# UVMag: a UV spectrograph + optical spectropolarimeter to study stellar magnetospheres

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Abstract: In the last decade magnetic fields have been detected in basically all types of stars. These discoveries gave rise to innovative studies on the mapping of magnetic fields and on their impact on stellar environment. To go even further, the UVMag international consortium proposes to combine UV spectroscopy, which allows us to study stellar winds, with optical spectropolarimetry, which allows us to study magnetic fields and the stellar surface, i.e. to study magnetospheres as a whole and over a complete stellar rotation period thanks to a space mission. A CNES R&T study is starting.

## The UVMag consortium

The UVMag consortium has been created in 2010 to discuss, design and promote UV spectroscopy associated to optical spectropolarimetry. The goal to propose a mission dedicated to stellar magnetospheres. The idea is based on the recent success of ground-based spectropolarimeters and use of archival UV data. The consortium is led by France, with strong collaborations from Canada, Germany, USA, Sweden, Switzerland, Ireland...

## Why a space mission ?

Research on stellar magnetism has been progressing very fast from the ground in the last decade, but we are missing information on the wind and magnetospheres because there is no UV spectrograph available for long fractions of time. Of course, the UV domain requires a space mission. To reconstruct the magnetospheres, we need to obtain simultaneous UV data and spectropolarimetry, continuously over several stellar rotation periods.

→ Space mission with UV spectroscopy + optical spectropolarimetry

## Main driver: stellar physics

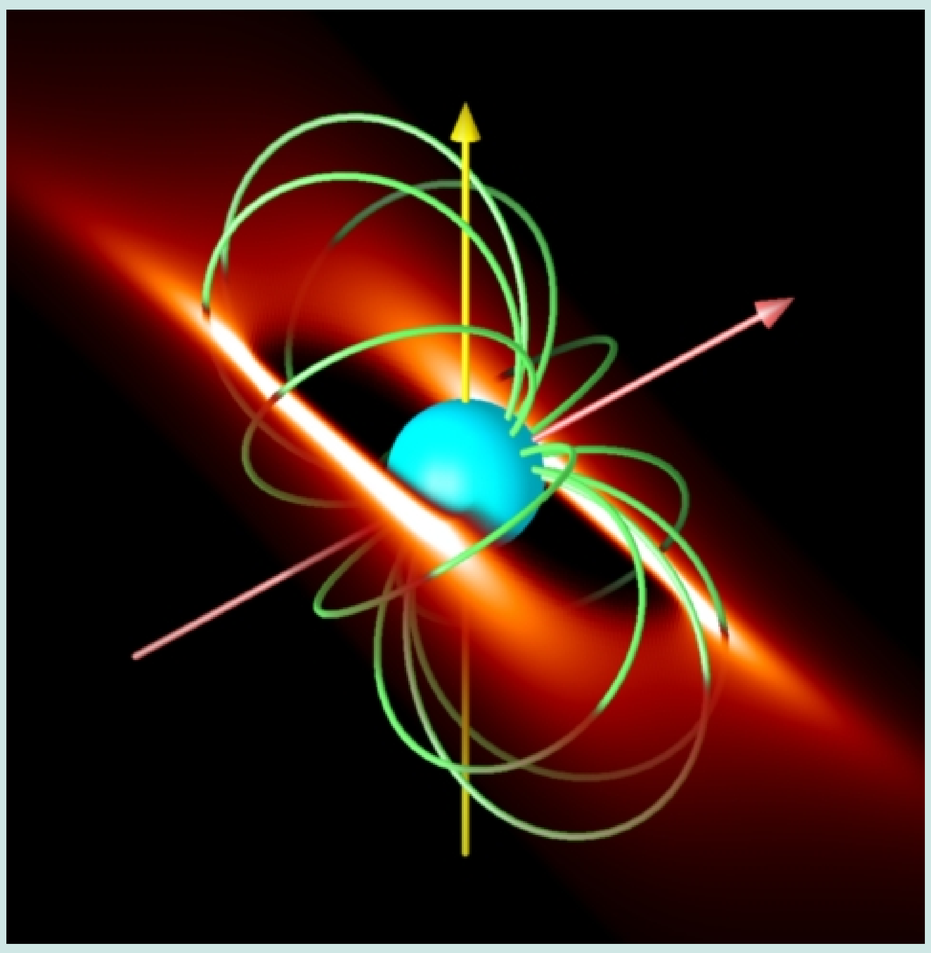
1. Massive stars
- Only recently discovered to be magnetic, ~6% of all massive stars are magnetic, field of fossil origin
- Activity: extreme testbeds for impact on/of rotation, mass loss, radiation,...
- Late stages of stellar evolution : magnetic neutron stars, millisecond magnetars, relation to hypernovae and GRBs ?

2. A and Ap stars
- Dichotomy: Ap stars are those with the strongest fields, while A stars have very faint fields. What causes this dichotomy ?

3. Cool stars
- Dynamo : the stellar cycle
- Solar twins: ability to observe a Sun e.g. during a « Maunder minimum » or with a different rotation rate
- Magnetospheric accretion

4. M stars
- Full convection threshold (at M4)?
- Magnetic topologies : strong axisymmetric dipolar field or less organized non-axisymmetric fields depending on the star.

5. Supergiants
etc...



## Specifications: UV spectrograph

| Spec | Minimum requirement | Aim |
|---|---|---|
| Range | 115-320 nm | 90-320 nm |
| Resolution | >25000 | 50000+1000 |
| S/N | >100 | >200 |

→ easy to achieve with current CCDs, similar to HST/STIS
→ benefit from new developments for WSO/HIRDES, CUSE, MUSE,...

## Specifications: optical spectropolarimeter

| Spec | Minimum requirement | Aim |
|---|---|---|
| Range | some lines in 390-870 nm | 390-870 nm |
| Resolution | 20000 | 60000 |
| S/N | > 100 | > 300 |
| Polarization | V | QUV |
| Instr. Pol. | < 3% | < 1% |

→ Never done from space.
→ Size and weight of ground-based concepts are not realistic for space.
→ Need to keep instrumental polarization under control.
→ Ongoing R&T funded by CNES

## Specifications: targets

| Spec | Requirement | Dream | |
|---|---|---|---|
| Magnitude | V=3-6 | V=2-10 → to reach clusters | |
| # stars | 4178 | 354694 | |
| # OB stars | 1075 | 22154 | |
| # cooler stars | 3103 | 332540 | |
| # mag OB stars | 65 | 1329 | (counting 6% mag) |
| # mag cooler stars | 1552 | 166270 | (counting 50% mag) |
| # targets | 50 | 200 | |
| Time per target | 4 weeks | 6 weeks → 4+2 in a 2nd period | |
| Mission duration | 4 years | 23 years → stellar cycles | |

## Additional possible science

- Starburst galaxies : requires low-resolution mode and larger mirror
- AGNs : requires low-resolution mode and much larger mirror
- ISM : requires resolution above 100000
- White dwarfs : requires far-UV and low-resolution mode
- Novae : Target of opportunity mode

→ This science will not drive the design but will be taken into account if easy to implement.

## Conclusions

The UVMag consortium has set the basic requirements for a space mission to study the magnetospheres of all types of stars. This is the next step to progress on the characterization and modeling of magnetospheres. Simultaneous UV spectroscopy and spectropolarimetry over long periods of time is indeed the only way to comprehend the full interaction between the stellar magnetic field and stellar wind.

You are interested in participating?
→ contact Coralie Neiner (coralie.neiner@obspm.fr)