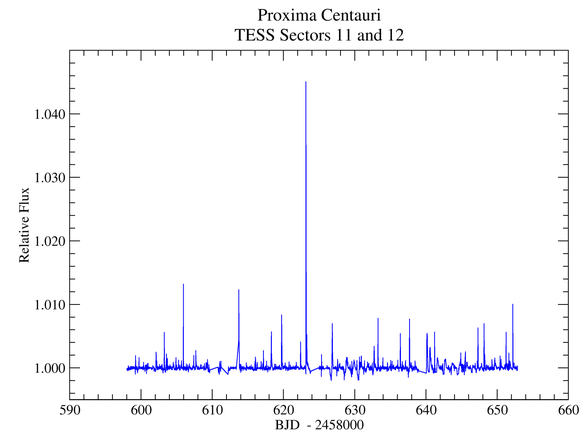


Transits deeper than 1 part per thousand may be fully or partially measured, confirming the event, improving the ephemeris, providing planet radius, and data on stellar granulation, spots, and limb darkening.

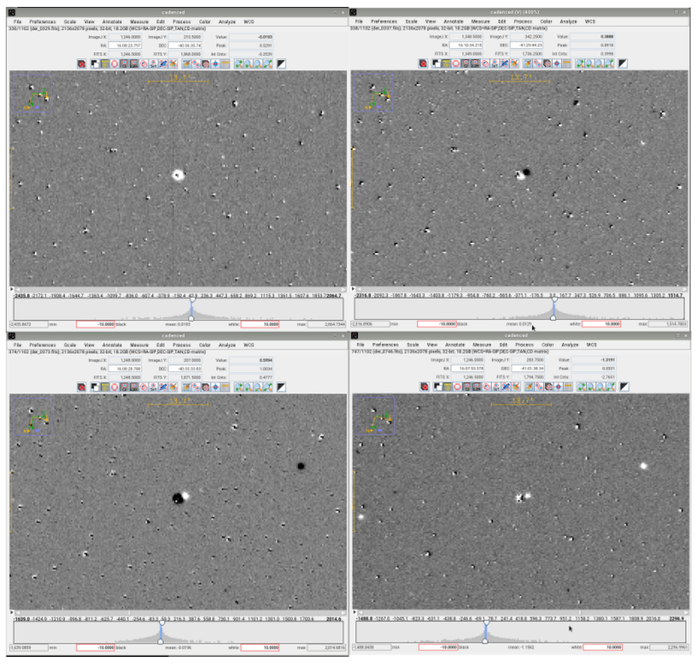
Stellar and Transient Events



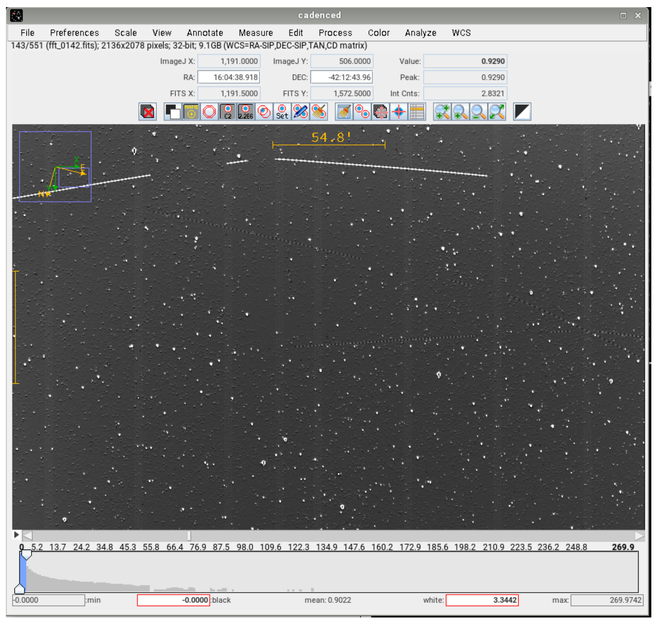
An exceptional flare on Proxima Centauri from the MKO CDK700 suggests the habitable zone there may not be so habitable after all. Flares and stellar activity inform of space weather affecting exoplanet atmospheres.



Frequent low-level flares from the full frame images are detected by photometry, and can be measured with multicolor ground-based observations as well.



Transient and periodic events are easily found using temporal derivatives of an image stack, and viewing the stack with AstroImageJ. The derivative removes the static components of the sequence, highlighting both temporal variations and spatial motion.



Alternatively, Fourier Transform processing visualizes temporal frequencies. Close to the ecliptic plane, asteroid tracks are revealed in Fourier slices such as this image, and their motions are evident in derivatives such as this video of sector 12, camera 1-1

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