The UVMag space project

Coralie Neiner
(LESIA, Paris-Meudon Observatory, France)
and the UVMag consortium

→ Stellar formation, evolution, structure and environment of all types of stars thanks to the study of their surface, wind and magnetosphere with UV+optical spectropolarimetry

The UVMag mission project

→ A medium size space mission with a 1.3m telescope equipped with a UV+optical spectropolarimeter

- Currently under R&D study funded by CNES
- To be proposed as a M-size mission at ESA
- Instrument also proposed for EUVO

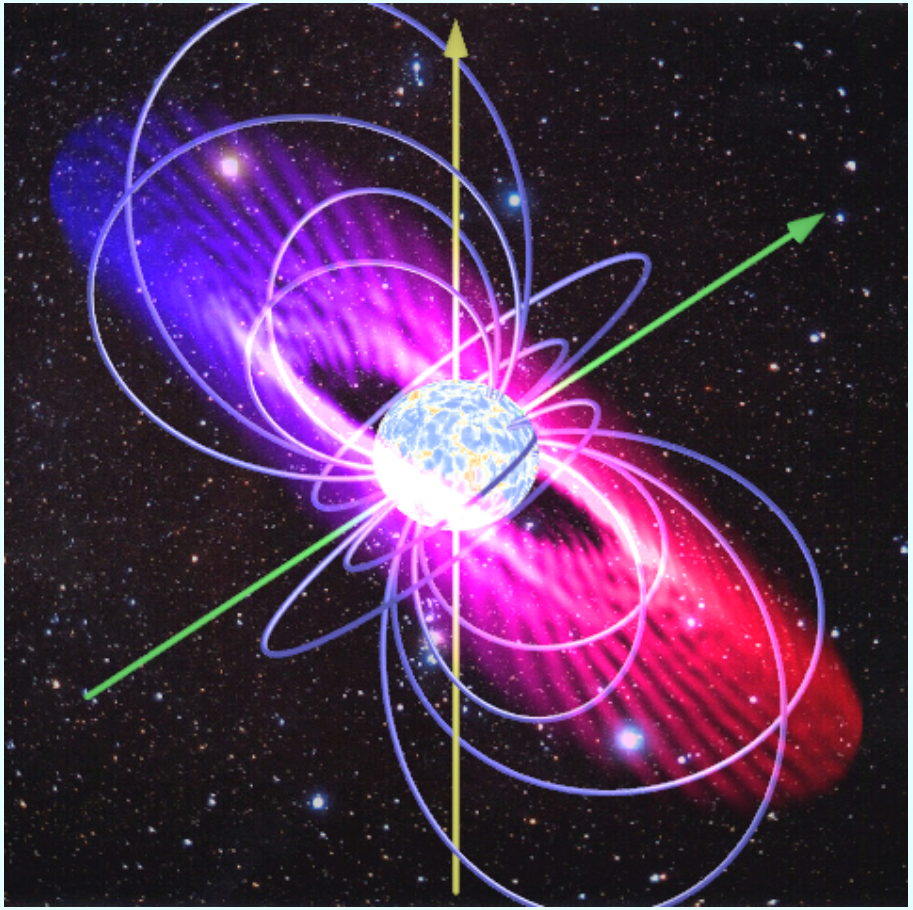
- PI: C. Neiner
- Science consortium: ~50 members from ~30 institutes from 11 countries (Belgium, Brazil, Canada, Chile (ESO), France, Germany, Ireland, Switzerland, Sweden, UK, USA)
- Payload consortium: France+Belgium for R&D

A UV and optical spectropolarimeter

- Spectropolarimetry in the UV allows to study the stellar wind, magnetosphere, chromosphere...

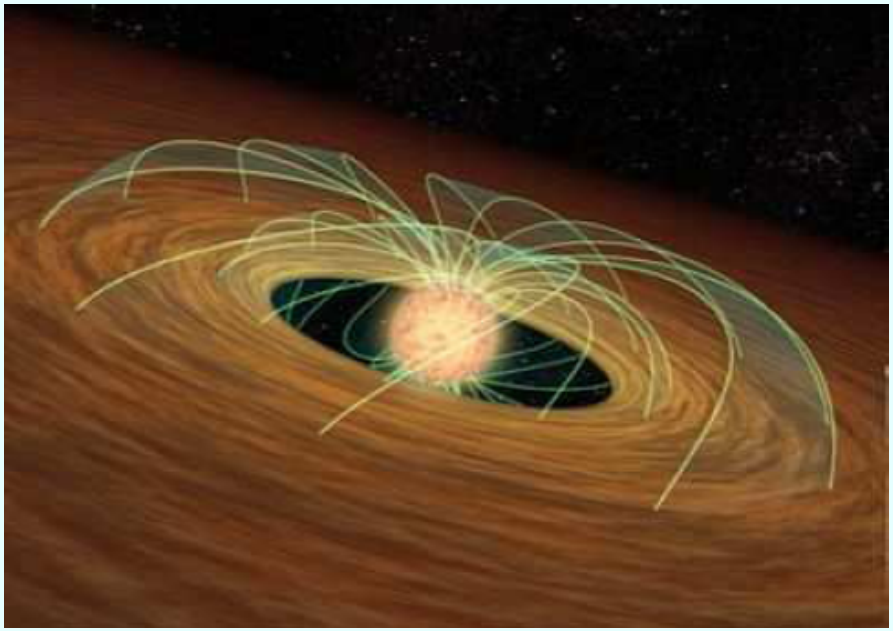
- Spectropolarimetry in the optical allows to study the magnetic field at the stellar surface, chemical spots...

→ Spectropolarimetry in the UV+optical over a rotation period allows to reconstruct the full 3D maps of the star from its surface to its environment



Science drivers: stellar formation and early phases

- Statistical properties of the various populations of stars? Incidence of magnetic fields? Properties of wind and mass loss (e.g O stars)?
- What causes the dichotomy of A stars: either with sub-G magnetic fields (Vega-like) or fields above ~300 G (Ap/Bp stars)?
- Timescales over which magnetospheric accretion stops in PMS stars?
- Why do T Tauri stars rotate slowly? How does the disk locking mechanism work?
- What happens during the magnetic stabilization phase at the start of the PMS? How does an abrupt change of magnetic obliquity affect the star and its environment?

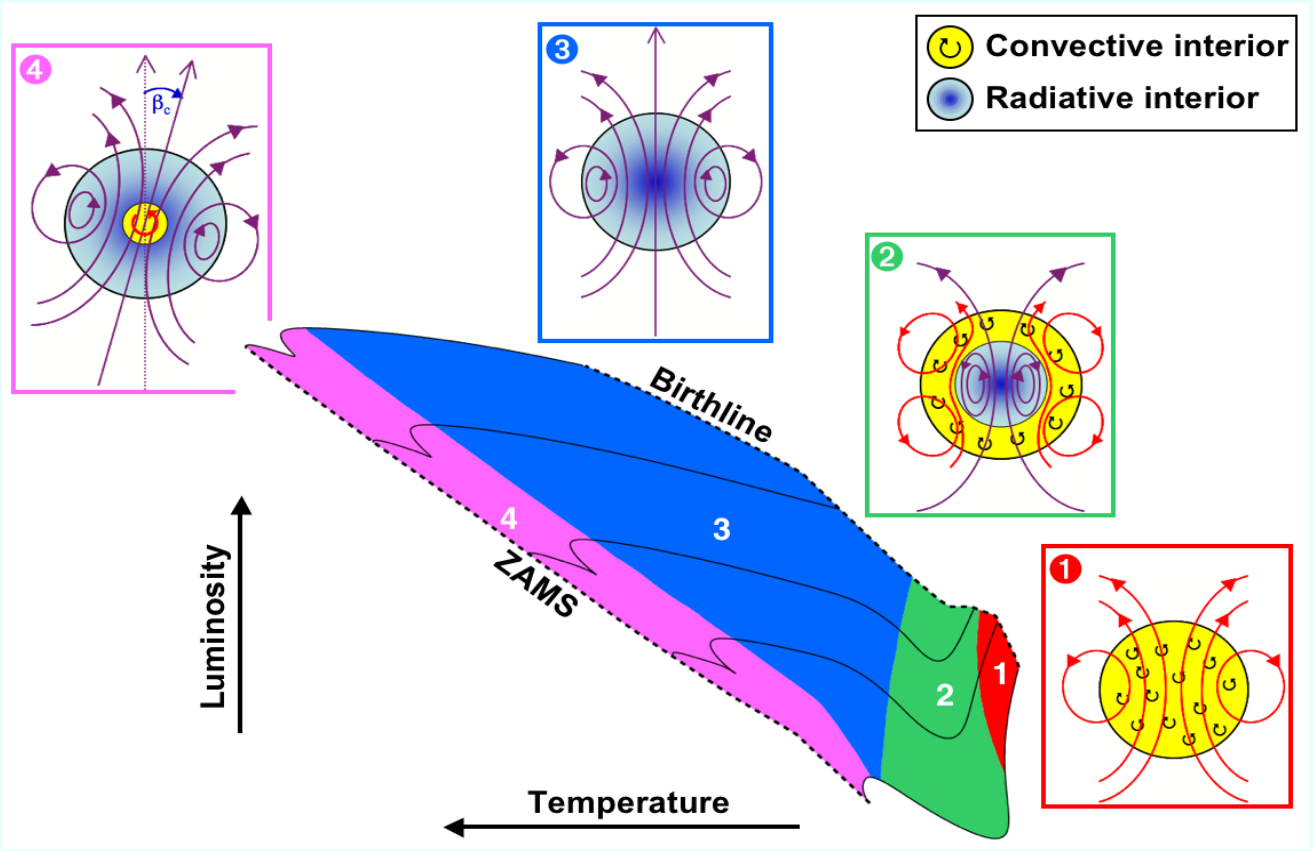


Science drivers: stellar structure

- Conditions to develop a dynamo magnetic field?
- Interplay between magnetic fields, rotation and wind in the activity of stars (e.g. impact of angular momentum loss due to the magnetically-driven wind on dynamo of cool stars which in turn affects the wind?)
- Conditions for OB stars to become Be stars? Causes of LBV outbursts? What happens when a star reaches critical rotational velocity? Origin of γ Cas stars behavior?
- How do the solar and stellar cycles work? Influence by the solar/stellar environment? Respective impacts of the global and small-scale solar-type dynamos?
- Explanation to diversity of magnetic properties of M dwarfs? How is their magnetism related to that of planets, brown dwarfs and of solar-type stars?

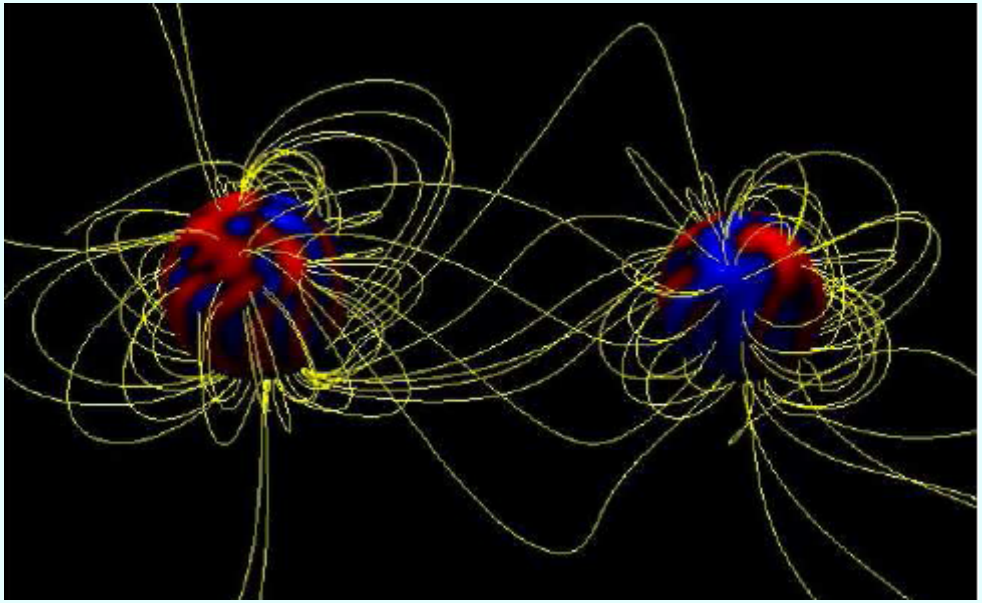
Science drivers: stellar evolution

- Role of magnetic field, rotation, metallicity and mass loss in the evolution of stars? In particular for their late stages (white dwarfs, supernovae, neutron stars, black holes, γ-ray bursts)?
- What allows a fossil magnetic field to survive the various phases of stellar evolution?
- How strong was the solar magnetic field when the Sun was young? How will it evolve?



Science drivers: stellar environment

- How does a stellar magnetic field influence mass loss, in particular wind clumping and a circumstellar disk/clouds?
- Impact of magnetospheric interactions on binary stars? Tidal effects?
- Impact of solar dynamo on Earth, and how does it evolve with time?
- Star-planet magnetospheric interactions?
- How do decretion disks of Be stars build up? How are they destroyed? How do instabilities in accretion disks develop?



Requirements

Specification	Requirement	Goal
UV+optical spectral range	117-320+ 390-870 nm	90-1000 nm
Resolving power in UV range	25000	100000 and 2000
Resolving power in optical range	35000	80000
S/N in UV range	100	200
S/N in optical range	100	300
Spectrograph efficiency in UV	5%	10%
Spectrograph efficiency in optical	10%	25%
Polarization	V in lines	QUV in lines and in continuum
Instrumental polarization	3%	1%
Polarization accuracy	0.3%	0.1%
Polarization sensitivity	$3\ 10^{-5}$	$1\ 10^{-5}$
Accuracy in radial velocity	1 km s^{-1}	0.3 km s^{-1}
Pointing stability	0.5 arcsec	0.2 arcsec
Target magnitude	V=3-10	V=2-15
Survey stars (sample 1)	4000	8000
Time per survey star	20 min	30 min
Targeted stars (sample 2)	50	100
Time per targeted star	4 weeks	6 weeks (4+1+1)
Mission duration	4 years	12 years

Targets

- 50 stars observed continuously over 2 rotation periods → 3D maps
  + solar-like stars re-observed every year → stellar cycles
- 4000 stars observed twice → survey

Spectral type	V=3-10	V=2-15	Magnetic rate	Magnetic V=3-10	Magnetic V=2-15
O	428	1823	6%	26	109
B	19940	42891	6%	1196	2573
A	53143	102442	10%	5314	10244
F	61867	105487	20%	12373	21097
G	55780	97365	20%	11156	19473
K	88358	121052	20%	17672	25421
M	10276	18367	20%	2055	3673
Be stars	1225	1705	1%	12	17
Herbig Ae/Be	44	60	10%	4	6
M dwarfs	94	693	50%	47	347

Additional science

With no change in the design:

- Structure and properties of ISM: local interstellar medium, H2 in diffuse molecular medium
- White dwarfs and cataclysmic variables: weak fields, accretion flows
- Exoplanetary magnetic fields: bow shocks, field strength of the planet
- Atomic physics in the UV

With Target of Opportunity mode:

- Novae: properties (abundances, structure, mass) of ejecta in UV

With better polarisation precision:

- Exoplanetary atmospheres: chemical and thermal structure of upper layers of atmospheres (Rayleigh diffusion)

Conclusions

UVMag project:

M-size space mission equipped with a UV+optical spectropolarimeter to study stellar formation, structure, evolution and environment + possible additional science

→ See http://lesia.obspm.fr/UVMag

International science consortium
+ ongoing R&D study for the spectropolarimeter

→ Want to join? Contact me! (coralie.neiner@obspm.fr)