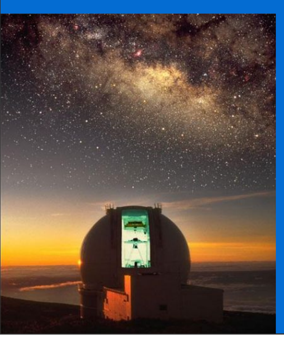
Exploring Exoplanet Neighbourhoods:

Implementing a Bright Star mode for use in the WEAVE-twilight survey



T. Hajnik [1,*], N. A. Walton [1], D. Terrett [3], S. Hughes [1], S. Pico [2], D. Murphy [1] and G. Dalton [3]

[1] Institute of Astronomy, University of Cambridge; [2] Isaac Newton Group, Santa Cruz de La Palma; [3] Department of Physics, University of Oxford
* th721@ast.cam.ac.uk

Chemical characterisation of exoplanet host stars provides valuable insights into planetary systems. Current spectroscopic surveys (e.g. APOGEE) often overlook stars brighter than V ~11 mag to focus on fainter targets, aiming to maximise multiplex efficiency. However, **PLATO** is set to discover thousands of new planet hosts at these brighter magnitudes (*Matuszewski+, 2023*), underscoring the importance of observing bright stars for comprehensive exoplanet host coverage. We propose using **WEAVE** for a cutting-edge, high precision spectroscopic survey to determine **chemical abundances** and **stellar parameters** for approximately **3,000 bright stars** that PLATO will soon observe.

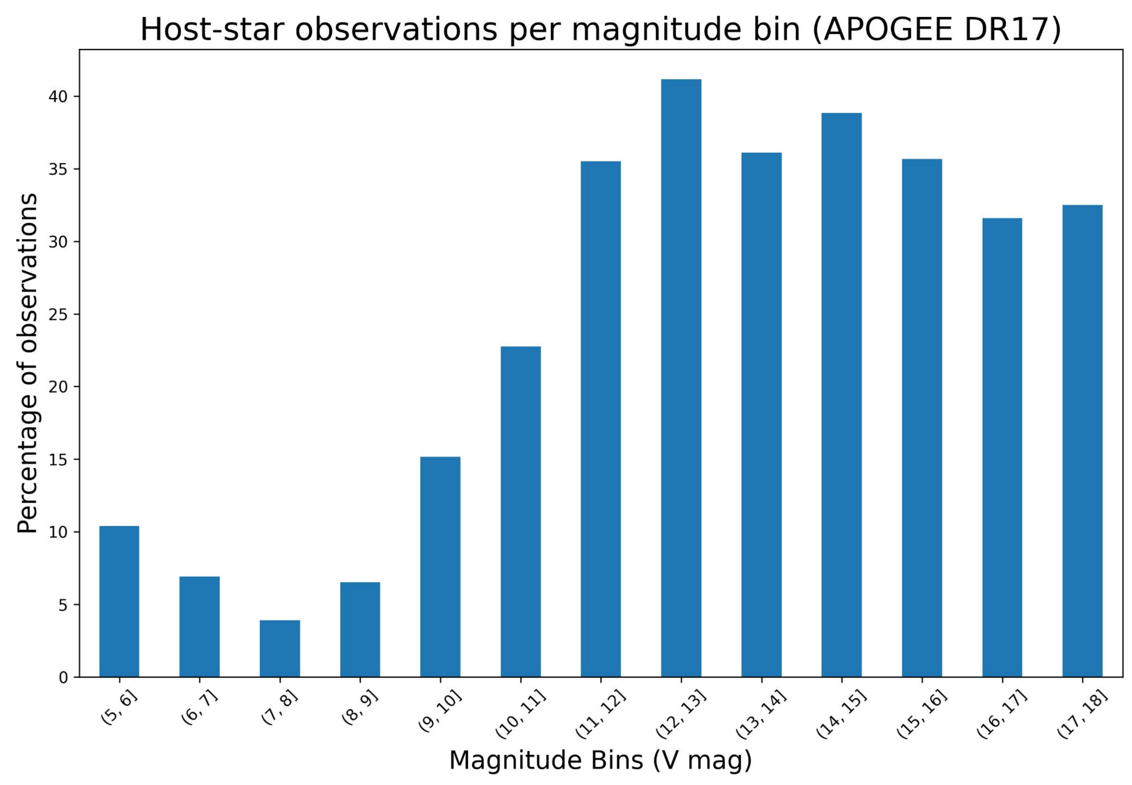
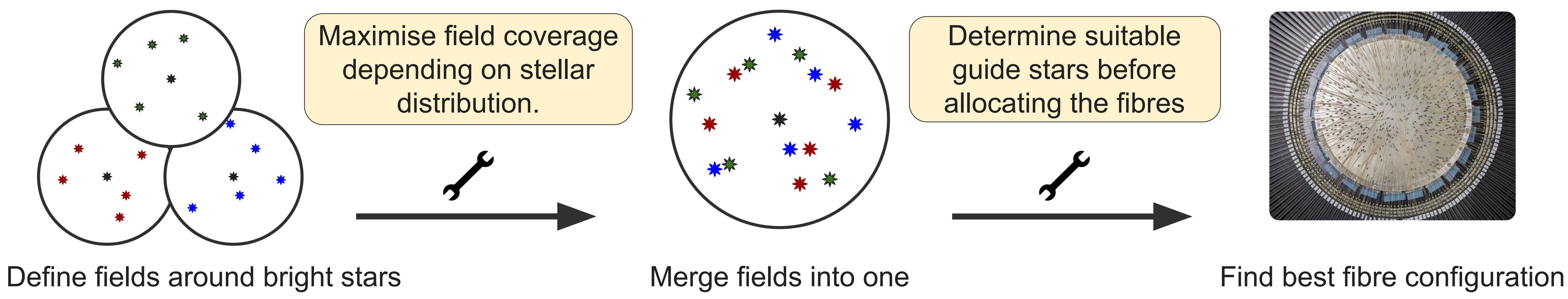


Fig.1: Percentage of host stars observed by APOGEE per magnitude bin. A preference for stars > 11 V mag is evident.

Host star abundances hold insight into planetary **occurrences, properties and possibly system architectures** (e.g. *Adibekyan+, 2021; Yun+, 2024*). WEAVE-twilight aims to measure abundances for **up to 16 elements** with **precisions** between **0.05 – 0.2 dex**, depending on star-type, elements and radial velocities. Observing fields are selected to lie within the northern PLATO Long-duration Observation Phase (LOP) field (*Nascimbeni+, 2022*), **focusing on stellar neighbourhoods** of known and candidate **exoplanet host stars**.

Tweaks to WEAVE workflow:



A novel observing mode has been developed which will **extend WEAVE's capabilities** into the **bright target domain**. This is enabled by a field creation process that defines each pointing around a bright central guide star. **Groups of fields** are then **superimposed** onto the field plate and two additional guide stars are defined for each. The guide fibre selection is then performed by allocating the closest available fibre to each target. Depending on the number of guide fibres available, 3 to potentially 5 fields can be defined.

These **merged fields** can then be **observed** in **quick succession**, covering larger areas, in a less time. This approach **enables short exposures** with WEAVE, allowing for efficient **observations during** otherwise **idle times** (twilight, bad seeing).

The observations will yield a **homogeneous spectral dataset** featuring **elemental abundances** of bright known or potential **exoplanet host stars** and their environments. Sourced from the northern PLATO LOP field,

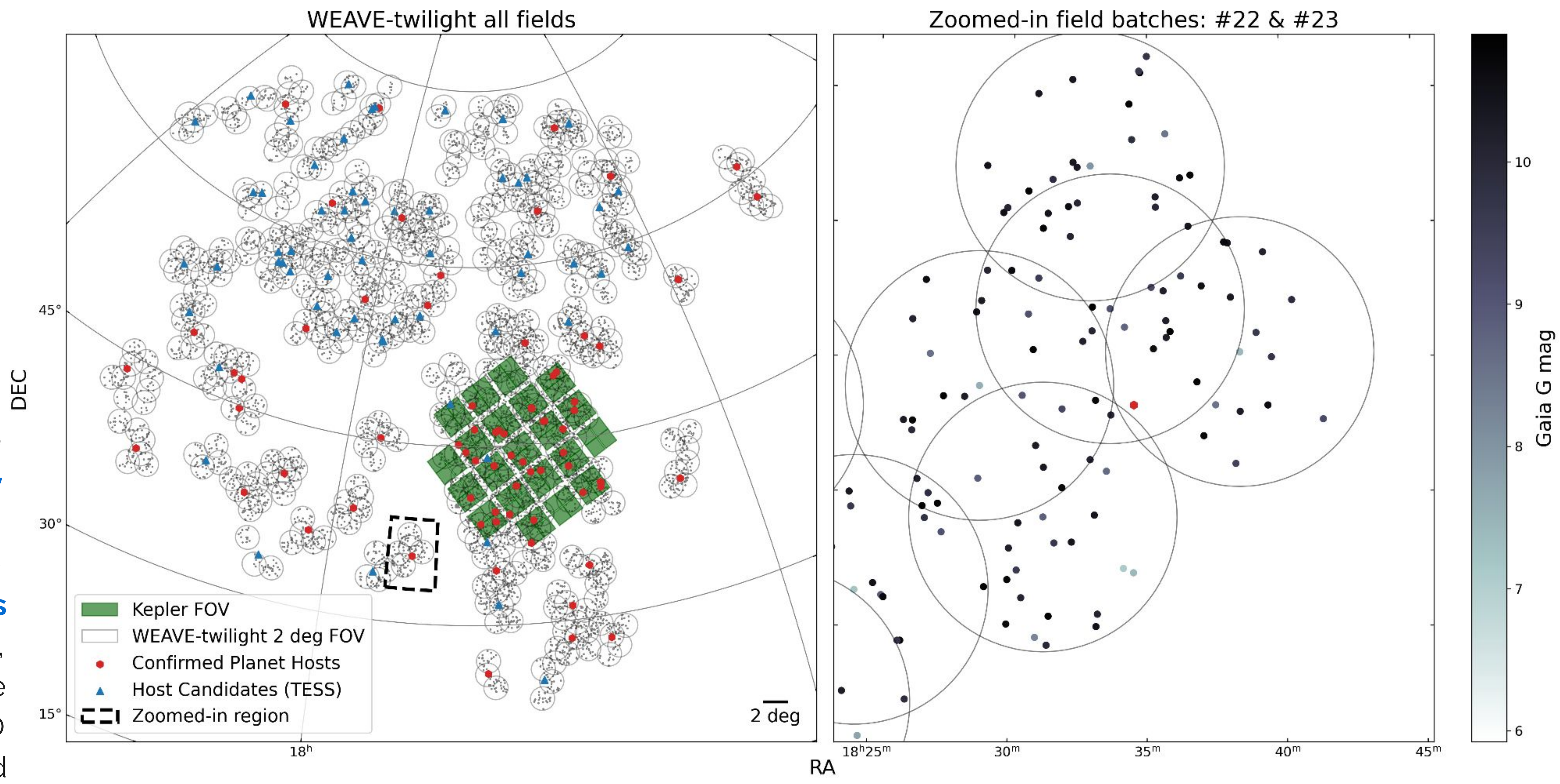


Fig.2: WEAVE fields on the sky. The irregular pattern arises as a function of the bright star distribution on the sky. All fields in the image have sufficient guide star coverage to enable the proposed observing mode.

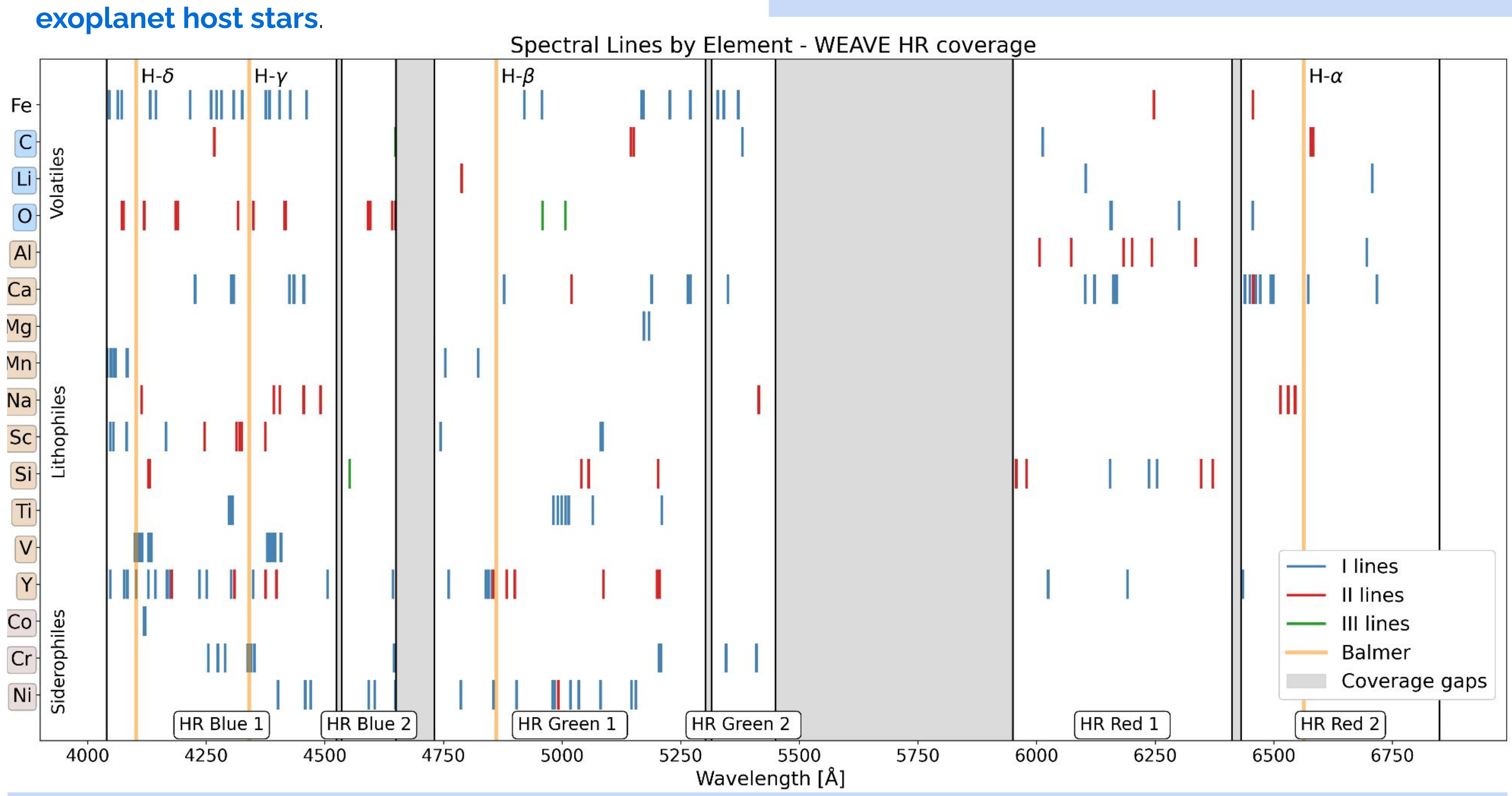


Fig.3: Spectral lines per element accessible by the WEAVE high-resolution mode (NIST database).

WEAVE-twilight serves as an initial **characterisation campaign** for **soon-to-be PLATO host stars**. Together with forthcoming WEAVE surveys and **GAIA astrometry**, this enables **precise chemo-dynamical profiles** of planet-hosting stars, facilitating detailed studies of star-planet relationships based on chemical composition.

- **Expand WEAVE capabilities**
  bright objects & low density fields
- **Pre-characterisation of PLATO targets**
  input catalogue from PLATO LOP
- **Homogeneous dataset**
  high-resolution abundances for ~3000 stars
- **Chemical abundances**
  Ca, Ni, Si, V, Na, Mg, Al, Fe, Sr, Ba, ...

References:
Matuszewski, F. et al., 2023 doi:10.1051/0004-6361/202245287.
Adibekyan, V. et al., 2021. doi:10.1126/science.abg8794.
Yun, S. et al., 2024. doi:10.48550/arXiv.2402.19321.
Nascimbeni, V. et al., 2022. doi:10.1051/0004-6361/202142256.

Funding:
This project has received funding from the European Union's Horizon 2020 research and innovation programme under the Marie Skłodowska-Curie grant agreement No 101072454 (MWGaiaDN).
Photos:
WHT: Isaac Newton Group, https://www.ing.iac.es/PR/wht_info/whtmway.jpg
WEAVE field plate: Sarah Hughes