New windows on massive stars: asteroseismology, interferometry, and spectropolarimetry
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The UVMag space project: UV and visible spectropolarimetry of massive stars

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Abstract. UVMag is a medium-size space telescope equipped with a high-resolution spectropolarimetrer working in the UV and visible domains. It will be proposed to ESA for a future M mission. It will allow scientists to study all types of stars as well as e.g. exoplanets and the interstellar medium. It will be particularly useful for massive stars, since their spectral energy distribution peaks in the UV. UVMag will allow us to study massive stars and their circumstellar environment (in particular the stellar wind) spectroscopically in great details. Moreover, with UVMag's polarimetric capabilities we will be able, for the first time, to measure the magnetic field of massive stars simultaneously at the stellar surface and in the wind lines, i.e. to completely map their magnetosphere.

Keywords. telescopes, space vehicles, instrumentation: polarimeters, instrumentation: spectrographs, stars: early-type, ultraviolet: stars

1. The UVMag space mission

UVMag is a space mission dedicated to the study of the dynamic 3D environment of stars and planets. It will consist in a 1.3-meter telescope and a spectropolarimeter covering the UV and visible wavelength range from 117 to 870 nm. An option for far-UV (90-117 nm) is also currently explored. The spectral resolution will be at least 25000 in the UV domain and at least 35000 in the visible domain. Full Stokes (IQUV) information, i.e. both circular and linear polarisation, will be obtained. More details on the spectropolarimeter design are available in Pertenaïs et al. (2014). The mission will be proposed to ESA this autumn as its M4 mission, for a launch in 2025. It will last 5 years.

2. What can UVMag do for massive stars?

UVMag is particularly well suited for massive stars since it will observe in the UV and visible domains, i.e. where massive stars emit most of their lines. UVMag will mainly target massive stars with magnitudes between V=3 and 10, but massive stars in the Magellanic Clouds will also be reachable with a longer exposure time. This will allow us to probe stars in a different environment. UVMag will allow us to:

- study the stellar wind through UV resonance lines and visible recombination lines, in particular for O stars;
- study wind clumping and the line-driven instabilities;
- study the magnetic field at the stellar surface with improved signal-to-noise. Indeed, thanks to the increased number of photons and of lines available in the UV compared to the visible domain, the signal-to-noise ratio of Zeeman magnetic signatures obtained with the LSD technique in the UV is higher than in the visible domain;
- study the magnetosphere and confinement of material around the star. Emission

from the plasma trapped in the magnetosphere can be observed in visible emission lines, while the confined wind can be studied in the UV resonance lines;

• study linear polarisation and depolarisation effects from circumstellar disks.

With UVMag we will thus be able to study the formation, evolution and environment of massive stars. More details about UVMag's science case for massive stars as well as for other topics can be found in Neiner et al. (2014).

3. UVMag's observing program

UVMag will observe three types of targets:

• Mapping targets: 50 to 100 stars (of all types) will be followed over at least one full rotation period with high cadence in order to study them in great details and reconstruct 3D maps of their surface and environment. These targets will be partly secured through the consortium core program and partly chosen following a competitive proposal process. Some targets (in particular solar-type stars) will be reobserve every year to study their variability over activity cycles.

• Survey targets: several thousands stars will be observed once or twice to provide information on their magnetic field, wind and environment. This will include an unbiased magnitude-limited statistical sample and targets selected through a competitive proposal process. These snapshot data will provide statistical results as well as specific inputs (e.g. wind terminal velocity) for stellar modelling.

• A Target of Opportunity (ToO) mode is also planned, in particular for supernovae and outbursting stars such as classical Be stars.

There are ∼50000 stars with 3<V<10 observable with UVMag. Among them, there are ∼20000 OB stars. Since 7% of OB stars are found to be magnetic (Wade et al. 2013), there are statistically ∼1400 magnetic OB stars among the ∼20000 OB stars. However, only ∼100 magnetic OB stars are known as of today. Although this number has been growing significantly since the new generation of spectropolarimeters (Narval at TBL, ESPaDOnS at CFHT and HarpsPol at ESO) is available, it will probably remain rather low in the coming decade. It is therefore probable that all magnetic OB stars known at the time of launch will be observed by UVMag in the survey sample (and several of them will be mapped in details). Of course, non-magnetic OB stars will also be observed.

For massive stars, the signal-to-noise ratio in the intensity spectrum will be above 100 in 20 minutes exposure, both in the UV and visible domains.

4. Conclusions

UVMag is an M-size space mission with a 1.3 meter telescope equipped with a high-resolution spectropolarimeter working in the UV and visible domain simultaneously. This mission will be particularly useful for the study of massive stars which emit most of their light in this wavelength domain. This includes the study of their wind, magnetic field, magnetosphere, disk, clouds as well as of their surface (e.g. spots).

References

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