Stellar activity
&
the SOLSTART group

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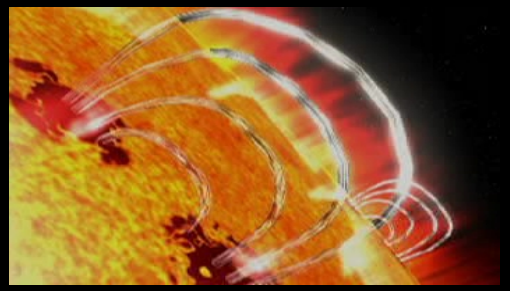
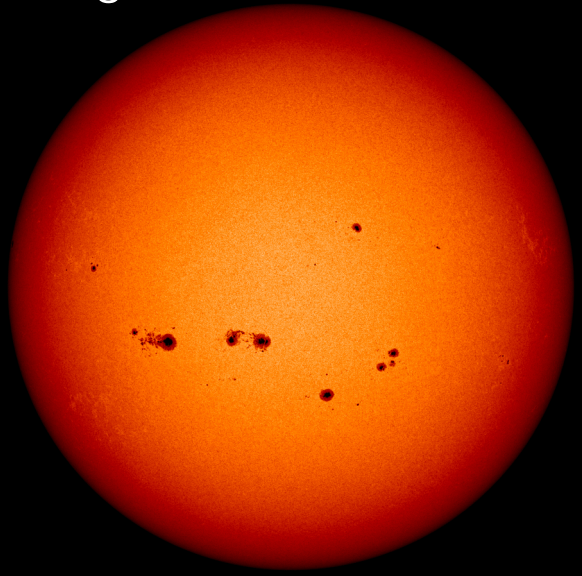
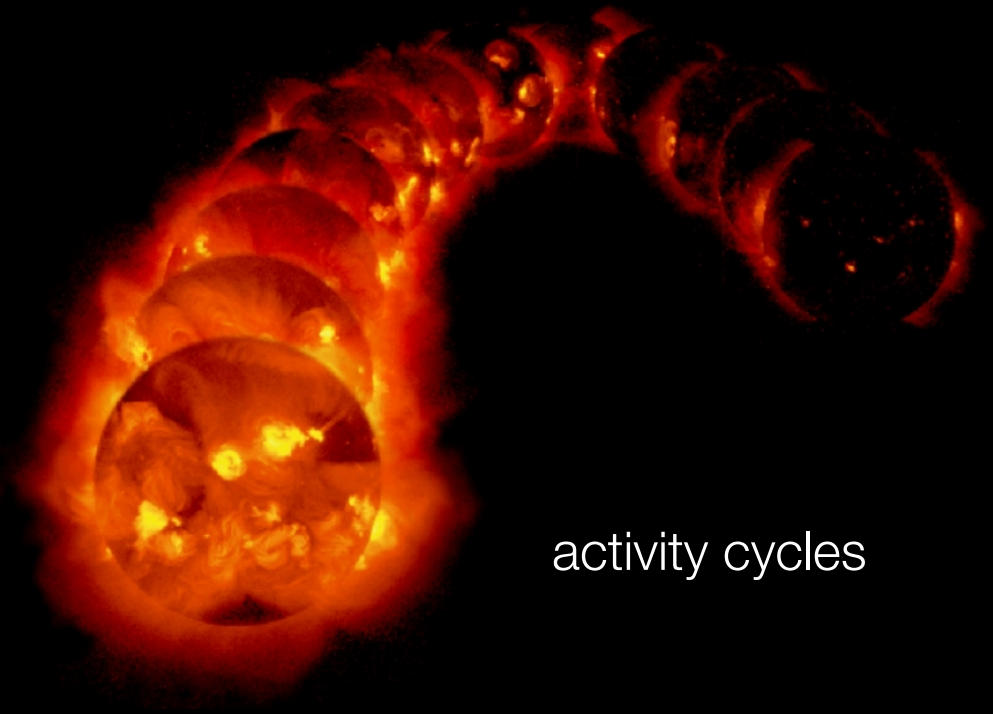
Rotation induces a magnetic dynamo in stars. This dynamo can produce on the surface and in the stellar atmosphere different activity signatures, like...

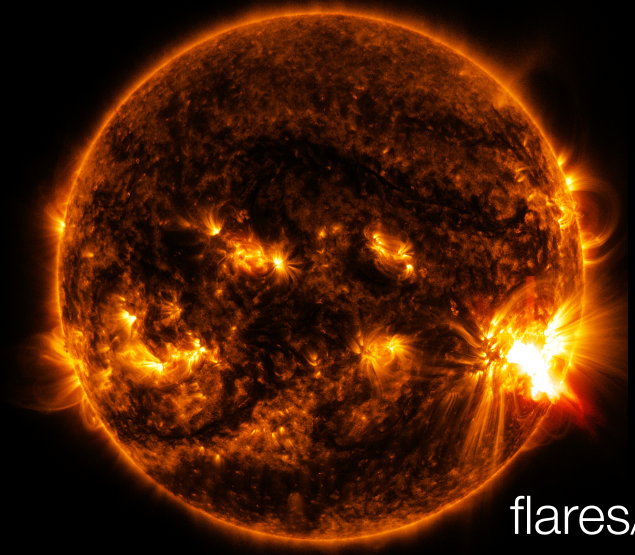




cool, dark spots

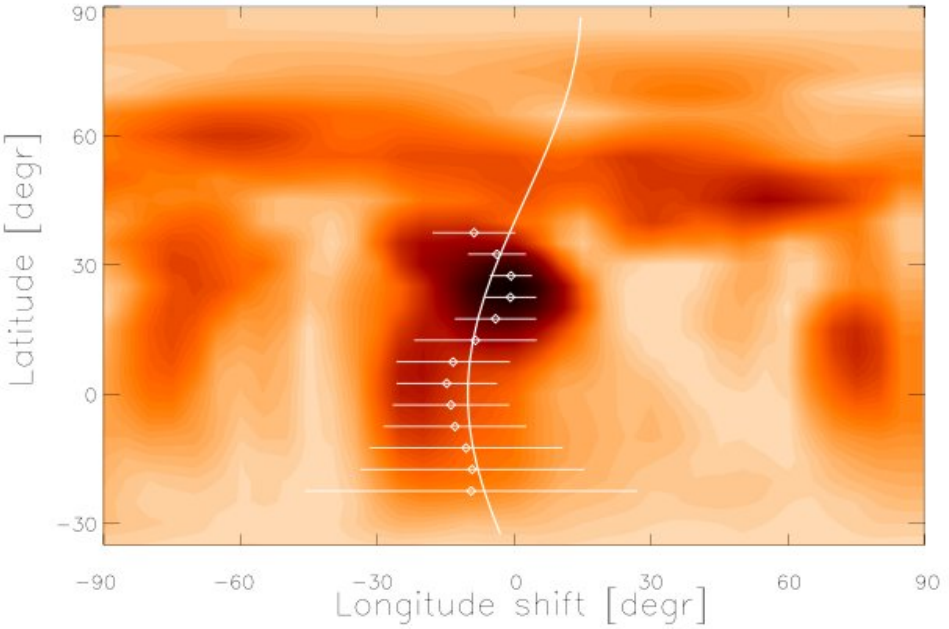


activity cycles

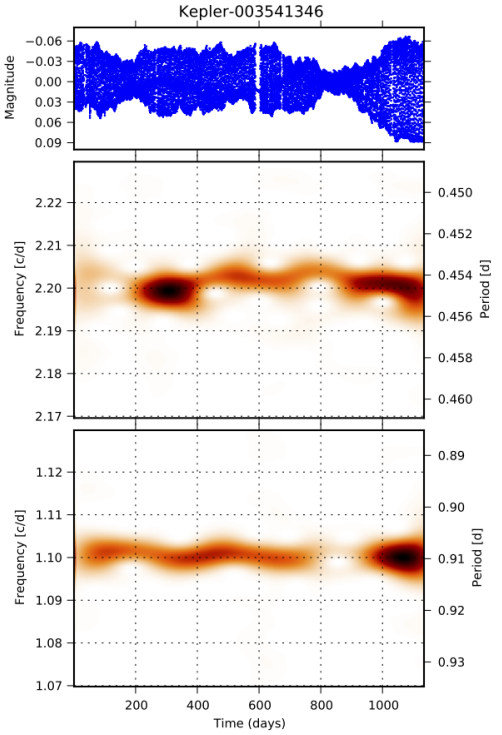


flares/coronal mass ejections
due to reconnection

The group studies different aspects of stellar magnetism, like activity cycles, and eruptive transient events that could have serious impact on orbiting planet atmospheres using surface mapping, photometry, spectroscopy, etc.



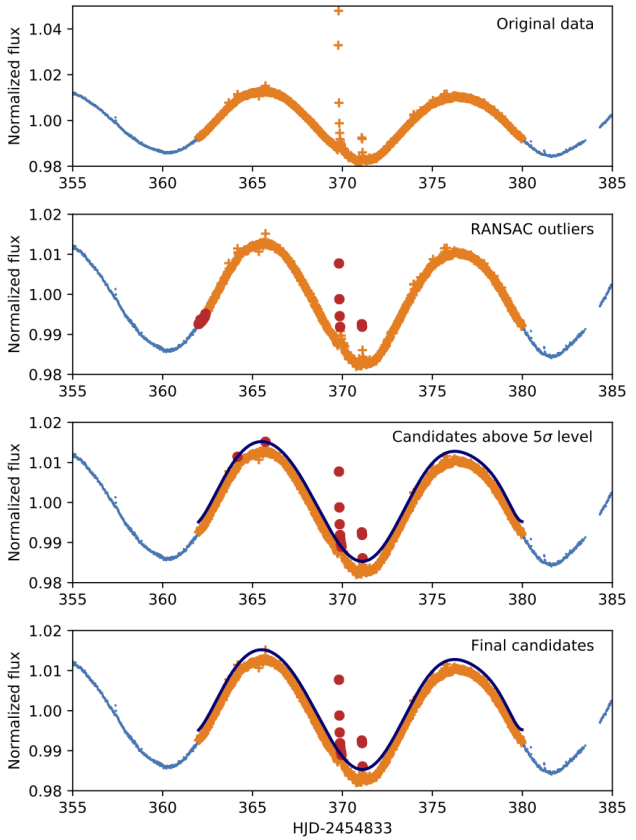
Differential rotation profile of DP CVn from surface Doppler-maps

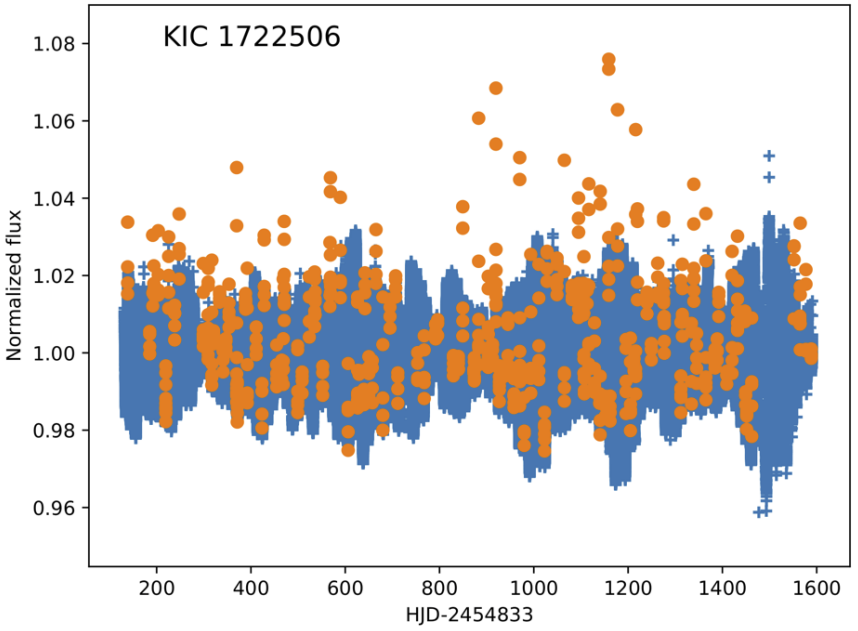


Finding stellar activity cycles in Kepler photometry

Recent highlights

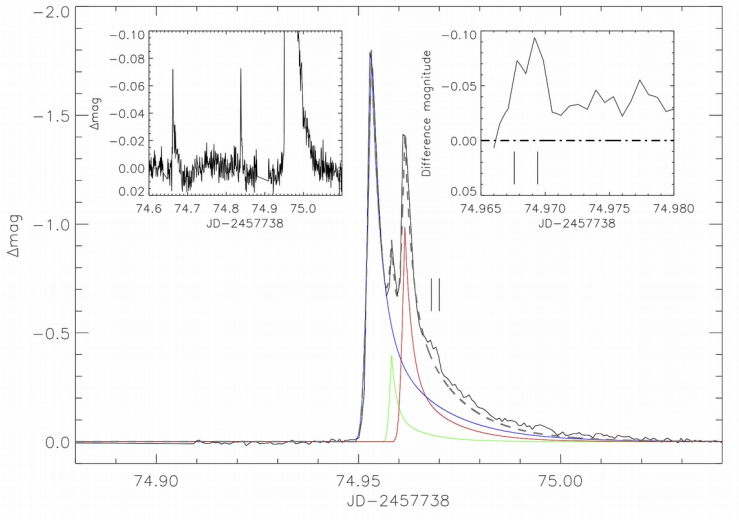
- Development of a code for identifying and analysing flares based on machine learning





Recent highlights

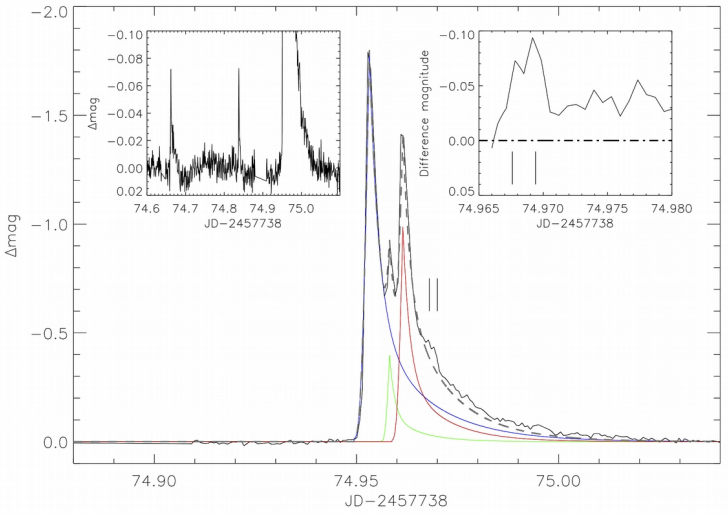
- Study of flaring activity of the TRAPPIST-1 system
- The observed frequent strong flares in such systems can change/destroy planetary atmospheres



max. Δmag~1.8

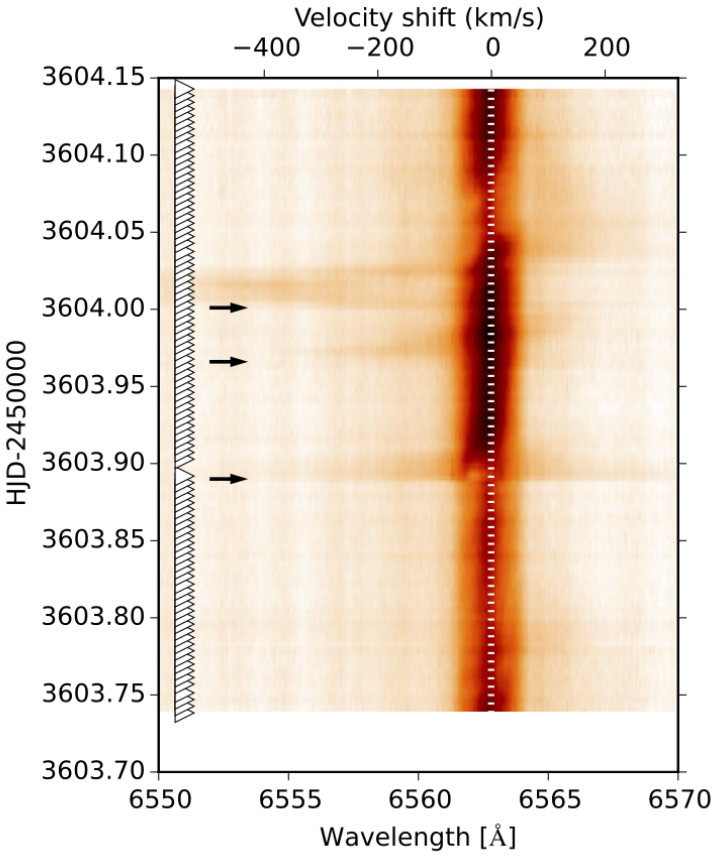
Recent highlights

- Venot et al. (2016): based on the 1985 flare of AD Leo (dV~0.5mag): the atmospheres of two hypothetical orbiting super-Earths would be significantly & irreversibly altered.
- Steady state would be reached in ~30 000 years, but large eruptions are more frequent → constantly changing atmosphere
- An eruption of this scale temporarily changes the habitable zone limits from 0.024-0.049AU to 0.048-0.097AU (very crude estimation)



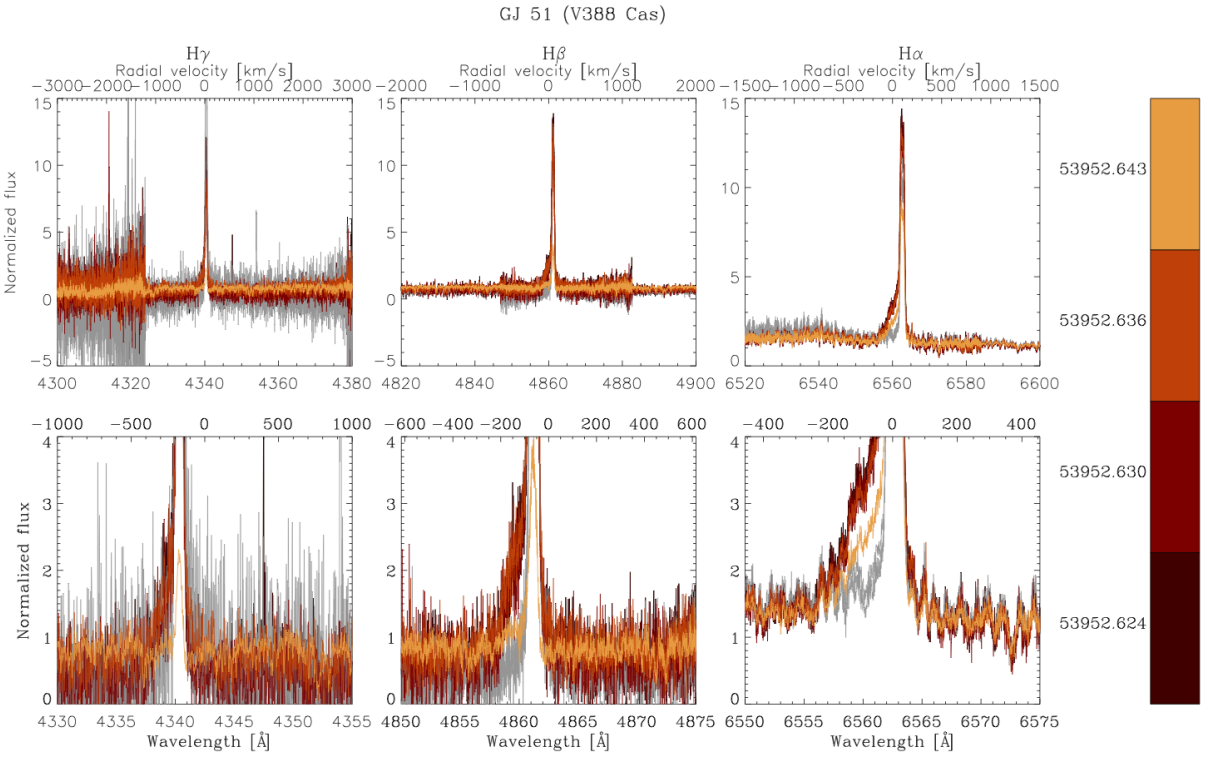
Recent highlights

- Coronal mass ejections are frequently seen on the Sun, but are sporadically observed events on other stars
- Their rarity can be due to observational bias or physical causes
- CMEs can be observed only by spectroscopy due to their Doppler-shifted emission/absorption peaks
- These can influence stellar evolution, but also influence their orbiting planets



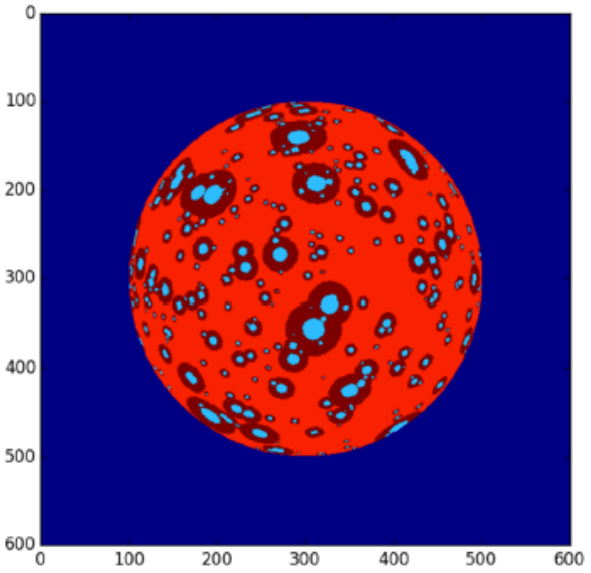
Recent highlights

- Since these events were rarely observed and large amount of data are needed for their detection, we initiated a thorough search for stellar CMEs in all available Virtual Observatory archive data

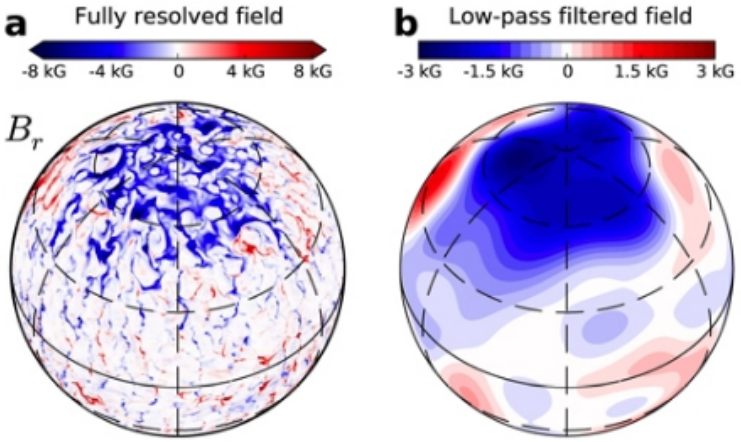


ARIEL & stellar activity

- According to ARIEL Assessment Study Report stellar activity is a “source of noise” to be avoided
- Photospheric starspots have small contribution to light variations in the IR regime



ARIEL-Sim star spot simulation with 10% spot coverage



Magnetic field configuration of a fully convective M-dwarf from numerical simulation

ARIEL & stellar activity

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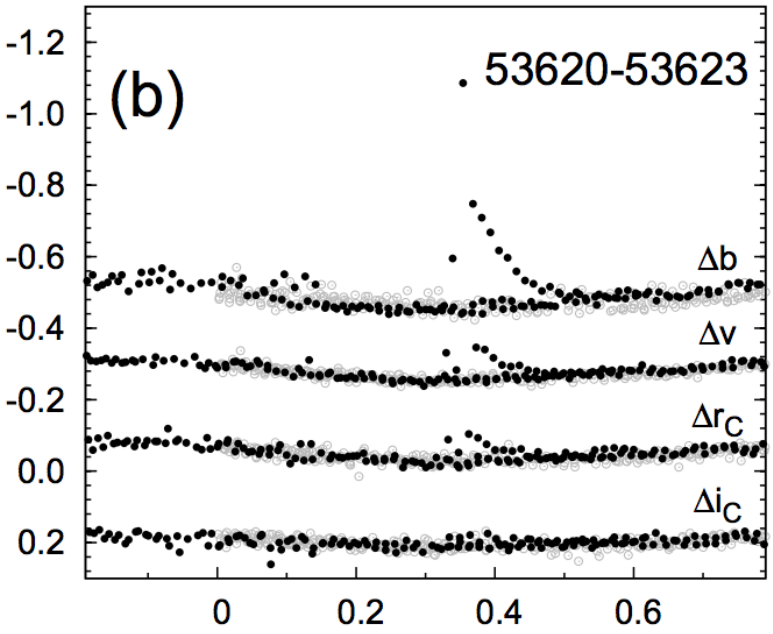
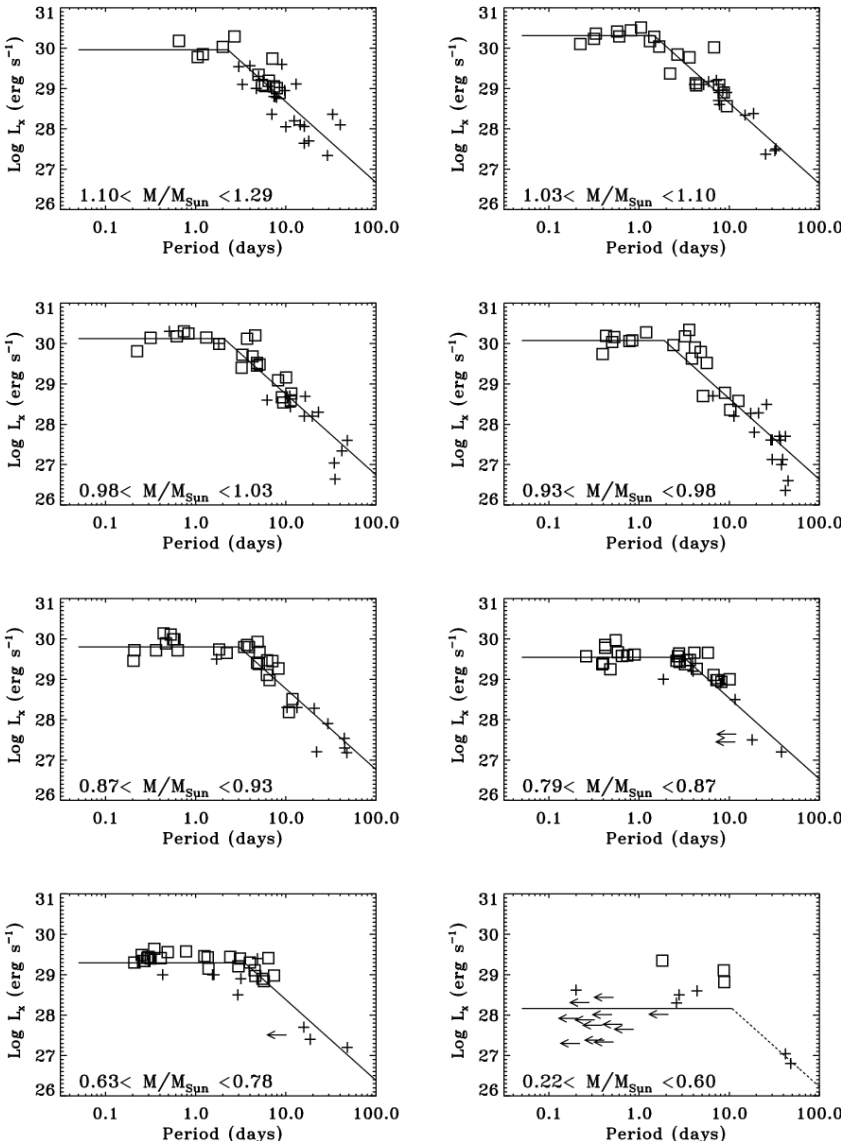
- Photospheric starspots have small contribution to light variations in the IR regime
- Flares are also more prominent at shorter wavelengths



Flare of an M-dwarf in multiple passbands

ARIEL & stellar activity

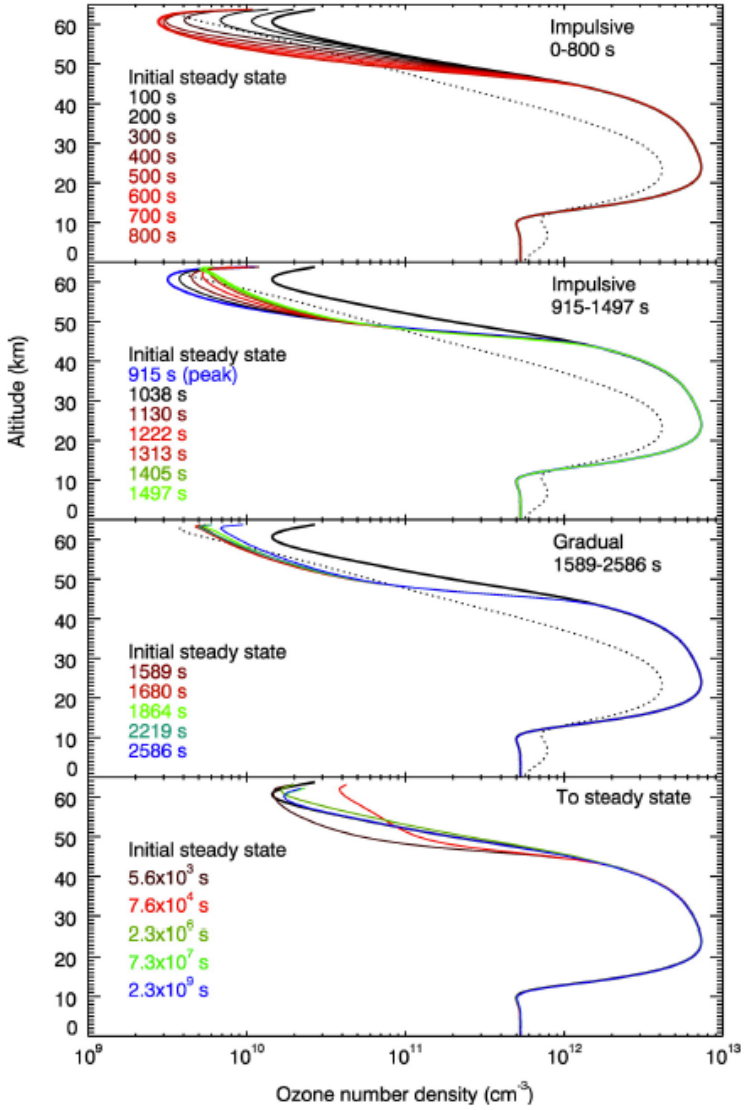
- Magnetic activity is an important property of young, fast-rotating stars
- This can have serious consequences on their exoplanets



Rotation (age) vs.
X-ray luminosity

ARIEL & stellar activity

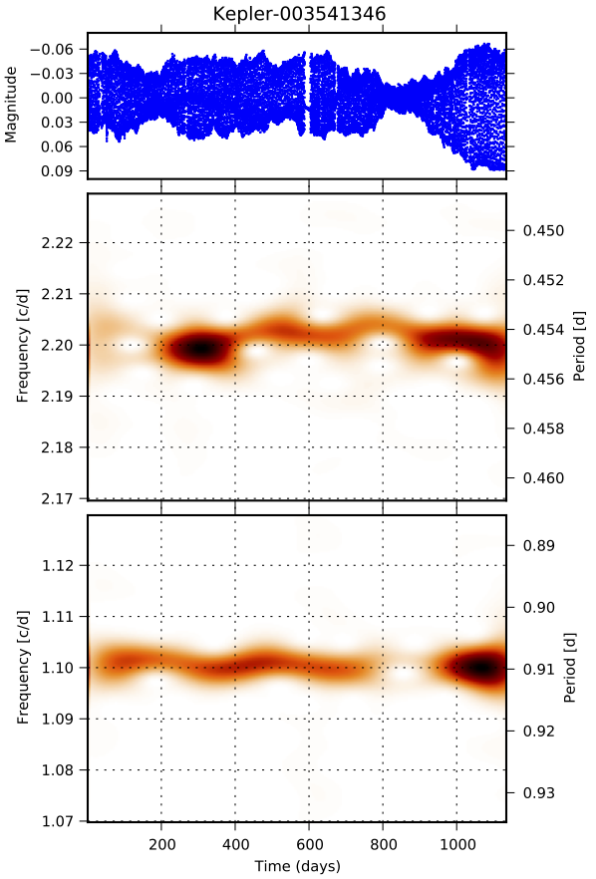
- Magnetic activity is an important property of young, fast-rotating stars
- This can have serious consequences on their exoplanets
- Some models already exist discussing the effects of activity on planets, but not much is known on the additive effects and observational confirmation is also missing



Model of the atmospheric changes of an Earth-like planet due to a large flare event

ARIEL & stellar activity

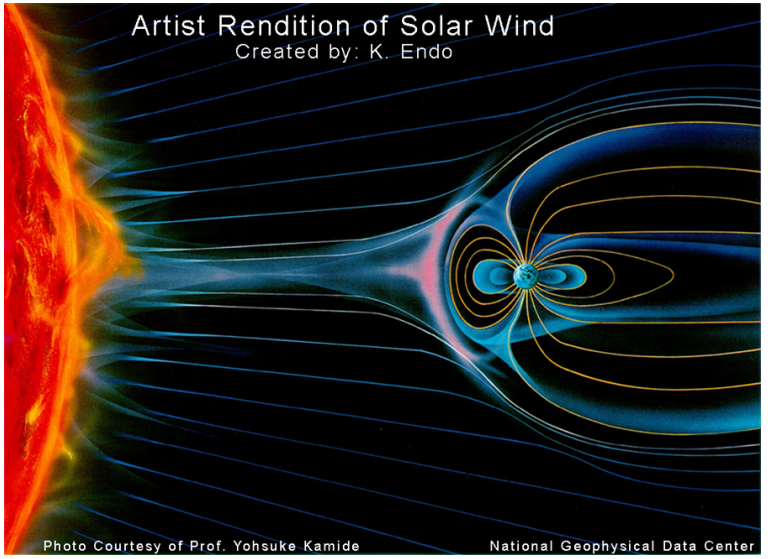
- Lifetime of ARIEL is planned to be 4-6 years
- The shortest known activity cycles are in the magnitude of ~1 year
- Variations in exoplanetary atmospheres might be detected



Activity cycles detected from Kepler observations

ARIEL & stellar activity

- The interaction of exoplanets and stellar magnetism is crucial for planetary evolution and for the search for life
- Can the system harbor life on long term? (first signs of life on Earth dates back to 4Gyr, although complex life based on eukaryotic cells took much longer time to form)



ARIEL & stellar activity

- The interaction of exoplanets and stellar magnetism is crucial for planetary evolution and for the search for life
- Can the system harbor life on long term? (first signs of life on Earth dates back to 4Gyr, although complex life based on eukaryotic cells took much longer time to form)
- O'Malley-James & Kaltenegger (2016) suggested protective bioluminescence as a proxy for detecting life (although the sample size of ARIEL will be probably too small)

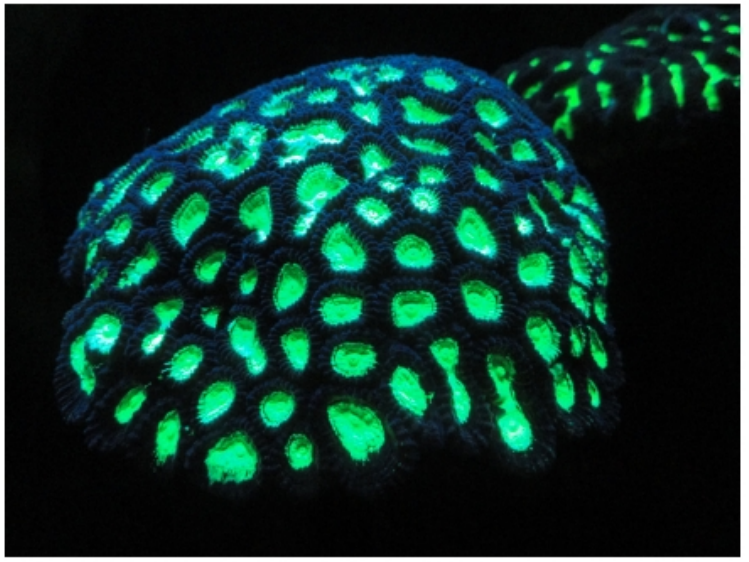


Figure 1. An example of coral fluorescence. Coral fluorescent proteins absorb near-UV and blue light and re-emit it at longer wavelengths (see e.g. Mazel & Fuchs

Planets around brown dwarfs

- The hosts themselves could be interesting
- Longer life time
- Most of them not active → good possible hosts for life
- Some BDs show activity signatures, but traditional methods (Hα emission) are not always suitable
- 2.7 um H2O, 3.3 um CH4 and 4.6 um CO bands were proposed as possible indicators of chromospheric activity, all within the reach of ARIEL