ÖAW — AUSTRIAN ACADEMY OF SCIENCES

STELLAR ACTIVITY PARAMETER AS A PROXY FOR STELLAR EXTREME UV FLUXES

A. G. Sreejith[1], L. Fossati[1], A. Youngblood[2], K. France[2], S. Ambily[2]
[1]IWF/ÖAW, Austria; [2]LASP/CU Boulder, Colorado, USA

Atmospheric escape is an important factor shaping the exoplanet population and hence drives our understanding of planet formation. Atmospheric escape from giant planets is driven primarily by the stellar X-ray and extreme-ultraviolet (EUV) radiation. EUV and longer wavelength UV radiation also power disequilibrium chemistry in the middle and upper atmosphere of exoplanets. Hence our knowledge of stellar UV fluxes play a vital role in the understanding of atmospheric escape and chemistry. While the far-ultraviolet fluxes can be observed for some stars, most of the EUV range is unobservable due to the lack of a space telescope with EUV capabilities and, for the more distant stars, to interstellar medium absorption. Thus, it becomes essential to have indirect means for inferring EUV fluxes from features observable at other wavelengths. We present here analytic functions for predicting the EUV emission of F-, G-, K-, and M-type stars from the log R'_{HK} activity parameter that is commonly obtained from ground-based optical observations of the CaII H&K lines. The scaling relations are based on a collection of about 100 nearby stars with published log R'_{HK} and EUV flux values, where the latter are either direct measurements or inferences from high-quality far-ultraviolet (FUV) spectra. The scaling relations presented here return EUV flux values with an accuracy of about three, which is slightly lower than that of other similar methods based on FUV or X-ray measurements.

We present here an analytic functions for predicting the EUV emission of F-, G-, K-, and M-type stars from the log R'_{HK} activity parameter allowing one to infer in a simple, direct way the EUV emission of a large number of late-type stars without the need for high-quality space-based observations.

The work is based on initial stellar sample from *France et al 2018*. We have updated distance and temperatures based on new measurements from GAIA observations. The stellar radius is also updated based on these new observations.

The EUV fluxes are based on scaling relations in *France et al 2018* when actual EUV observations from IUE are not available.

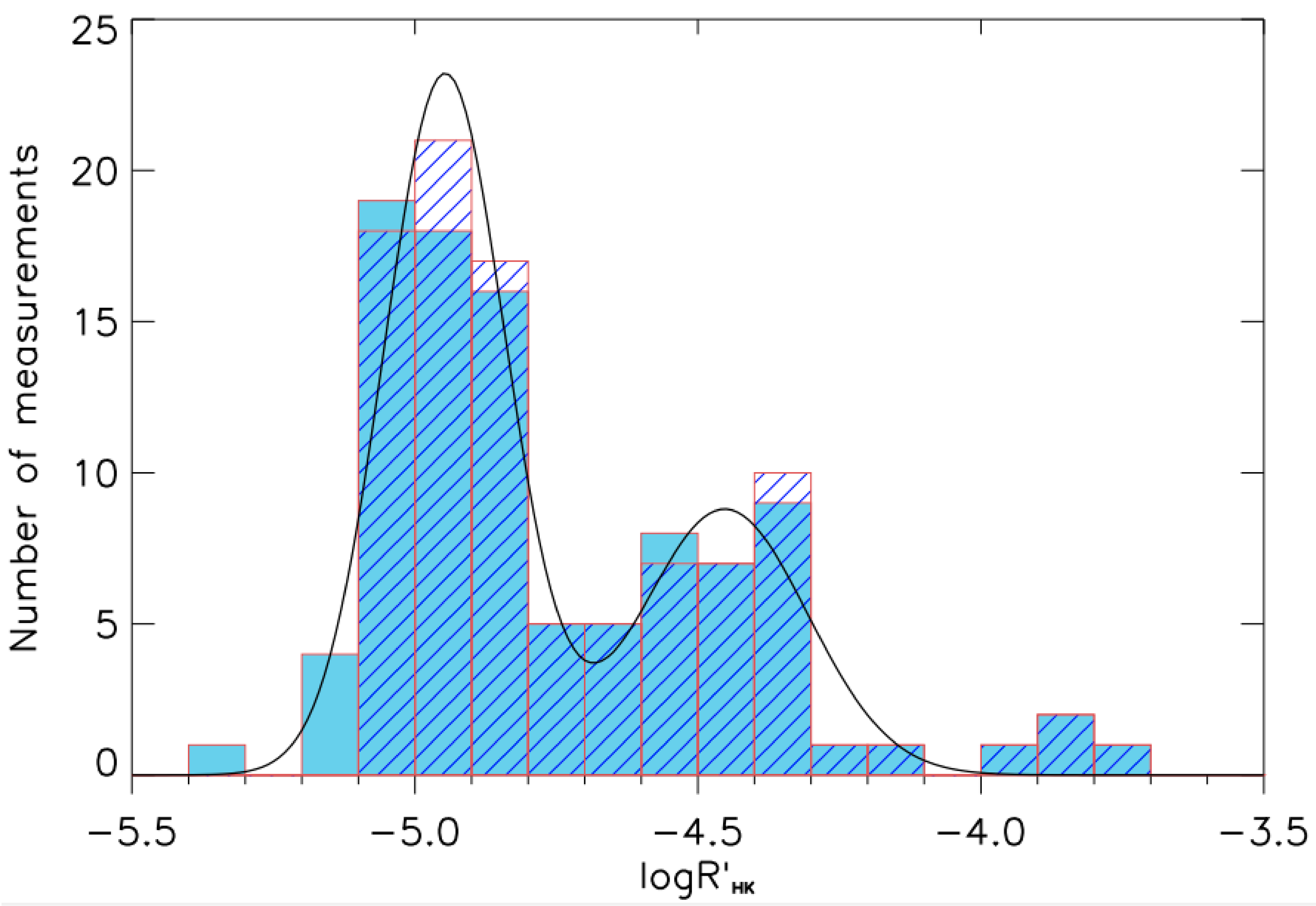

Figure 1. Distribution of the median log R'HK values for all stars considered in our work before outlier removal (blue shaded; 99 stars) and after (hatched; 96 stars),

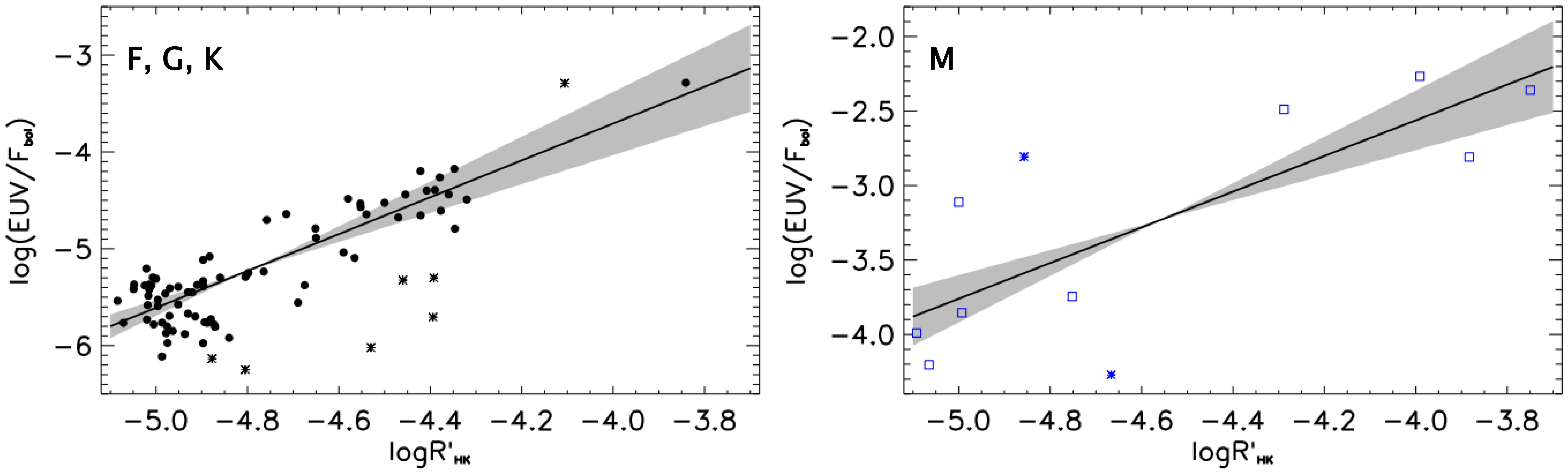

Figure 2. Correlation between the stellar activity index and EUV flux for F-, G-, K-type stars (left; black dots) and M-type stars (right; open blue squares). The RMS on log(EUV/Fbol) after the fit for F-, G-, and K-type stars and for M-type stars is 0.40 and 0.48, respectively. The stars removed as a result of the sigma clipping are indicated by the asterisks. The grey areas indicate the uncertainties on the fits.

ANALYTICAL RELATION

We find that the correlation between the stellar activity index (log R'_{HK}) and the EUV flux in the 90–911 Å wavelength range can be described by a linear fit of the form

$$\log_{10}\left(\frac{\mathrm{EUV}(90-911\text{Å})}{\mathrm{F_{bol}}}\right) = C_1 \times \log R'_{HK} + C_2$$

where the c_1 and c_2 coefficients are listed in the Table. We further compute the Pearson correlation coefficients (PCC) for log R'_{HK} vs log(EUV /F_{bol}), obtaining that the linear correlations are indeed significant.

Sp. Type	C1	C2	RMS	PCC
F, G, K	1.90 ± 0.41	3.90 ± 1.96	0.40	0.8748
M	1.20 ± 0.36	2.23 ± 1.64	0.48	0.8753

These results indicate also that our scaling relations provide EUV fluxes with an accuracy of about a factor of three, which is slightly higher than that of other similar methods based on FUV or X-ray measurements and can be therefore used to estimate wavelength-integrated stellar EUV fluxes for stars for which X-ray or FUV observations are either not available or not possible, hence enabling one to more accurately study, for example, the upper atmospheres of planets orbiting late-type stars and their interaction with the host star.

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IWF — SPACE RESEARCH INSTITUTE, SREEJITH.AICKARA@OEAW.AC.AT

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