Helium observations of exoplanet atmospheres are connected to stellar coronal abundances

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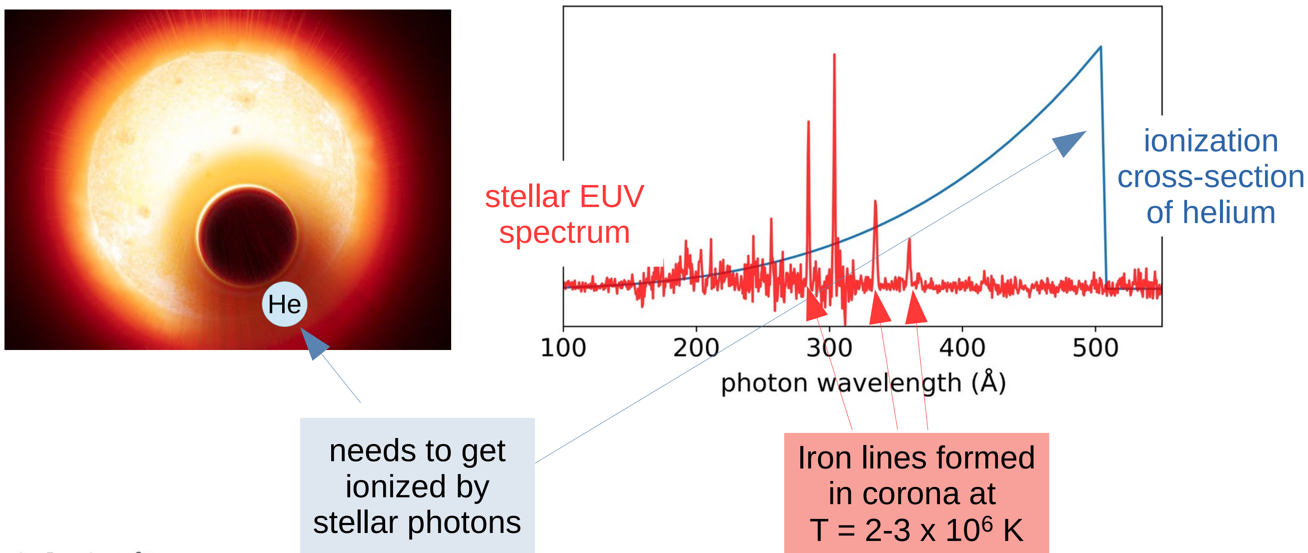
What‘s the deal with helium transits of exoplanets?

- Atmospheres of hot Jupiters and Neptunes planets are known to evaporate; since they consist mainly of hydrogen and helium, observing the **escaping atmopshere in spectral lines** of H and He is a good idea.
- Hydrogen problem: photons need to travel through interstellar medium (ISM) to reach us, get absorbed by H in the ISM.
- The metastable lines of He in the near-infrared (10830 Å) don‘t have that problem - they travel through the ISM unperturbed (Oklopcik et al. 2018, Spake et al. 2018).
- Successful method: 6 extended atmospheres detected through He10830 in the past 2 years, versus roughly the same number in H Lyman-alpha in 20 years.

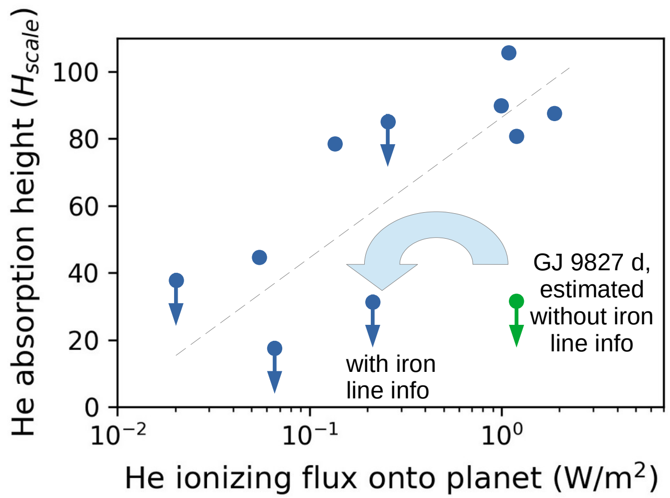
Where does the stellar corona come in?

- Helium in the exoplanet‘s atmosphere needs to be in the correct excitation state to procude absorption in the Helium 10830 lines → this happens by the planetary **helium getting ionized** and then recapturing an electron.
- Ionization is caused by stellar photons in a moderately narrow wavelength range in the extreme-UV (EUV), bluewards of the helium ionization energy at 504 Å - observationally accessible through archival spectra with the EUVE telescope.
- The typical stellar spectrum in that range has a strong contribution from **coronal emission lines of iron**.
- Stars with strong emission in coronal iron lines cause more helium ionization in their exoplanet‘s atmosphere than equally X-ray/EUV bright ones with low iron line emission.



Coronal abundances help selecting the best exoplanets for helium observations

- How big is the effect? Exoplanet irradiation close to the ionization threshold can vary by a factor of ~5, just by varying the strength of coronal iron lines.
- Contributing factors are: stellar abundances in general, stellar coronal abundances (i.e. the first ionization potential effect, which typically makes M dwarf coronae low in iron line emission, see Wood et al. 2018), coronal temperatures (is the corona hot enough to produce iron emission in the first place?).
- This can explain why some gaseous exoplanets with strong overall X-ray and EUV irradiation do not show extra depth in the helium 10830 lines - because the iron lines are weak and the irradiation near the ionization threshold is lower than expected.
- → **Select exoplanets for helium transit observations** based on overall X-ray/EUV irradiation **and expected EUV iron line strength** of the host stars; these can be estimated from stellar X-ray spectra!



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