The biggest flares from the smallest stars with NGTS

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Abstract

We present results from searching for stellar flares on ultracool dwarfs with the Next Generation Transit Survey (NGTS). We show that while the maximum flare energy decreases with spectral type, late M stars such as TRAPPIST-1 can still have flare energies hundred times that of the Carrington event.

Stellar activity- who flares wins?

Stellar flares are explosive phenomena caused by reconnection events in the magnetic field of a star, which release energy from radio up to hard X-ray wavelengths. For nearby planets such as those in the "habitable" zone of ultracool dwarfs (e.g. TRAPPIST-1), the UV and X-ray irradiation released may cause ozone depletion and biological damage [1]. Alternatively, flares may be required to provide needed NUV flux for prebiotic chemistry and abiogenesis in these cool systems [2].

NGTS

We have used the full frame images of the Next Generation Transit Survey (NGTS) to constrain flare properties (e.g. energy) as a function of spectral type. NGTS consists of 12 telescopes with an instantaneous field of view of 96 square degrees [3]. It operates with a 13 second cadence and no set target list, allowing us to search for flares from both the brightest stars and those which only become detectable when flaring.

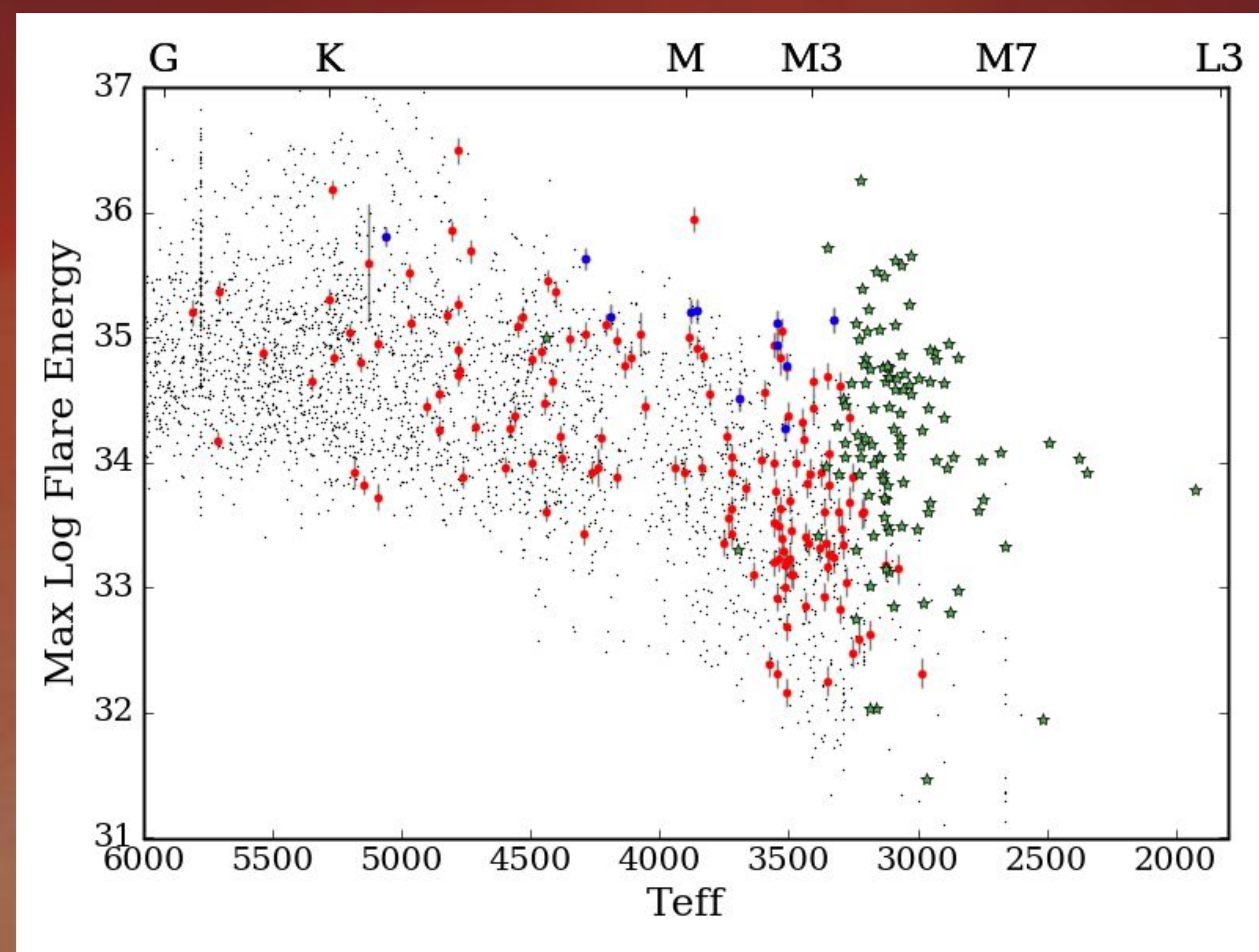

Figure 1. Maximum flare energy with effective temperature for flares detected in our survey. Equivalent spectral type is shown on the top. Red points indicate stars from the primary NGTS survey ($i' < 16$), green stars are those from our targeted survey. Blue points are stars associated with the Orion nebula (4 Myr in age). Underlying black points are stars from the *Kepler* long cadence sample, the energies of which were adjusted *a posteriori* [8].

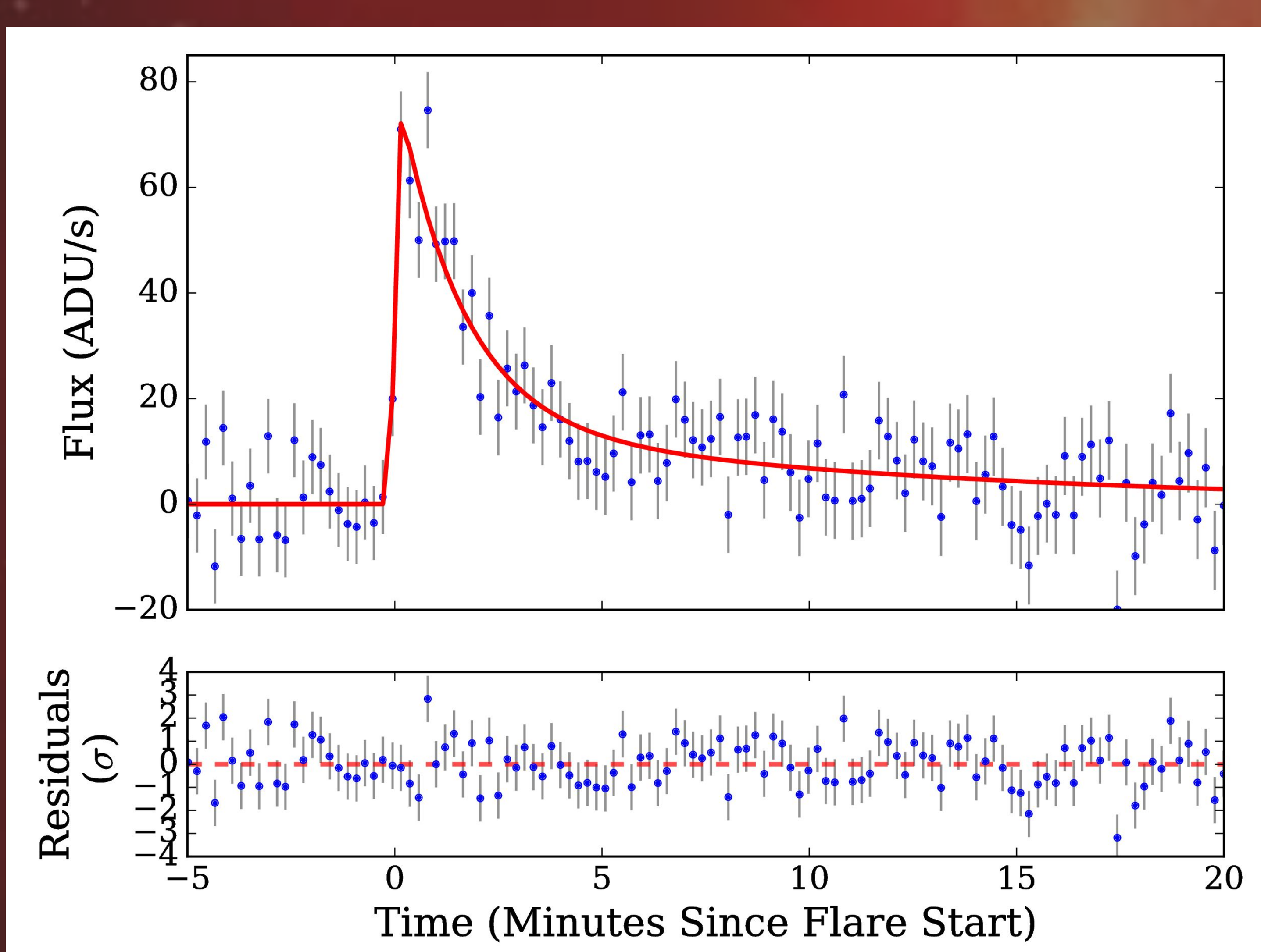

Figure 2. The flare detected from the L2.5 dwarf ULAS J224940.13-011236.9. This is the first white-light flare ever detected from an L2.5 dwarf and has an energy ten times that of the Carrington event - from a star the size of Jupiter.

Results

We have detected 754 flares from 445 stars with spectral types from G5 to L2.5. This range probes from Solar-type stars through the fully convective transition and down to the brown dwarf boundary [4], a region rarely probed in flare studies. Where possible we calculate the amplitude, duration and the energy of each flare, assuming a 9000K blackbody [5]. Figure 1 shows how the maximum flare energy of stars in our sample varies with spectral type.

Our results show that late M dwarfs can flare with energies hundreds to thousands of times that of the Carrington event [6]. At the surface of an Earth-sized planet around an ultracool dwarf, these events are the same as a million Carrington events. Flare amplitudes vary from the per cent level to several magnitudes, such as the $\Delta i' = 6$ ($\Delta V \sim 10$) flare detected from an L2.5 dwarf (Fig. 2), the smallest star to show a white light flare to date [7].

We are also currently using NGTS to investigate how flare properties (e.g. occurrence rates) vary as a function of age, by targeting open clusters and stellar associations. We are finding that, as expected, younger stars flare more often and with greater energies than their main sequence counterparts (see the Orion associated stars in Fig. 1).

References

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This work made use of the Starlink STILTS package, along with the Vizier catalog access tool.
The NGTS consortium comprises four UK universities (Warwick, Leicester, Belfast, Cambridge) with partner institutes in Germany (DLR, Berlin) and Switzerland (Geneva Observatory)
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