Stellar Flares Detected By NGTS

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Conference Abstract

Stellar flares are explosive events on the surface of stars, believed to be due to the release of magnetic energy in magnetic reconnection events [1]. These events are marked with a sudden increase of flux emission, followed by a gradual decay. This increase in flux takes place across a wide range of wavelengths, from radio to X-ray [2]. In particular there is a strong increase in UV emission. This UV emission can have damaging effects on nearby exoplanets, in particular on their atmospheres. Studies from [3] and [4] have shown the UV irradiation associated with a single large stellar flare from AD Leo, for an Earth-like planet, could deplete the ozone layer and irreversibly alter atmospheric chemical abundances. Further flares within a short timescale could then allow sudden UV irradiation to reach the planetary surface.

Previous works have found that K and M stars will flare with greater relative amplitudes compared to those of earlier spectral type [5], with flare behaviour also changing within spectral types [6]. It is these spectral types that are of current interest to exoplanet astronomers, particularly with the recent discoveries of LHS 1140b, a super-Earth in the habitable zone of an M4.5V star [7] and of the 7 Earth sized planets in the TRAPPIST-1 system [8]. We now know it is possible for Earth sized planets to exist close in such proximity to their host star, however this proximity can also increase their chance of flare impact. Due to the aforementioned effects of large stellar flares on an Earth-like planet, knowledge of the flare properties is required to aid in determining the habitability of such systems.

The Next Generation Transit Survey (NGTS) is a wide-field survey designed to detect Neptune-sized exoplanets around bright ($I \leq 16$) K and M stars [9]. It consists of 12 telescopes located at the ESO Paranal Observatory in Chile which together have a total field of view of 96 square degrees. Each camera has an exposure time of 10 seconds, enabling fast observations of stars across the southern sky for 100s of hours during a full season. Our bandpass of 550-900nm is designed to focus on K and M stars, due to the increased amplitudes of transit signals from these low mass systems. Consequently, NGTS has the capabilities to monitor lightcurves in high cadence for hundreds of thousands of stars, making it ideal for detecting and characterising the morphology of stellar flares.

In this talk I will present results from our search for stellar flares in the NGTS datasets. I will initially present NGTS, discussing its aims, current achievements and why it is well suited for studies of stellar flares. I will then proceed to discuss the methods used to detect and confirm flares on 11 fields of data, along with details of the over 330 flares we have found in the process. These flares are from over 180 stars, ranging from G8V to M5V, including over 30 from K stars. All these flares have been temporally resolved beyond that of the *Kepler* short cadence [10], enabling detection of the flare rise and detailed substructure. For these detected flares, where possible we calculate flare parameters such as bolometric energy, flare duration and fractional amplitude. We can then compare these flare parameters to stellar parameters, to search for relations. Of note is the maximum flare energy against stellar colour, shown in Figure 1. With this knowledge, we can obtain empirical lower limits of the maximum energy expected to be output from a stellar flare for a chosen star. Studies of the flare duration will also allow modellers to know how long an exoplanet could be in the vicinity of such a flare, another thing NGTS is capable of. Along with these results I will present examples from the NGTS dataset of our most active stars and what could happen to hypothetical exoplanets orbiting them – from their magnetosphere to their surface. An example of such a system HD41362C, of which we have detected 23 flares. A mixture of simple and complex events, the largest of which has an lower energy limit of 4×10^{34} erg – over 100x larger than the largest event seen from the Sun, the Carrington Event. This flare is shown in Figure 2 and also shows the capabilities of the high cadence of NGTS in resolving significant substructure, along with potential habitability-affecting flares. For these stars we can also determine how often flares are expected, contributing to results from previous studies. Along with the effects of a stellar flare on an exoplanet I will also discuss whether, for our case study stars, their vulnerability of the exoplanet atmosphere to multiple flare events. Finally I will detail how we intend to make our findings available to the public.

References

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Short Summary

The Next Generation Transit Survey (NGTS) is a transiting exoplanet survey, searching for Neptune-sized exoplanets around bright K and M stars. In this talk I will present the detection of stellar flares in the NGTS dataset, along with their effects on exoplanet habitability.