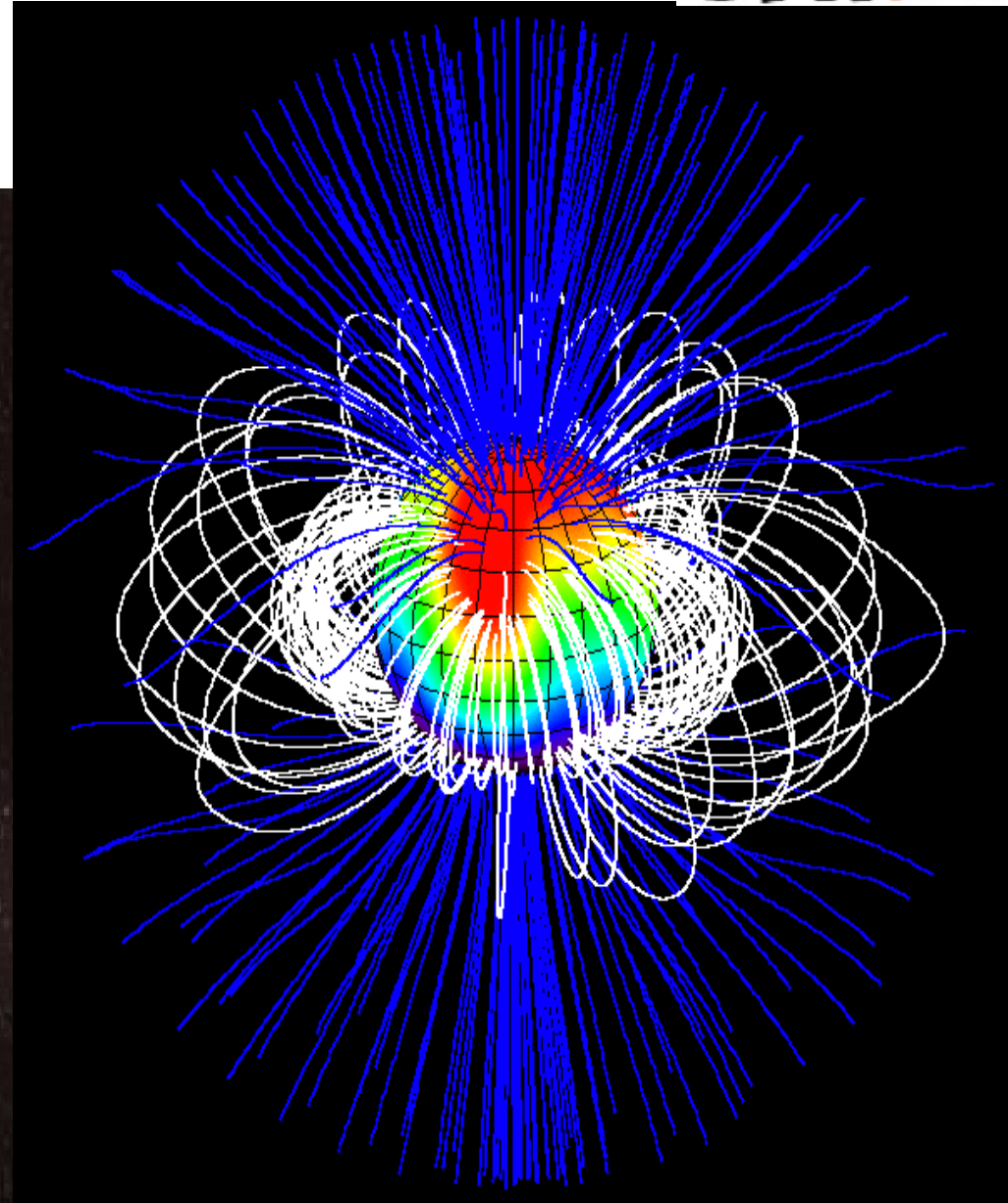


# SPIRou : Legacy Survey & NIRPS synergies



Xavier Delfosse / IPAG  
And the SPIRou team

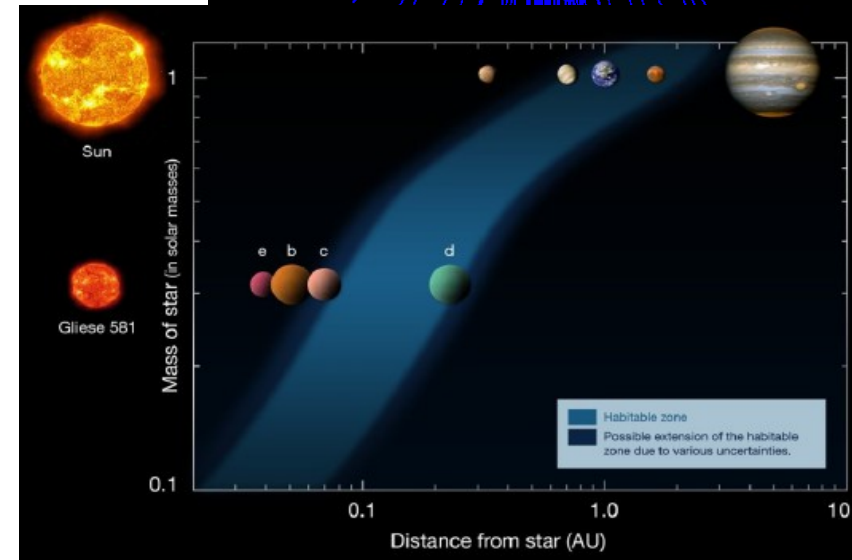
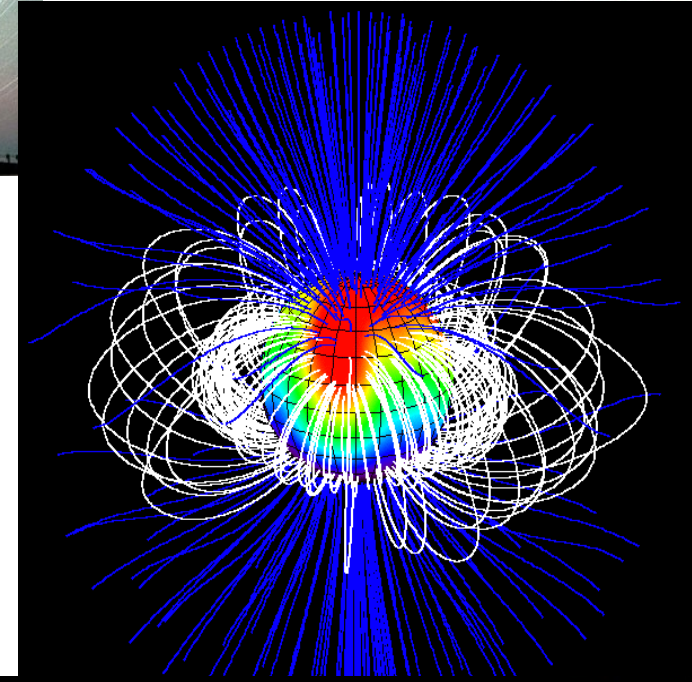


# SPIRou



## Spectropolarimètre Proche InfraRouge

- New generation instrument for CFHT (2017)
- SPIRou aims at becoming **world-leader on two forefront science topics** :
  - The quest for habitable Earth-like planets around very low-mass star/ M-dwarfs (see I.Boisse and G.Hébrard talks),
  - The study of low-mass star and planet formation in the presence of magnetic fields (see J.F. Donati talk).
- **SPIRou will be coupled with a large survey**



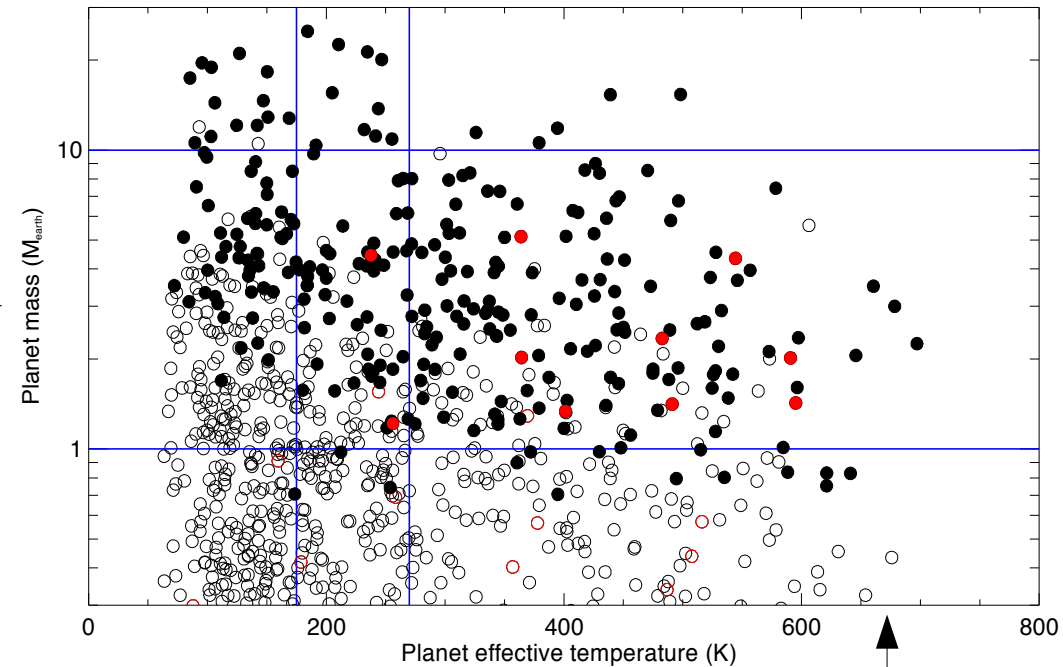
# SPIRou Science Requirements



## Planets around M-dwarfs

- 1 m/s accuracy is needed to detect Super-Earth in Habitable Zone Around early/mid M-dwarfs

- 3 m/s accuracy is needed to detect Super-Earth around late M-dwarfs



MC simulation

Filled circle : detected planets with SPIRou  
(1m/s accuracy in 5' on J~8.5)

# SPIRou Specifications

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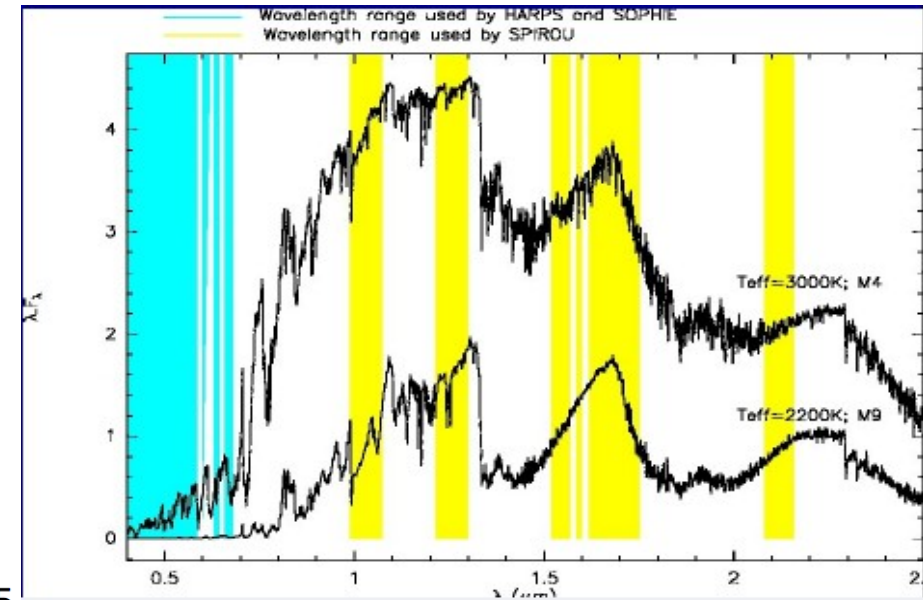
- **Single-shot spectral domain covering YJHK (0.98-2.35  $\mu\text{m}$ )**
  - Very high spectral RV content in K-band for M-dwarfs
  - Magnetic field of (embedded) young stars in early phase
- **spectral resolution 70K-75K**
  - Optimize RV accuracy for typical FWHM of M-dwarfs lines
- **Radial velocity stability : 1m/s**
  - Detection of Earth/Super-Earth in HZ of M-dwarfs
- **Linear and circular polarimetric capacity :**
  - 1-2 % max crosstalk and down to a sensitivity <10 ppm (ESPaDOnS -like)
  - Stellar Magnetic field
  - Disentangle activity and keplerian RV signal
- **SN~100 per 2km/s pixel in hr @ J=12.0 ; K=11 :**
  - throughput of 15 %
  - Efficiency for a large RV and polarimetric survey
- **Efficiency of 70% and 90% for Texp of 15 and 60 minutes / 4min overheads per exposures**
  - Efficiency for a large RV and polarimetric survey

# SPIRou Specifications



1m/s accuracy achieved with SPIRou for SN=172

- 5 min for J=8.3
- 15 min for J=9.5
- 30 min for H=10.25



## Expected RV photon noise uncertainties on SPIROU Comparison with HARPS and ESPRESSO

M4 dwarf J= 9.5 15 min on SPIROU → 1 m/s (J=13 15 min → 5

			SPIROU	HARPS	ESPRESSO
K0	V-J = 1.5	V=11	2.9 m/s ?	1.6 m/s	0.6 m/s
K5	V-J = 2.5	V=12	1.8 m/s ?	2.5 m/s	1 m/s
K7	V-J = 2.8	V=12.3	1.6 m/s ?	2.9 m/s	1.2 m/s
M0	V-J = 3.0	V=12.5	1.4 m/s ?	3.2 m/s	1.3 m/s
M3	V-J = 3.8	V=13.3	1.0 m/s	4.5 m/s	1.8 m/s
M5	V-J = 5.0	V=14.5	1.0 m/s	7.9 m/s	3.2 m/s



- ❑ **7** Countries: Canada, France, Switzerland, Taiwan, Brazil, Portugal, Hawaii
- ❑ **12** Institutes:  
HIA/NRC, IRAP/OMP, IPAG, UdM, UdL, CFHT, ASIAA, OG, OHP/LAM, CAUP, LNA, IAP
- ❑ **59** FTE for the 2014-2017 period

**PI** : J.-F. Donati (IRAP) / Co-PI : R.Doyon (UdM)

**PM** : D.Kouach (OMP) / DPM : M. Lacombe (OMP)

**PS** : X.Delfosse (IPAG) / E.Artigau (UdM) / CFHT-PS : C.Moutou (CFHT)

**SE** : S.Baratchart (IRAP)

# SPIROU : schedule



- 2008 : Retenu sur appel d'offre CFHT (Canada-France-Hawaii Telescope) ; pour financement d'une étude du concept (phase A)
  - Oct 2010 : CoDR (Conceptual Design Review) ; ---> passage en phase B
  - Oct 2012 : PDR (Preliminary Design Review) ; ----> passage en phase C
  - Avril 2014 : FDR (Final Design Review) + consolidation du plan de financement
  - Sept 2014 : SPIROU Science Meeting : Legacy Survey definition
- 
- [2014-2016](#) : Réalisation / Intégration (France et Canada)
  - [2016-2017](#) : Acceptance Test in France
  - [2017](#) : first light (Hawaii / CFHT)

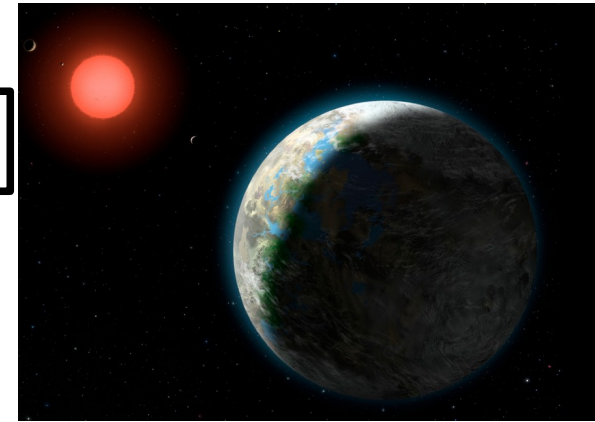
# SPIRou Legacy Survey



The two main science goal of SPIRou required very large amount of time

- the quest for habitable Earth-like planets around very- low-mass stars,
- the study of low-mass star and planet formation in the presence of magnetic fields

SPIRou only makes sense if coupled to a large Survey



## •Building the CFHT's future / 2007 CFHT users'meeting :

« The ESPaDOnS team is actively working towards building an infrared version of ESPaDOnS (Spirou)...  
... such a monitoring program would require many observing nights and a case could be made to have the instrument on the telescope all year long. »



# SPIRou Legacy Survey



SL1 / WP1 :  
Detecting low mass planets  
150-200 nights

SL2 / WP2 :  
RV Follow up of transiting planets  
150-200 nights

SL3 / WP3 :  
Impact of magnetic fields on low  
Mass stars/planets formation  
125 nights

WP4 :  
Common to  
Planets survey

WP5 :  
Common to all SPIROU LS

Duration : 5 years (Today the principle of a 3 years large survey is validated by CFHT board) |  
100 nights/years

# SPIRou Legacy Survey



SL1 / WP1 :  
Detecting low mass planets  
150-200 nights

- Focused on a small sample (50, 100, 200 ?) of M-dwarfs
- A census of planets in very close solar neighborhood (including Super-Earth in Habitable Zone)
- Search the best candidates for future characterisation mission
  - \* in particular detection of reflected light for non-transiting planets / HIRES-PCS/ELT, space,
  - \* 10 microns imagery can characterize planets in external HZ around closest M-dwarfs
  - \* census of planets in habitable zone in solar neighbourhood
- Planetary statistics properties for planets around  $>M4$  and  $P>30$  days (domain not or partially covered by TESS)

# SPIRou Legacy Survey



SL2 / WP2 :  
RV Follow up of transiting planets  
150-200 nights

- Mass measurements (with typical accuracy of 10%) of transiting planets candidates (TESS, K2, ExTrA)
    - \* Mass-radius relation → planets density, constitution
  - Search for another planets in TESS system
  - Detect planets from TESS mono-transit detection
  - Select best candidates for transiting planets characterization (JWST, ELT)
- > A very similar objective that the NIRPS one.

# SPIRou Legacy Survey



WP4 - WP5:  
Use SL1 and SL2

- Dynamics studies : stability, dynamical evolution
- Stars-planets interaction : magnetic interaction, tidal effect
- Spectral analysis of M-dwarfs spectra : stellar parameters and planetary statistics
- Stellar magnetic analysis : use of polarimetric capacity to filter activity jitter

# SPIRou Legacy Survey

## Structure



WP1 : detecting low-mass planets

WP1.1 : Input catalog

WP1.2 : Planets detection

WP1.3 : Detection limits and statistics

WP1.4 : Photometric follow up of SPIRou Planets

resp : X Delfosse, E Artigau, C Moutou, F Bouchy

coord : L. Malo / E. Artigau / T.Forveille

coord : C.Moutou / F.Bouchy / X.Delfosse

coord : A.Cumming / X.Delfosse

coord S.Metchev / M.Deleuil

WP2 : RV follow-up of transiting pl.

WP2.1 : target selection

WP2.2 : Planet characterization

WP2.3 : Complementary observations

Resp : R Doyon, G Hébrard, J.Rowe

coord : G.Hébrard, J.Rowe, X.Bonfils

coord : G.Hébrard, X.Bonfils, E.Artigau + ?

coord : R.Doyon, A.Lecavelier

WP4 : common studies of planetary system

WP4.1 : RV optimization

WP4.2 : filtering activity

WP4.3 : Dynamics

WP4.4 : Star-planet interaction

WP4.5 : Habitable zone

resp : I Boisse, C Baruteau

coord : F.Bouchy / E.Artigau

coord : I.Boisse / P.Figueira

coord : J.Laskar / C.Baruteau

coord : S.Brun / C.Moutou

coord : F.Forget / F.Selsis

WP5 : Study common to all SPIRou Legacy Survey

WP5.1 : Spectral analysis

WP5.2 : Stellar magnetic properties of M-dwarfs

WP5.3 : Earth atmosphere

resp : J Morin, L Malo, S Brun

coord : J. Dias do Nascimento / L.Malo

coord : J.Morin, L.Jouve, P.Petit

coord : P.Figueira

# SPIRou Legacy Survey People (SL1 and SL2)



- France :

F.Allard, **I.Boisse**, X.Bonfils, M.Bonnefoy, **0.3\*F.Bouchy**, M.Deleuil, **X.Delfosse**, J.-F. Donati, T.Forveille, P.Fouqué, T.Guillot, **G.Hébrard**, J.Laskar, A. Lecavellier, N.Meunier, **J.Morin**, **C.Moutou**, P.Petit, C.Reylé + students

- Canada :

**E. Artigau**, L.Albert, A.Cumming, N.Crouzet, **R.Doyon**, D.Dragomir, E.Hébrard, R.Jayawardhana, D.Lafrenière, **L.Malo**, C.Marois, J.Matthews, S.Metchev, L.Nelson, **J.Rowe**, D.Valencia, K.Venn, G.Wade + students

- Brazil :

A.A.Brito, B.Castilho, J.Dias du Nascimento, E.Martioli, C.V.Rodrigues, R.K.Saito + students

- Switzerland :

Y.Alibert, **0.7\*F.Bouchy**, X.Dumusque, C.Lovis, F.Pepe, S.Udry + students

- Portugal :

A.Correia, P.Figueira, N.Santos + students

- Another countries

E.Gaidos, L.Rogers

A lot of people in common with NIRPS...

... but not all.