The EvryFlare survey: superflares, spots, and stellar rotation of the cool stars in Evryscope and TESS



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Key EvryFlare survey results

We search 4068 cool stars for flares in 2+ years of Evryscope photometry, focusing on stars with high-cadence data obtained by both Evryscope and TESS.



One night of Evryscope data

We detect 575 large flares from 284 cool stars. Of these, the largest increased the stellar brightness by 5.6 mag and released 10^{36.2} erg.

We observe a superflare from the triple M-dwarf system, LTT 1445. The system hosts the closest exoplanet transiting an M-dwarf¹.

Of the 1822 stars around which TESS may discover temperate rocky planets², we observe 14.6 \pm 2 % emit large flares.

References: [1] Winters et al. (2019), Accepted in AJ, arXiv:1906.10147v2 [2] Kaltenegger et al. (2019), ApJ, 874L, 8K

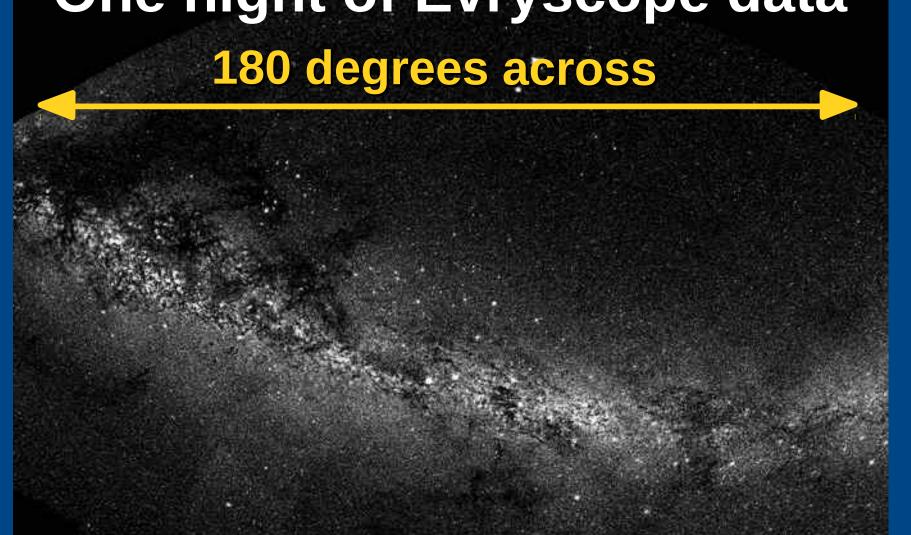
Twenty-two 60mm telescopes

First gigapixel all-sky survey

13 arcseconds / pixel resolution

8000 square-degree field-of-view

Long-term, high-cadence monitoring of millions of stars simultaneously



EvryFlare I (arXiv:1904.10421v2, in press 🗱), EvryFlare II (arXiv:1907.10735, submitted 🗱



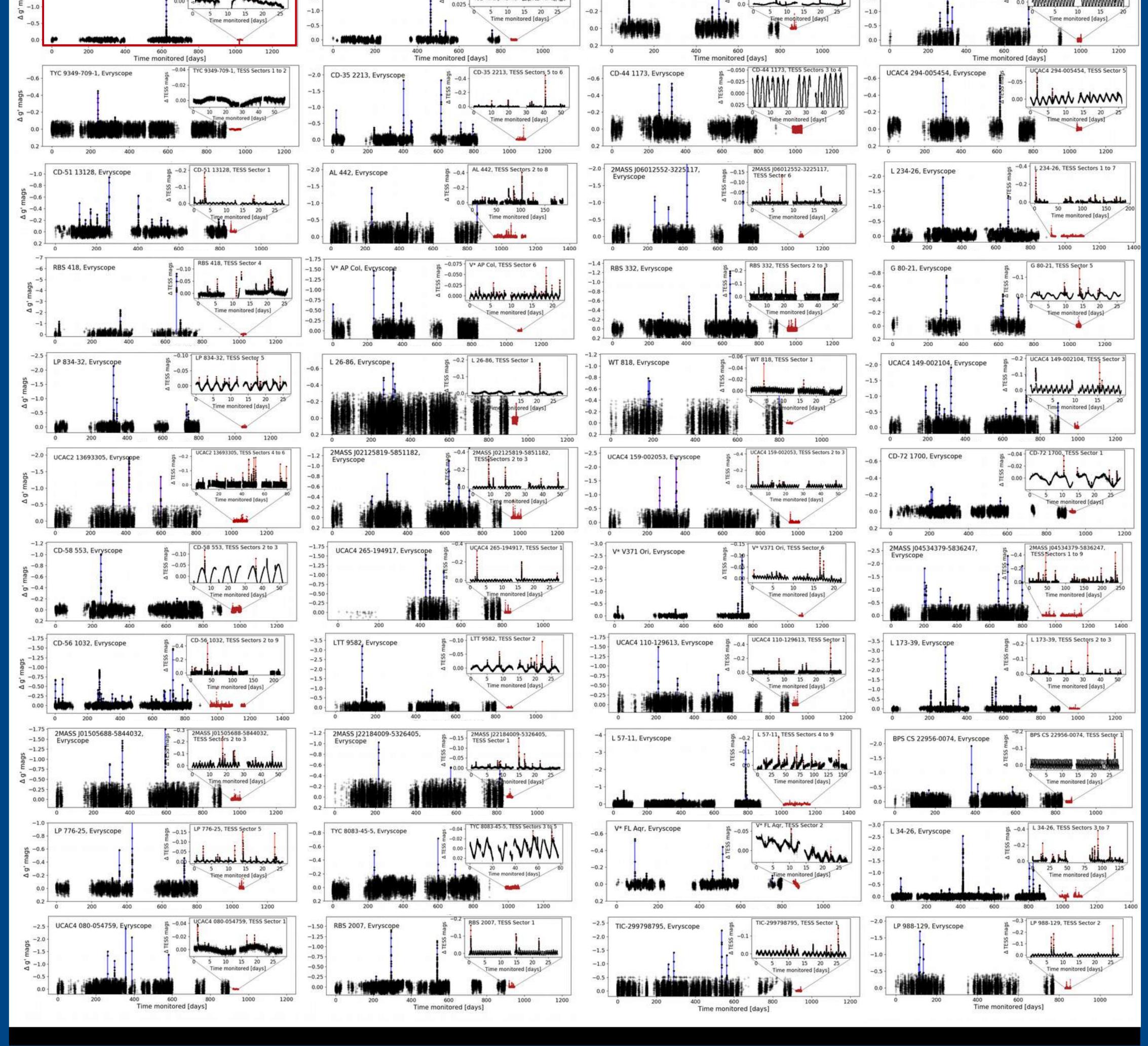
All stellar flare and stellar rotation data in the EvryFlare paper series is available in machine-readable form. Raw Evryscope light curves are usually available by request.

Flares in Evryscope and TESS light curves of 284 cool stars

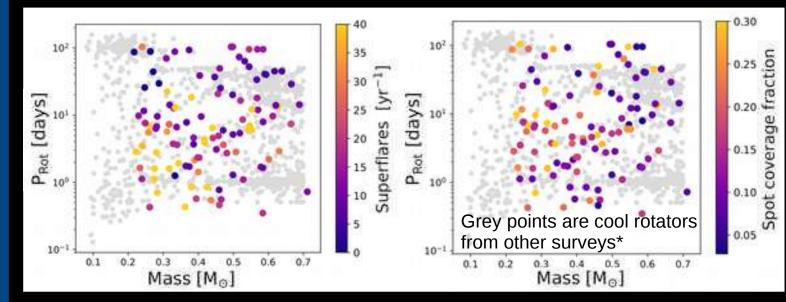
Evryscope and inset TESS light curve of each flare star for a subset of 44 out of 284 stars. While several sectors of TESS observations capture frequent flares of lower energy, long-term Evryscope observations capture the rare, high-energy flares.

-2.0 LTT 1445 (TOI 455), Evryscope	-0.04 [LTT 1445 (TOI 455), TESS Sector 4]	-2.5 V* HK Aqr, Evryscope	m -0.050 V* HK Aqr, TESS Sector 2	G 273-59, Evryscope	g =0.2 G 273-59, TESS Sector 2	-2.5 Barta 161 12, Evryscope	딹 -0.2 Barta 161 12, TESS Sector 3
s −1.5 ·	-0.02 - 50 - 50 - 50 - 50 - 50 - 50 - 50 -	-2.0 -	© -0.025 0.000	-0.4	е SS -0.1-	-2.0	

	EVRYSC	E OSS	
Aperture	61mm	105mm	
Precision @ 10 th -mag	5 mmag / hr	0.2 mmag / hr	
Precision @ 16 th -mag	3% / hr	1% / hr	
Pixel sampling	I 3"/pix	21"/pix	
FoV	8000 sq. deg. (12000 sq. deg. / night)	2300 sq. deg.	
Survey length	5+ years	27 days (most of sky)	
Cadence	2 mins	15-30 mins (much faster for selected targets)	
Filter	Blue	Red	



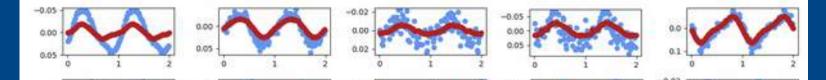
Activity & rotation of 113 flare stars during spin-down

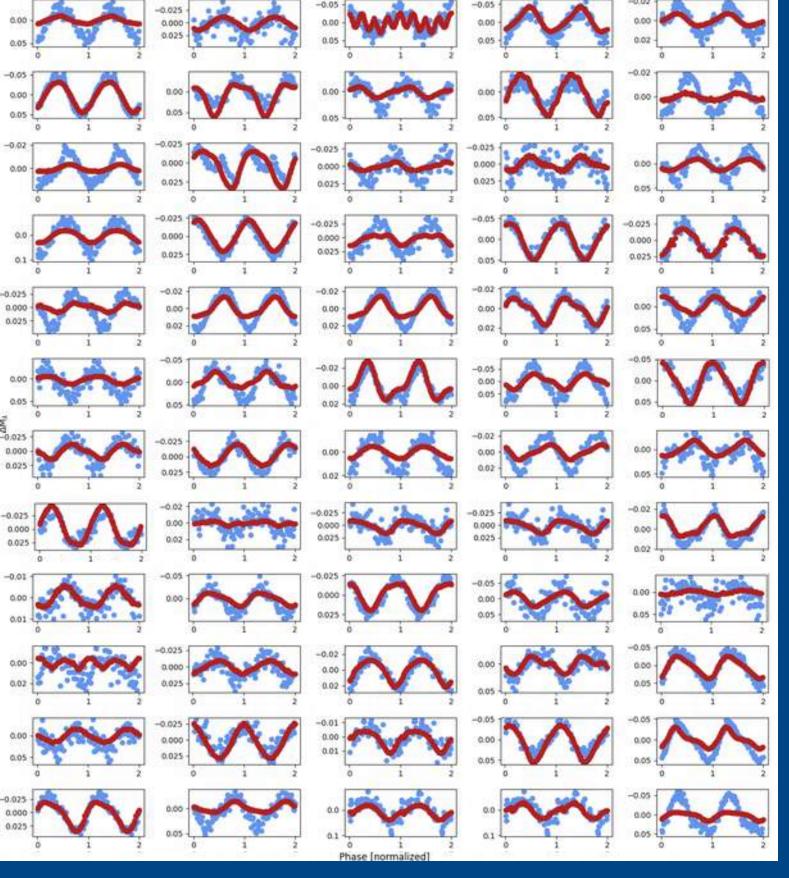


Rotation periods detected in the Evryscope light curves of 113 active cool stars.

Increased starspot coverage and superflare rate for low mass & short period rotators.

NTESS light curves in the red are folded to **Evryscope-detected periods. Phase-folded** & binned Evryscope light curves in the blue:





We acknowledge support of this work under the NASA NNH18ZDA001N-XRP grant 80NSSC19K0290. This work includes data collected by the TESS mission. Funding for the TESS mission is provided by the NASA Explorer Program. | Bottom right panel: * grey points are rotation periods of cool stars from the MEarth and KELT surveys. MEarth rotators are from Newton et al. (2016), ApJ, 821, 93 and Newton et al. (2018), AJ, 156, 217. KELT rotators are from Oelkers et al. (2018), AJ, 155, 39.