

# 2XMM Cool-Star Variability Survey: the 2XMM/Tycho Sample



John Pye, Duncan Fyfe, Simon Rosen, Anja Schröder  
Department of Physics & Astronomy, University of Leicester, United Kingdom

We have used the XMM-Newton 2XMM Serendipitous Source Catalogue to search for flare events from cool (spectral type F – M) stars in the Tycho (Hipparcos) catalogue. We have so far found 37 stars with flares (a total of 85 flare events, from the 2XMMp subset); of these stars 24 are the target of the XMM observation and 13 are serendipitous observations. We present examples of the serendipitous discoveries – most of these are previously little-studied objects – and the distributions of measured flare parameters.

**2XMM on the Web**  
<http://xmmssc-www.star.le.ac.uk/>  
<http://xmm.esac.esa.int/xsa/>  
<http://www.ledas.ac.uk/>

Note. All results are over the full energy band of the 2XMM timeseries, i.e. ~0.2 – 12 keV.

## Statistics

**Key Information**

- Tycho catalogue: ~2.5 million stars,  $V < 13$
- Tycho stars in 2XMMp: ~2000
- Number with lightcurves: ~500
  - Number indicated as X-ray variable: ~80
    - Number with obvious flares: 37 (85 flares)
    - Number which are XMM observation target: 24 (65 flares)
    - Number which are serendipitous 2XMM sources: 13 (20 flares)
      - **Little optical or previous X-ray data for most of these stars**

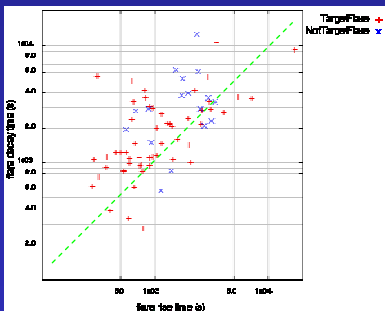
2XMMp → 2XMM: increase in number of stars by factor ~1.5

- Observed %age flaring time ~8% & 1% for the serendipitous and target subsets respectively.
- Observed flare frequency ~600/yr & ~60/yr.

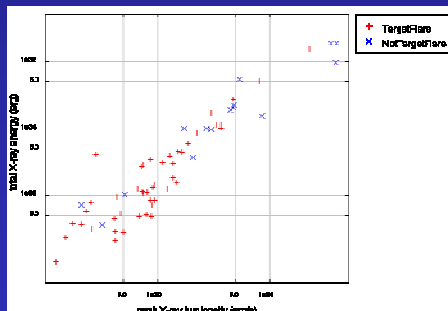
NB. These are 'raw' numbers – there are many corrections to be applied, e.g. the observation of several 'large' flares from the serendipitous subset and none from the target subset, may simply be a bias effect due to ~3 times longer total exposure for the serendipitous subset.

The target objects are dominated by well known active stars such as RS CVn-type binaries, dMe stars and T Tau-type stars.

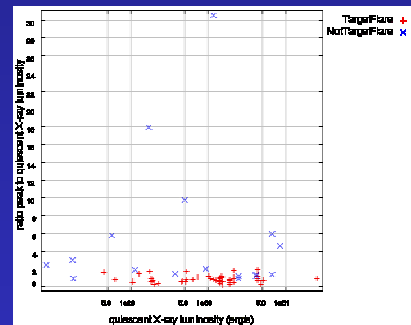
Blue: serendipitous stars    Red: target stars



Flare decay time vs. rise time (s) (peak to 1/e in both cases).

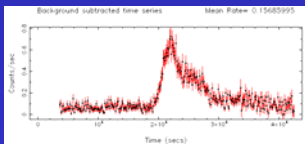


Total X-ray flare energy (erg) vs. peak X-ray luminosity (erg/s).

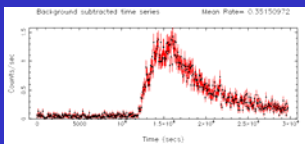


Ratio of flare peak to quiescent X-ray luminosity vs. quiescent X-ray luminosity (erg/s).

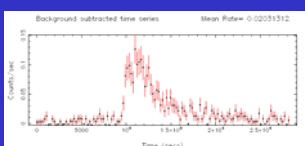
## Examples of Serendipitous Detections (i.e. not the target of the XMM observation)



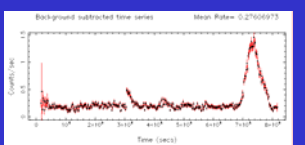
**HD 14716**,  $V=9.5$ , F5V. X-ray lightcurve – XMM EPIC PN. Five other XMM observations totalling ~60 ks show X-ray emission at ~the quiescent level of the illustrated lightcurve.



**2MASS 23163068+7905362 = 1RXS J231628.7+790531**,  $V=11.2$ , B-V~0.8. X-ray lightcurve – XMM EPIC MOS1.



**2MASS 16505100-6859165**,  $V=11.8$ , B-V~0.9. X-ray lightcurve – XMM EPIC MOS1. Four other XMM observations totalling ~50 ks show X-ray emission at ~the quiescent level of the illustrated lightcurve.

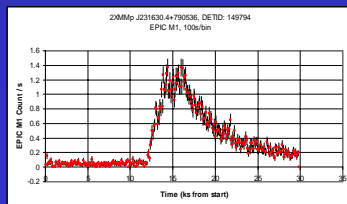


**2MASS 04072181-1210033**,  $V=11.7$ , B-V~0.5. X-ray lightcurve – XMM EPIC PN. A second, ~80ks observation ~2 days later, showed lower-level flare-like variability.

There is very little published information for most of these stars.

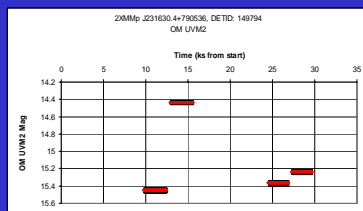
**End Goals include...**

- A catalogue of 2XMM stellar flares
- Stellar flaring statistics
- Search for 'super-flares' from 'solar-type' stars



**2MASS 23163068+7905362 = 1RXS J231628.7+790531**,  $V=11.2$ , B-V~0.8.

X-ray lightcurve – XMM EPIC MOS1



UV lightcurve – XMM OM UVM2 filter