Synergies between ARIEL and the ELTs

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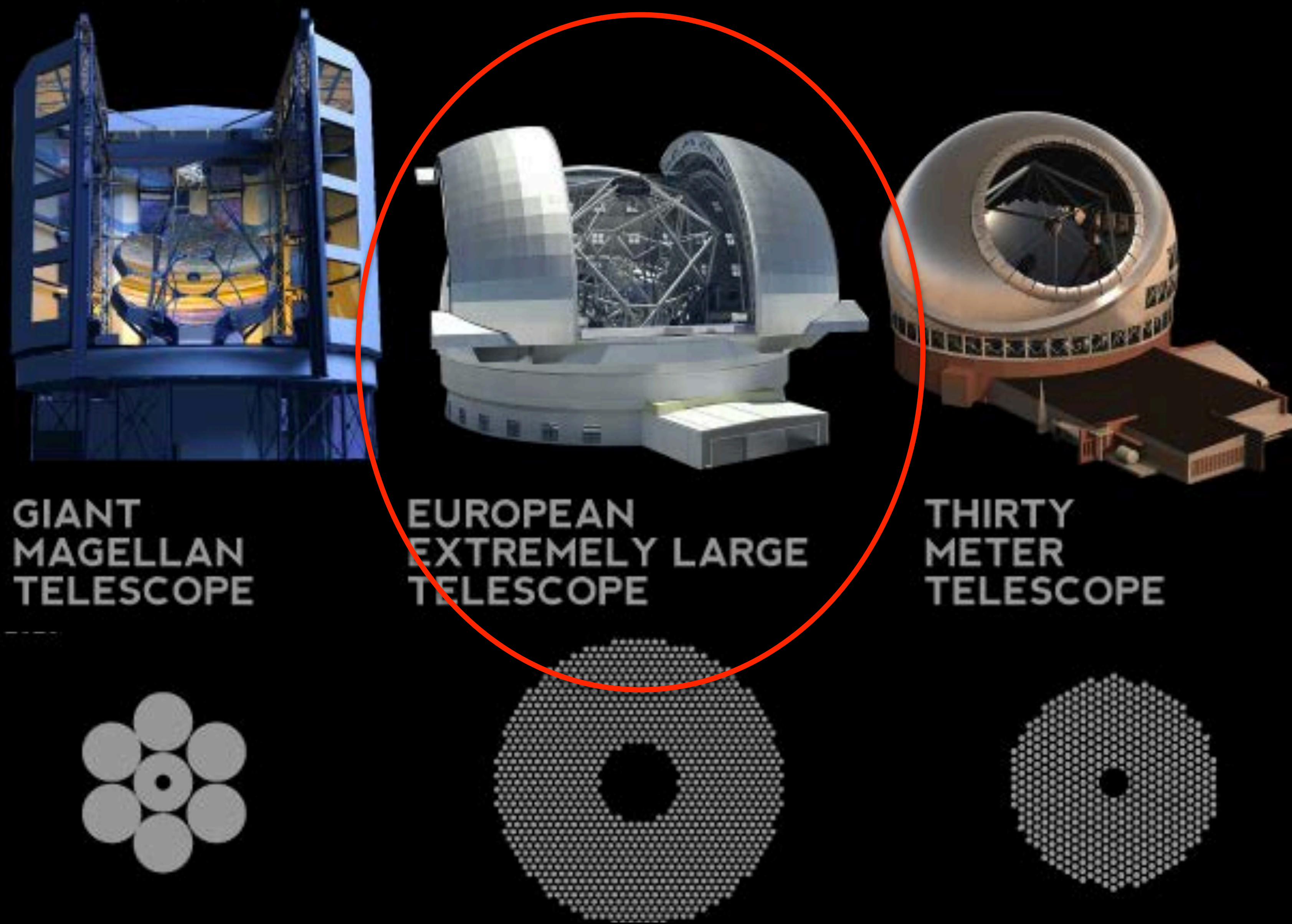
ARIEL Science Conference, ESTEC Jan 2020

A quick review of ARIEL – ELT overlapping observations

Waiting till 2028/2030 …

252 288 000.0 s remaining

Waiting till 2028 …


GIANT MAGELLAN TELESCOPE
EUROPEAN EXTREMELY LARGE TELESCOPE
THIRTY METER TELESCOPE

Exoplanets with ELTs

High contrast imaging: ***METIS***

- ✧ Volume-limited sample *vs* mag-limited sample
- ✧ Self-luminous young massive *vs* typically evolved planets
- ✧ Cold planets (100's AU) *vs* hot planets
- ✧ Same initial composition, different ages/evolution
- ✧ Non-transiting *vs* transiting

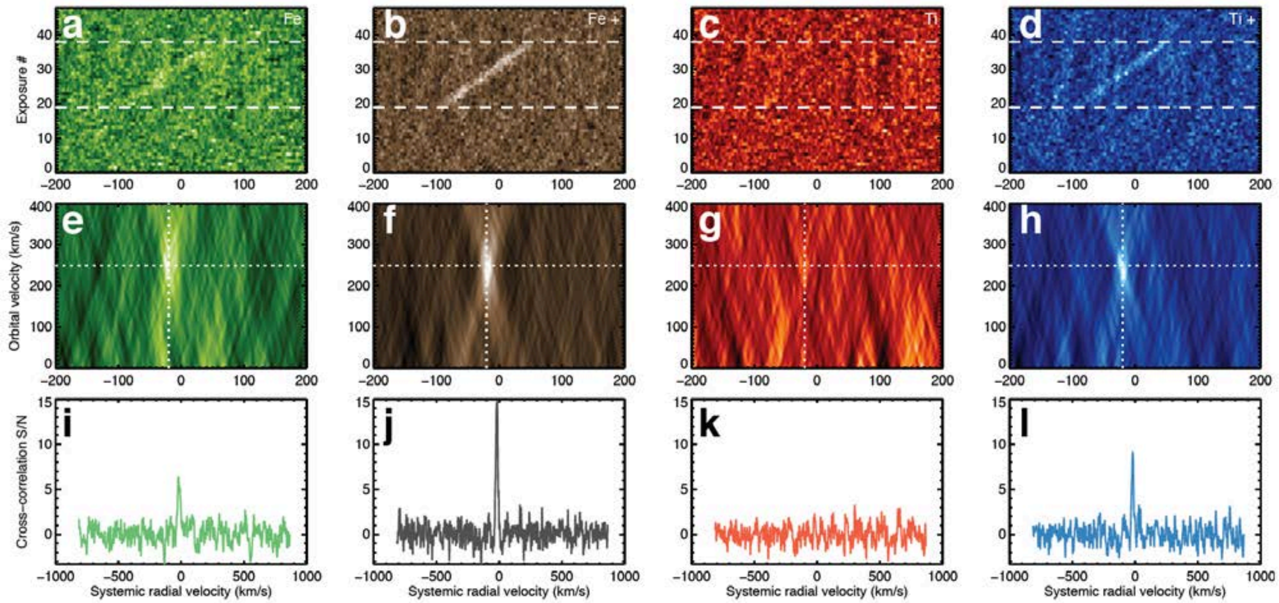
High resolution spectroscopy: ***HIRES***

- ✧ Science Case: ***Exo-planet atmospheres and signatures of life*** So, focus in small rocky planets
- ✧ Transit spectroscopy and reflected light
- ✧ Visible and near IR only 0.5-2.4 μm
- ✧ Extremely powerful for Jupiter and Neptune planets

Synergies: Atmospheric chemistry

ELTs will detect atomic and ion species.

Metallicities will tell us about planet formation



Hoeijmakers et al, 2018

Kelt-9b, Teq 400K

Synergies: Atmospheric chemistry

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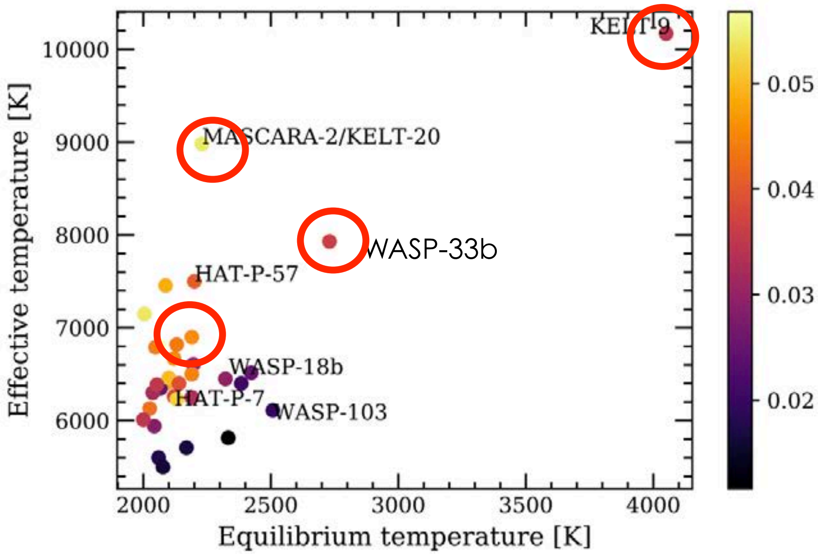
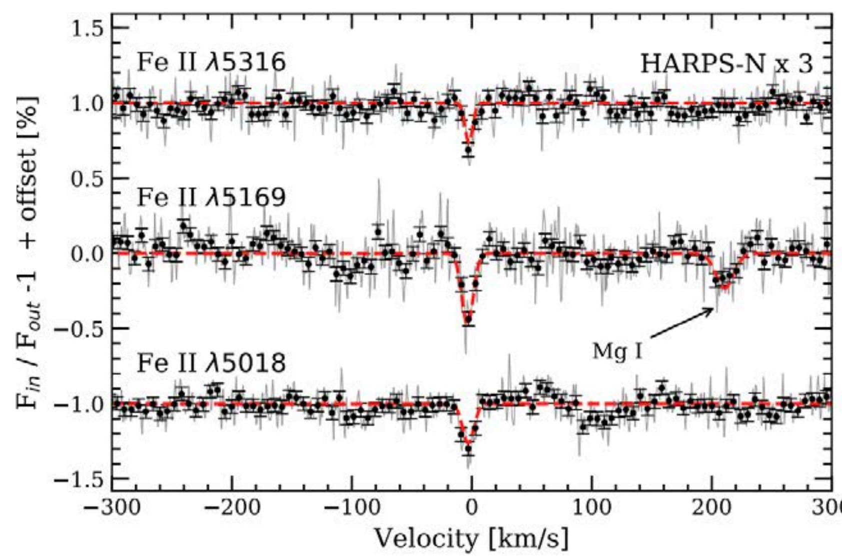


Kelt-9b, Teq 4000K

MASCARA-2, Teq 2200K
Casasayas et al, 2019



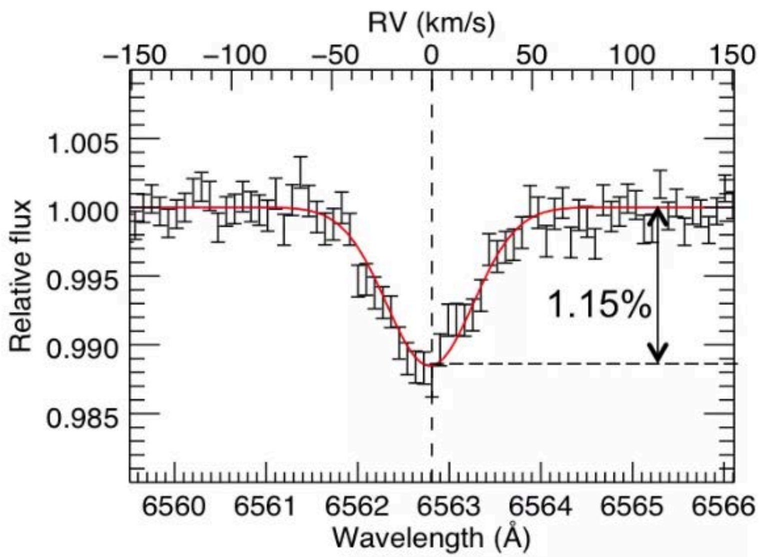
Fe, Fe^+, Mg^+, Ti^+, Ca^+, ...

Synergies: Atmospheric evolution

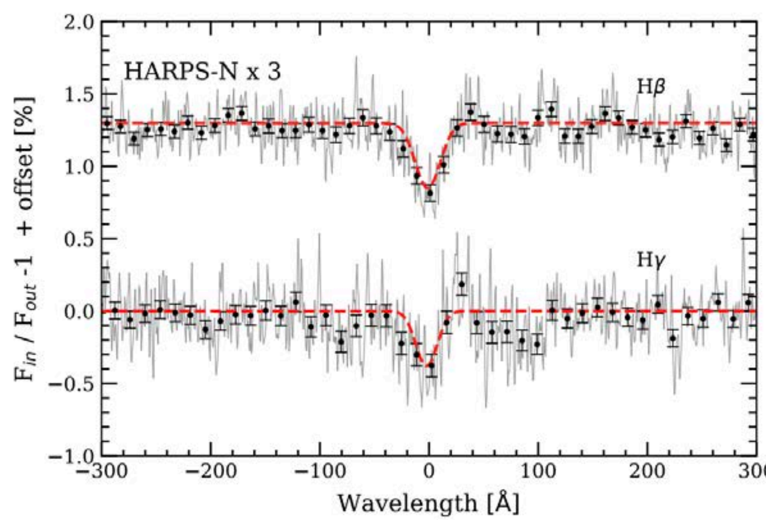
ARIEL is setup to do ***taxonomy*** of planetary atmosphere types and evolution.

But ARIEL will not measure stellar lines that might be crucial to ***understand evaporation and atmospheric evolution processes*** and put its own measurements in context

Hα line related to planetary escape
Yan et al, 2018

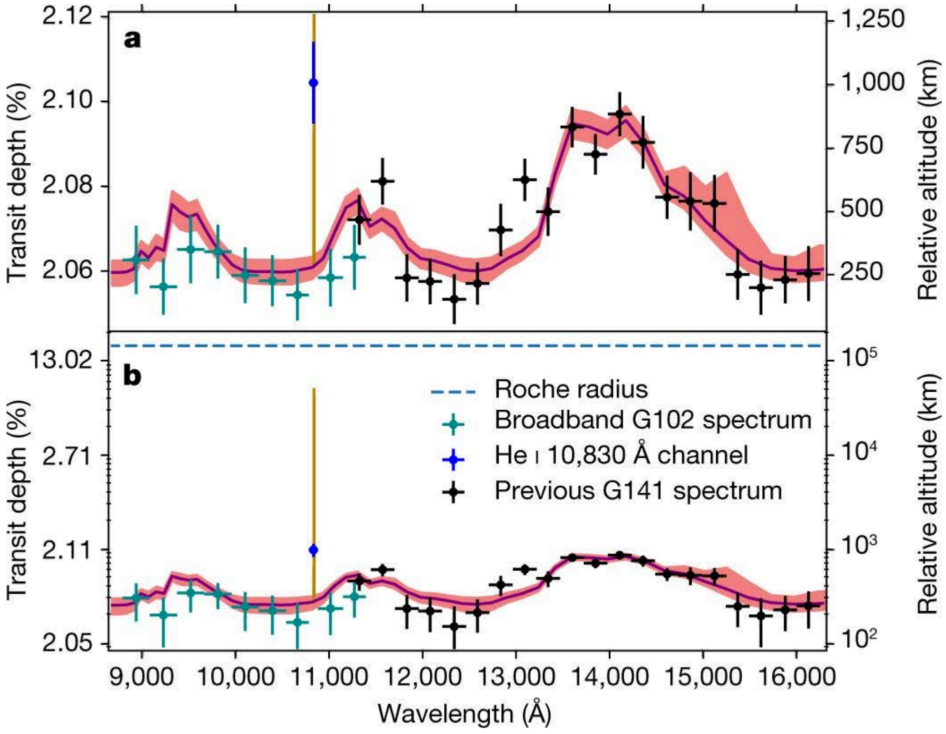


The full Balmer series can be detected
Casasayas et al, 2019



Synergies: Atmospheric evolution

A new tracer is the He I metastable triplet

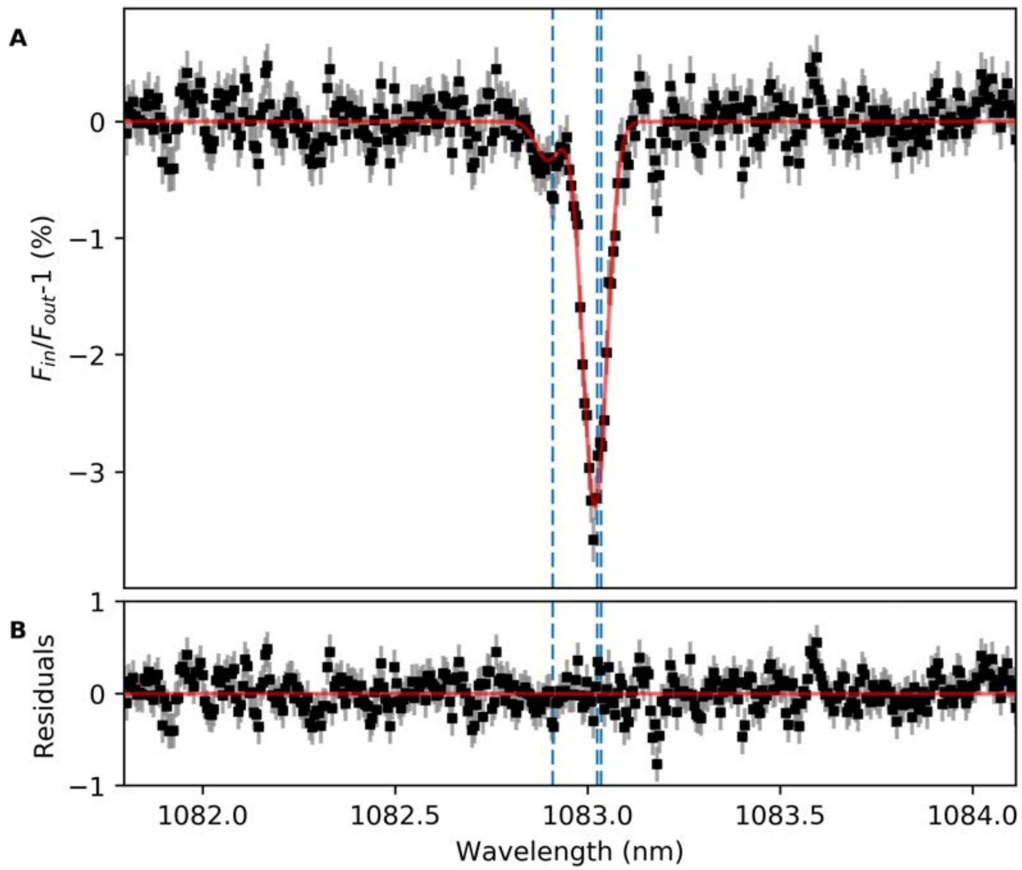


HST detection

Spake et al, 2018

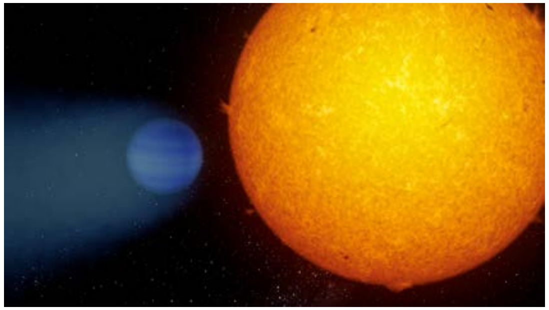
Synergies: Atmospheric evolution

A new tracer is the He I metastable triplet



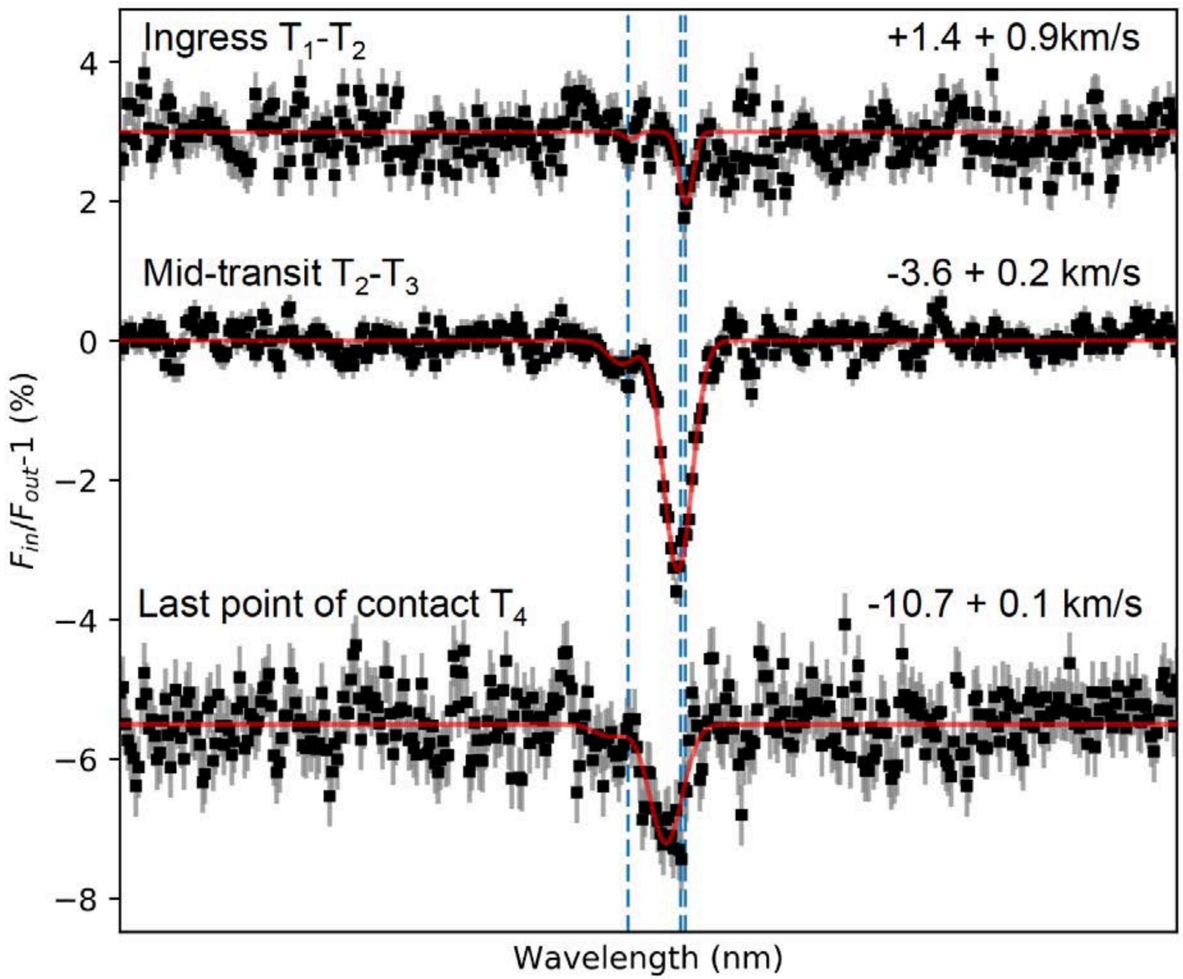
He I absorption
Nortmann et al, 2018

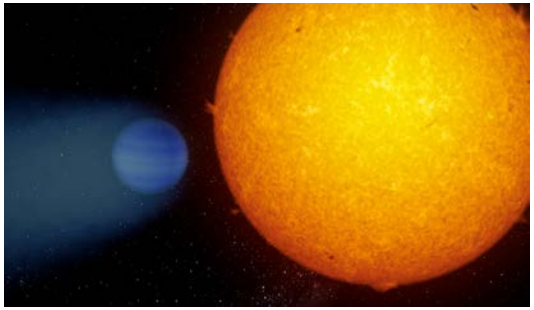
Line profiles
Escape velocities
Geometry



Synergies: Atmospheric evolution

A new tracer is the He I metastable triplet



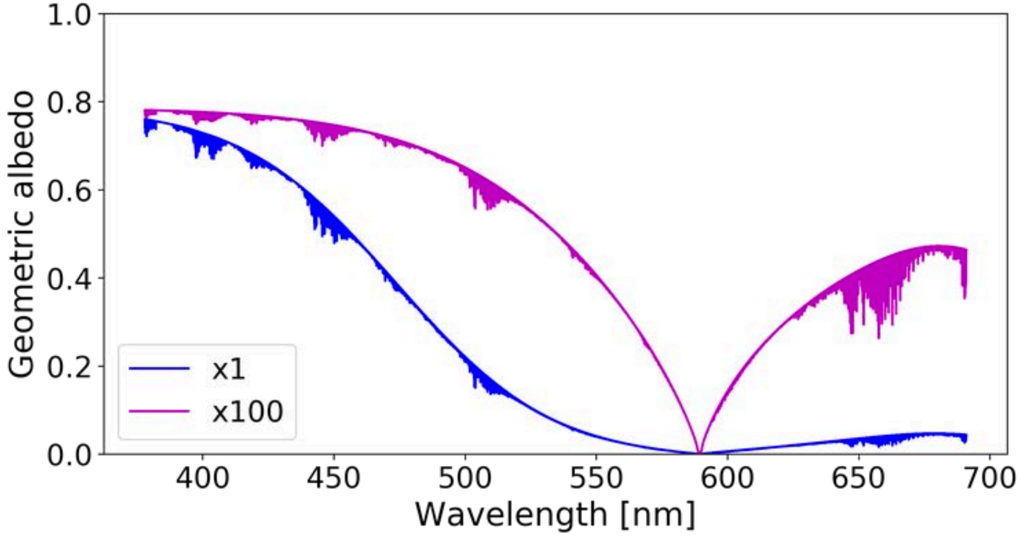


Synergies: Albedos

The ELT will have the capability of detecting reflected light and do spectral albedo measurements for a range of planets

Visible range species (Tio, VO, FeH,..) might be detected this way

ESPRESSO already attempting the low hanging fruits



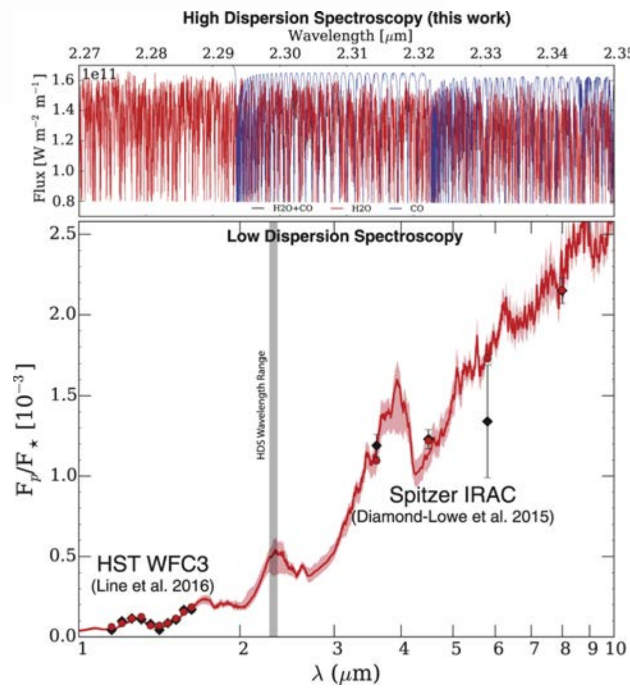
Martins et al, 2018

Synergies: multi-resolution puzzle solving

A Framework to Combine Low- and High-resolution Spectroscopy for the Atmospheres of Transiting Exoplanets

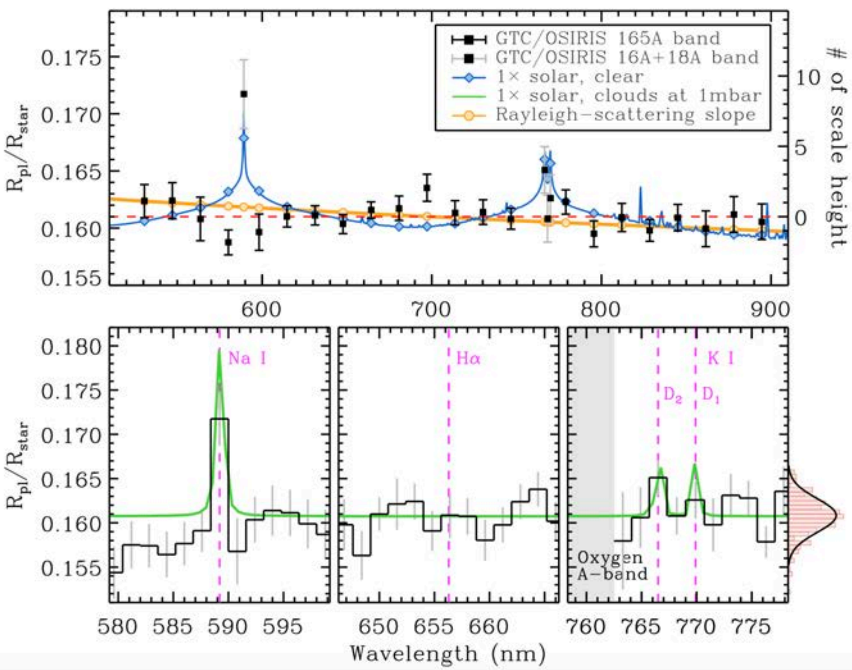
Authors: M. Brogi, M. Line, J. Bean, J.-M. Désert, and H. Schwarz

2017 *The Astrophysical Journal Letters* **839** L2.

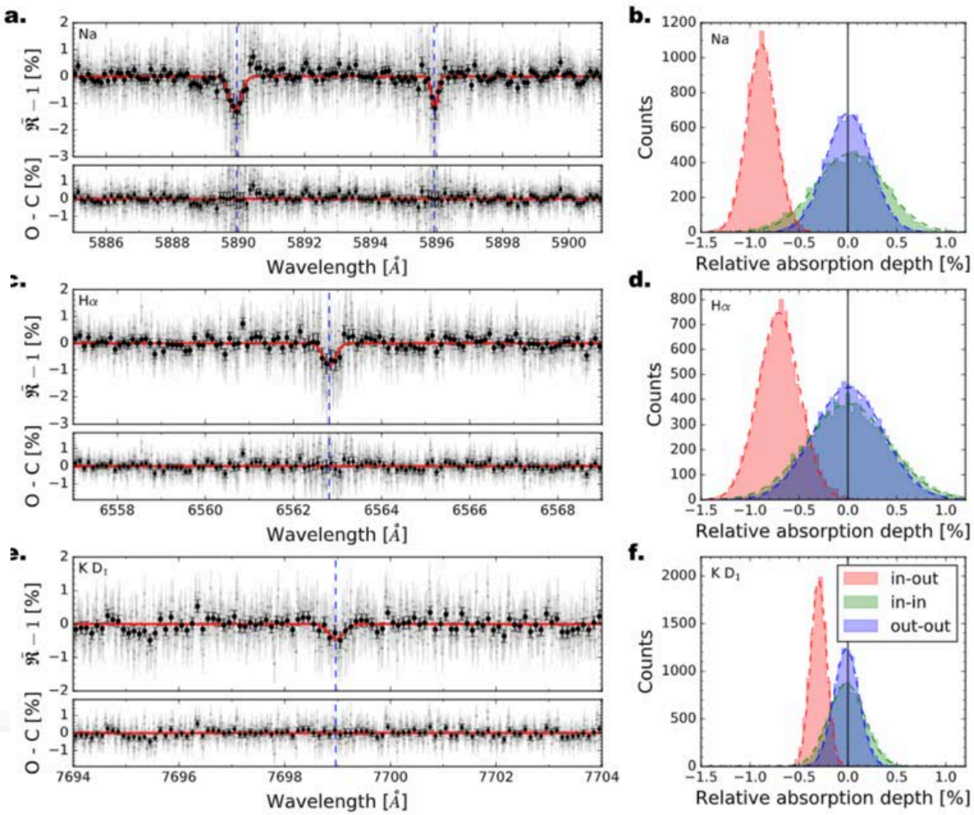


Synergies: multi-resolution puzzle solving

Reconciling High and low resolution observations, the case of WASP-52b



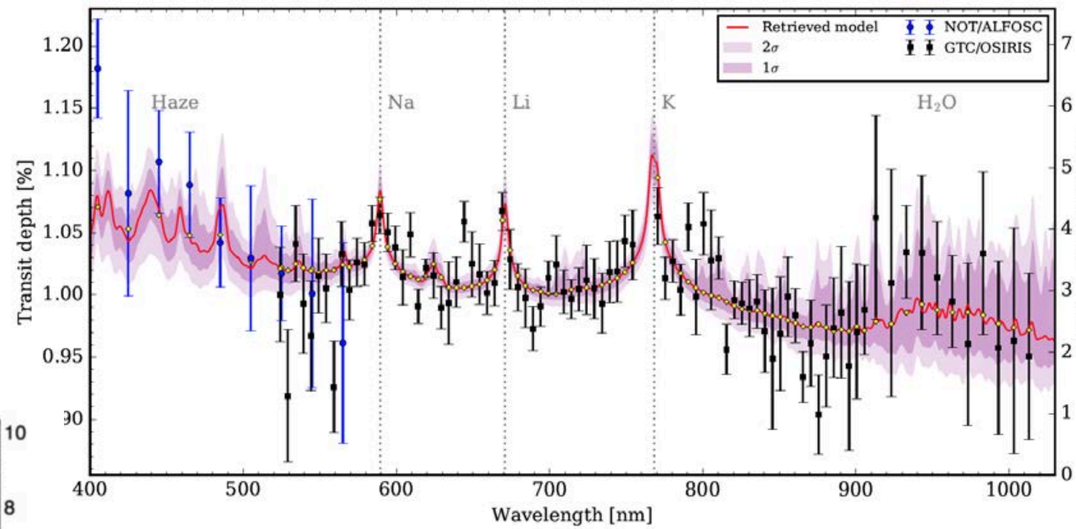
Chen et al, 2017



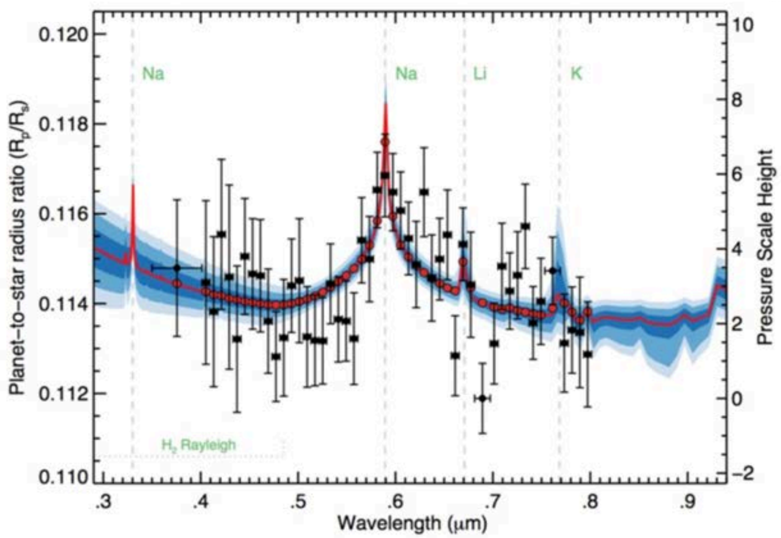
Chen et al, sub., 2020

Synergies: multi-resolution puzzle solving

Reconciling High and low resolution observations, the case of WASP-127b, WASP-21b or HD209456b



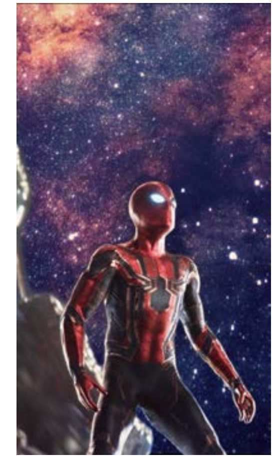
Nikolov et al, 2018



Chen et al, 2018

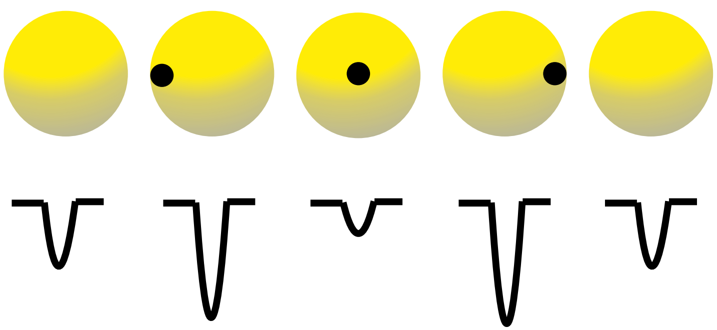
CARMENES, HARPS and ESPRESSO observations do not detect these species

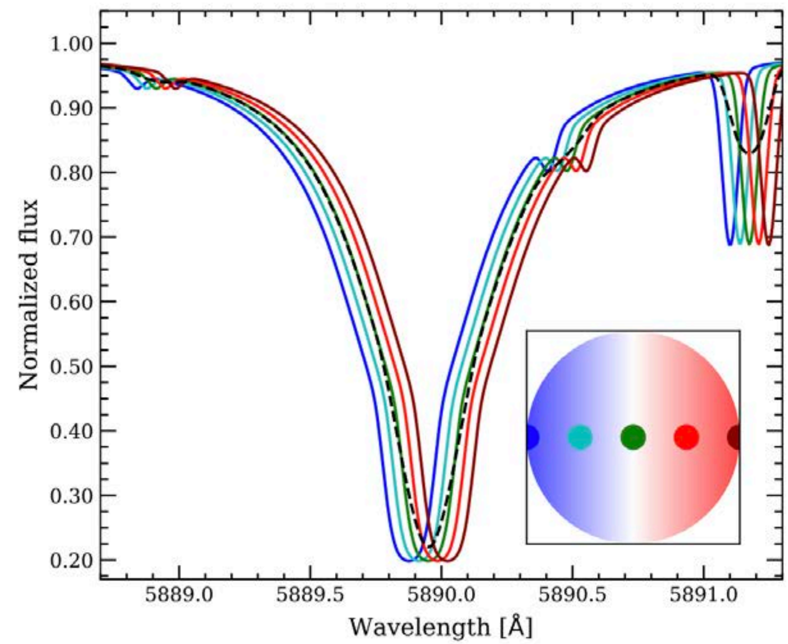
Synergies: Rise to new challenges



With great SNR comes … greater nasty effects to be accounted for.

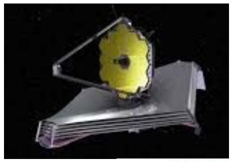
Effects like the CLV and RME become very relevant



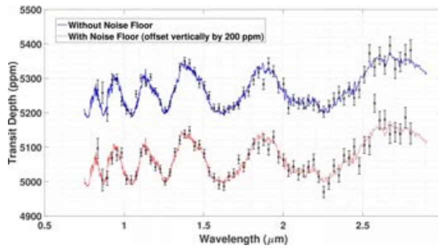


Casasayas et al, 2020

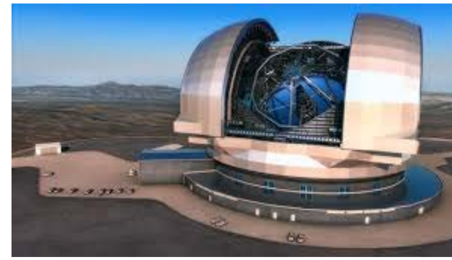
The Landscape in 2025/8

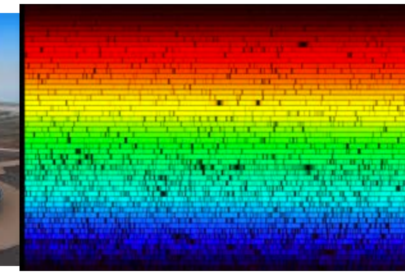


Multi-resolution approach common



Low-resolution spectra

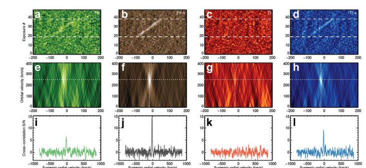


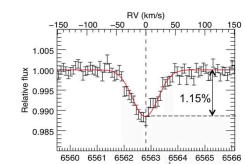


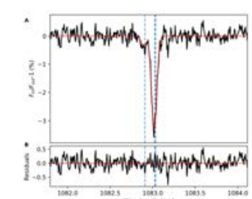
High-resolution spectra

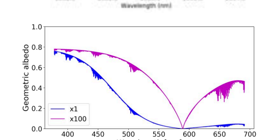
- Composition
- Pressure levels
- Rayleigh slopes
- Clouds/hazes

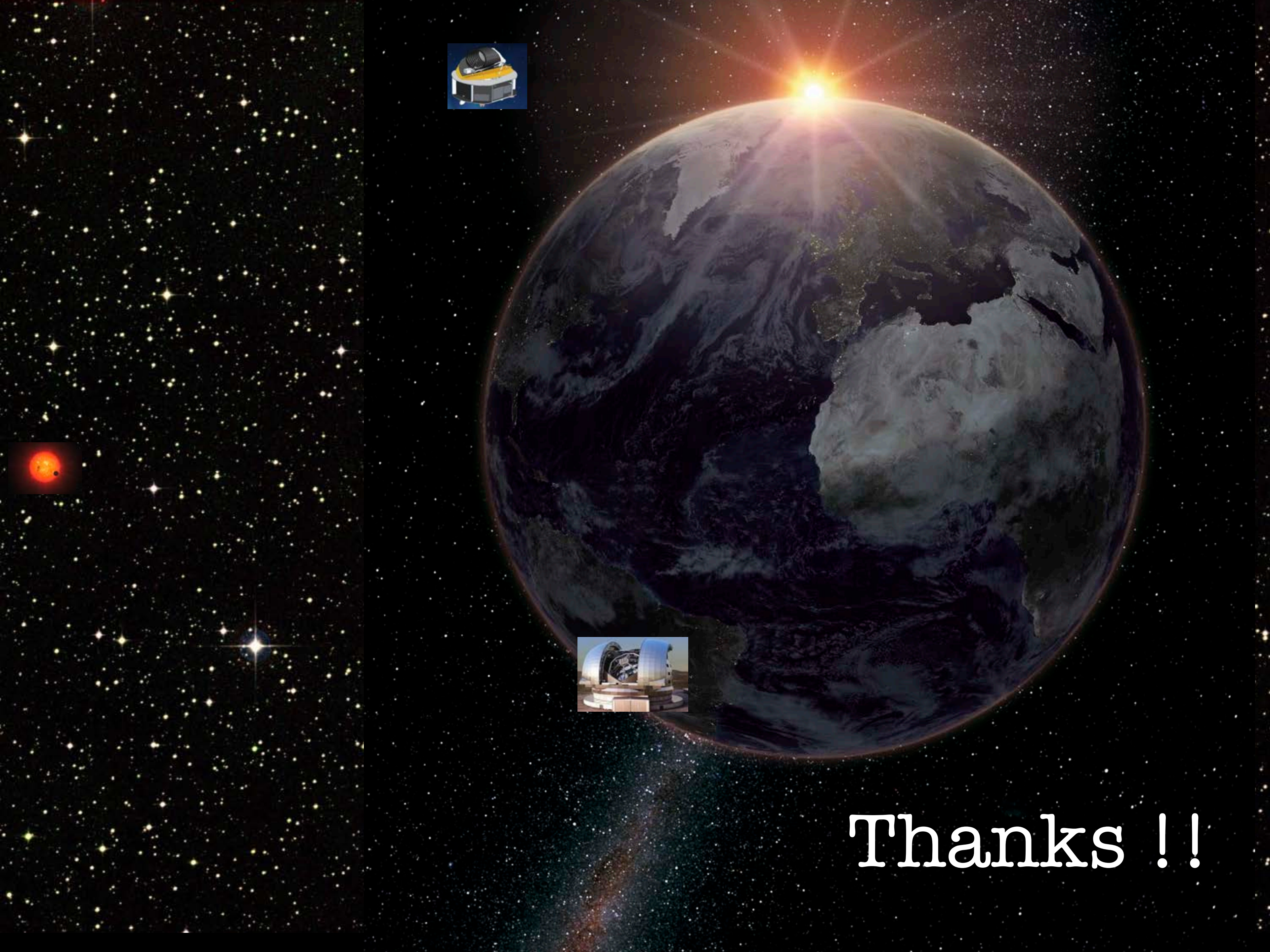
- Line profiles
- Metallicities,
- Planetary escape
- Albedos










Thanks !!