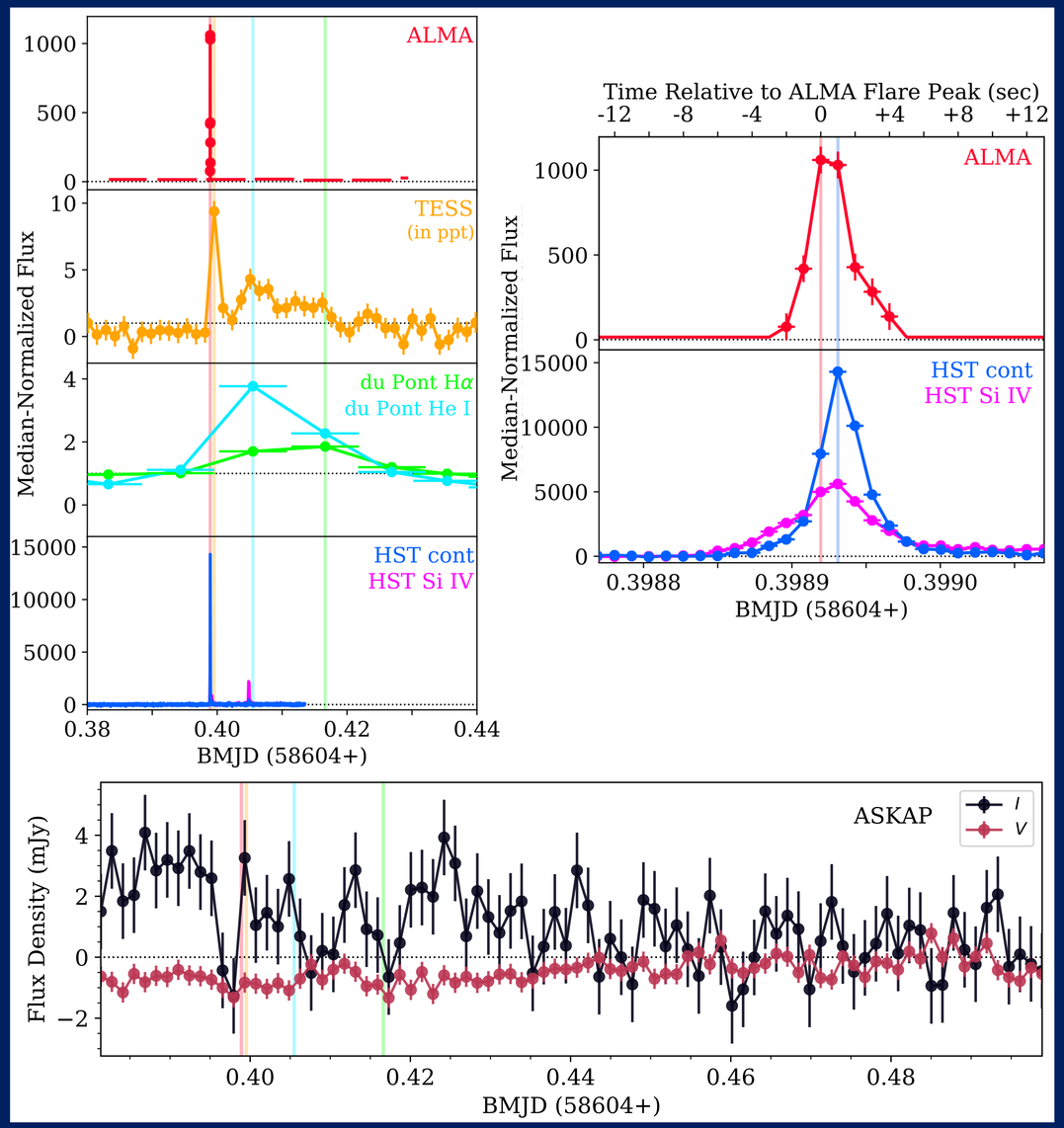
Discovery of an Extremely Short Duration 'Building Block' Flare from Proxima Centauri



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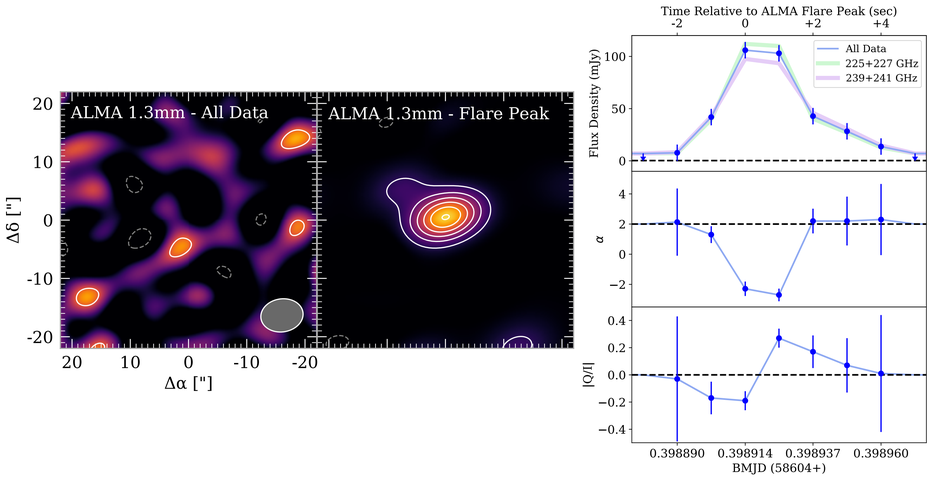
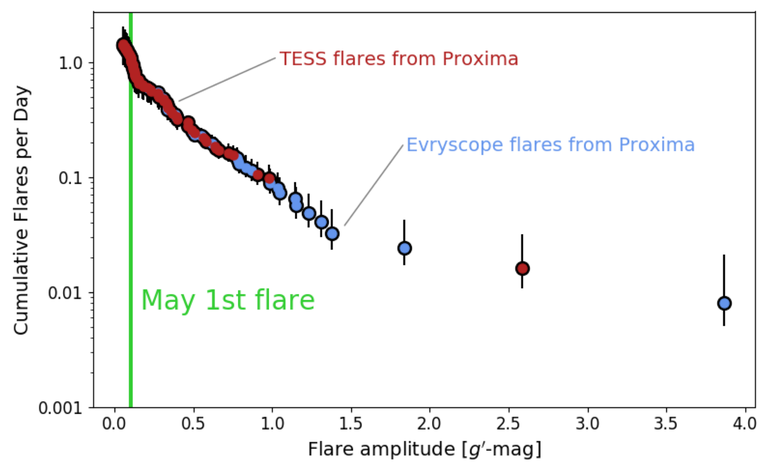
At a distance of only 1.3 pc, Proxima Cen is the closest exoplanetary system orbiting an M-type flare star, making it a benchmark case to explore the properties and potential effects of stellar activity on exoplanet atmospheres. Here, we present the discovery of an extreme flaring event from Proxima Cen by the Australian Square Kilometre Array Pathfinder (ASKAP), the Atacama Large Millimeter/submillimeter Array (ALMA), the Transiting Exoplanet Survey Satellite (TESS), the du Pont telescope at Las Campanas, and the Hubble Space Telescope (HST). In the millimeter and FUV, this flare is the brightest ever detected, brightening by a factor of >1000 and >14000 as seen by ALMA and HST, respectively. The millimeter and FUV continuum emission trace each other closely during the flare, suggesting that millimeter emission could serve as a proxy for FUV emission from stellar flares and become a powerful new tool to constrain the high-energy radiation environment of exoplanets. Optical emission is decoupled, peaking at a much lower level with a time delay. The extremely short duration of this event indicates that it could originate from a single flare loop or 'building block.' These are the first results from a larger campaign executed in April-July 2019 consisting of roughly 40 hours of simultaneous observations of Proxima Cen spanning radio to X-ray wavelengths.

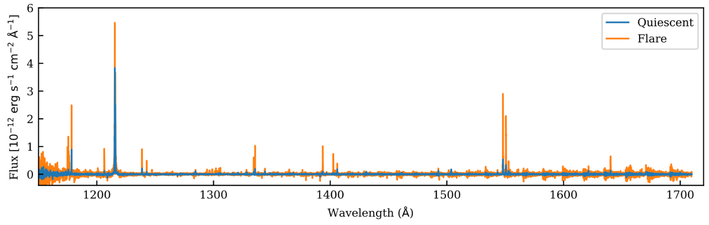


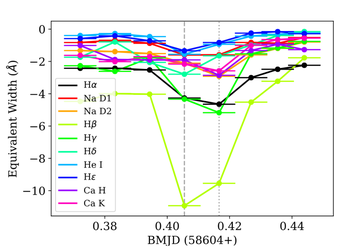
The spectral index (middle, α) and lower limit on the linear polarization fraction (bottom, |Q/I|) of the ALMA emission during this event are comparable to previously observed millimeter flares.

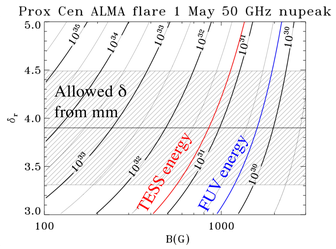
The flare is relatively weak in the optical when compared against all other stellar flares observed from Proxima by TESS and Evryscope.

Larger optical flares make up 75% of TESS and Evryscope observations. Flares of equal or greater energy and amplitude occur once per day in the optical.









Several strong FUV emission lines (i.e., C^{2+} and Si^{2+} ions) appear only during the flare.

Some optical lines peak later (i.e., Ca K and Hα).

The magnetic field strength in the radio-emitting source (B) can be constrained by the index of the accelerated particle distribution (δ_r) and the non-thermal energy in accelerated particles.