Stars and their variability observed from space
C. Neiner, W. W. Weiss, D. Baade, R. E. Griffin, C. C. Lovekin, A. F. J. Moffat (eds)

THE INFLUENCE OF STELLAR X-RAY AND UV RADIATION ON EXOPLANETS

S.R.G. Joyce[1], J.P. Pye[1], J.D. Nichols[1] and The Exoplanets-A consortium[2]

Abstract. The Exoplanets-A project is a collaboration comprised of 7 institutions in Europe to study exoplanets and their host stars. The project aims to develop new tools for modelling exoplanet atmospheres. Itk includes improving our understanding of the stellar radiation environment through gathering observations and creating models of stellar atmospheres. Variability of stellar XUV radiation on short (days) to long (Gyr) time-scales can have a profound influence on the evolution and potential habitability of orbiting exoplanets. Data, models and software developed during the project will be made publicly available to aid the next stages of exoplanet research with JWST and beyond.

Keywords: X-rays:stars, Ultraviolet:stars, Planet–star interactions

1 Introduction

We have identified 113 stars known to have transiting exoplanets, and which have been observed with HST and/or Spitzer. Many of these stars are prime candidates for additional transit spectroscopy, providing detailed characterisation of the exoplanet atmosphere. Atmospheric modelling requires knowledge of the host-star spectrum, in particular the high-energy XUV which can influence the planetary atmosphere's temperature, structure and composition. For example, some hot-Jupiters show evidence of rapid atmospheric evaporation caused by intense X-ray irradiation (e.g. Lalitha et al. 2018). As a first step we have identified existing X-ray and UV data available for 113 stars from HST, XMM-Newton, Galex, Swift and other X-ray/UV observatories (Fig. 1). These data will be combined with new analyses to construct a database of the XUV properties of transiting exoplanet host stars (Pye et al. 2019).

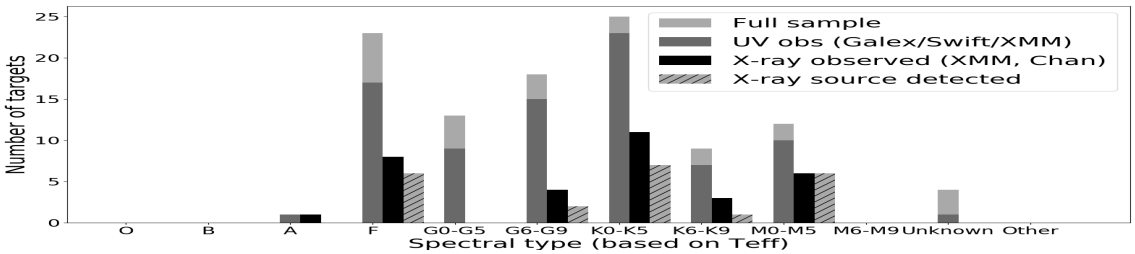

Fig. 1. The spectral type distribution of the 113 stars in the sample. Light grey indicates the total number of stars in each spectral-type range. A total of 94 stars, or 83% of the sample, have existing UV data (dark grey). 38 have been observed by X-ray satellites (black), resulting in 24 positive detections (striped bars).

2 X-ray and UV radiation from host stars

Individual measurements of a star's X-ray and UV luminosity are useful for estimating the flux received by its planets. However, the intrinsic variability of phenomena which produce XUV radiation, such as flares, and the

[1] School of Physics and Astronomy, University of Leicester, Leicester, UK
[2] Exoplanet Atmosphere New Emission Transmission Spectra Analysis : CEA Saclay, Paris, France; CAB-INTA, Madrid, Spain; MPIA, Heidelberg, Germany; University College London, U.K.; University of Leicester, U.K.; SRON, Utrecht, NL; Universitat Wien, Austria.

longer term changes due to active-region evolution and possible activity cycles, limit the usefulness of a single measurement. If a flare occurred during the observation it could increase the measured luminosity significantly. A number of planet-hosting stars have been observed multiple times by Galex, Swift (UVOT) and XMM (Optical Monitor) at UV wavelengths (Fig. 2). Similarly, multiple observations exist at X-ray wavelengths from XMM, Rosat, Chandra and other observatories. Compiling these observations will make it possible to estimate variability over approximately 2 decades. Repeated measurements also help to establish the average luminosity of a star, highlighting those observations which may have been affected by flaring activity. Estimating the frequency of flares for stars of different spectral types and ages is also important for taking into account the effects these high energy events may have on planets.

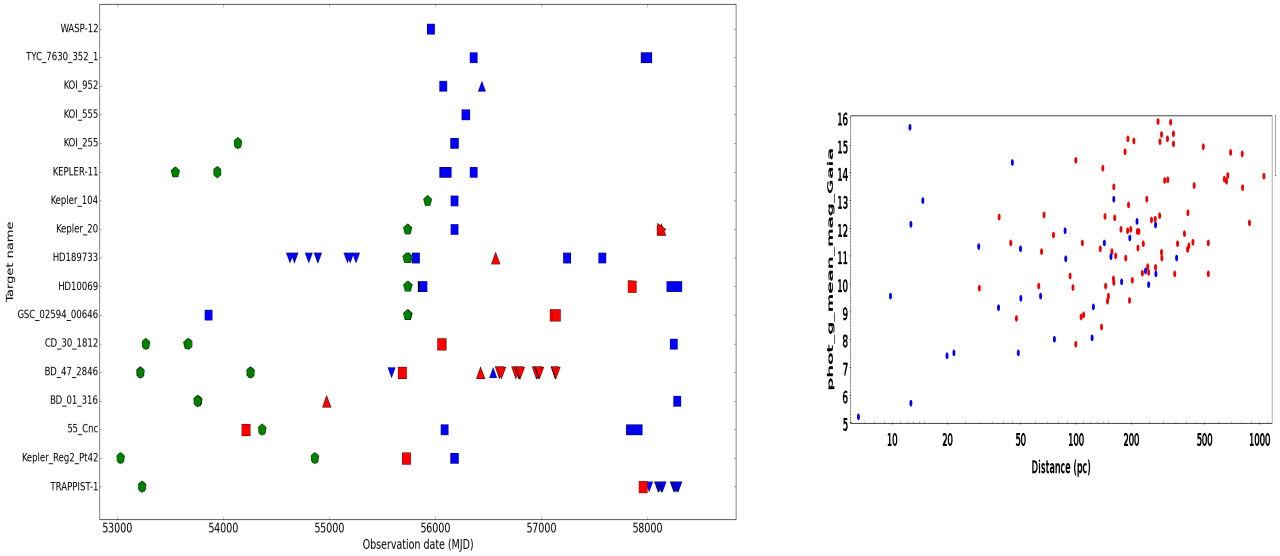

Fig. 2. Left: Timeline of UV observations covering approximately 20 years. Some stars have been observed by Galex (green), Swift UVOT (blue) and the XMM-Newton optical monitor (red), producing in total a longer timeline than any single observatory. **Right:** The distribution of the 113 host stars according to *Gaiag* magnitude (optical) and distance. Targets with available X-ray data are highlighted in blue.

The combination of detailed characterisation of host stars, together with analyses of existing and upcoming transit spectroscopy of the exoplanet atmospheres, will make it possible to investigate the links between stellar activity and the evolution of planetary atmospheres. Many questions remain about the early formation of planets which takes place when young stars are at their most active magnetically. Data gathered by this project will be made available online, providing a valuable database for use in investigations of the evolution of stars, planets and the influences that stars have on habitability.

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