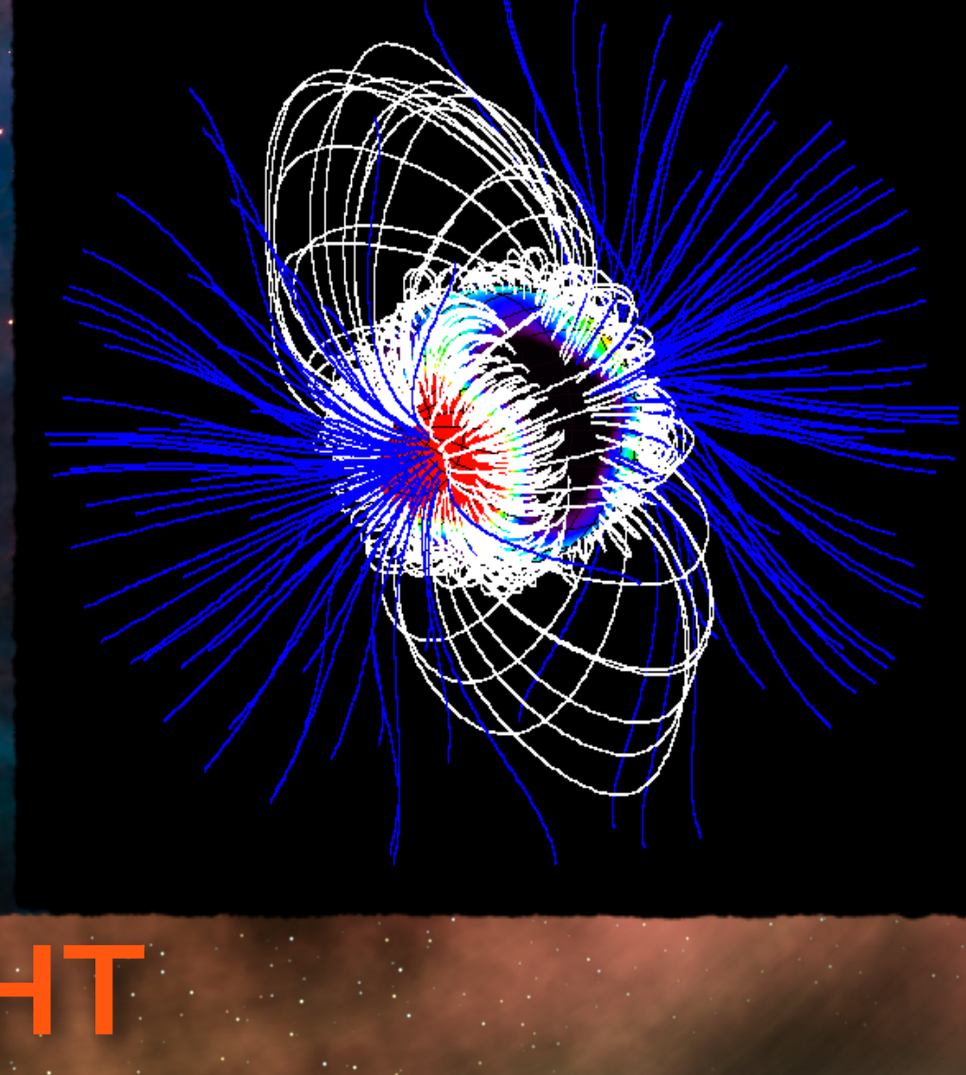
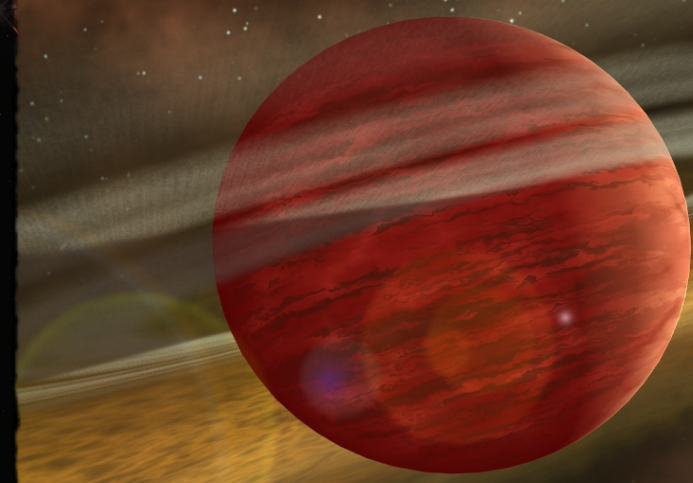


SPIRou @ CFHT

exploring nearby habitable worlds



an international project for pioneering science

France, Canada, CFHT, Brazil, Taiwan, Switzerland & Portugal

SPIRou @ CFHT

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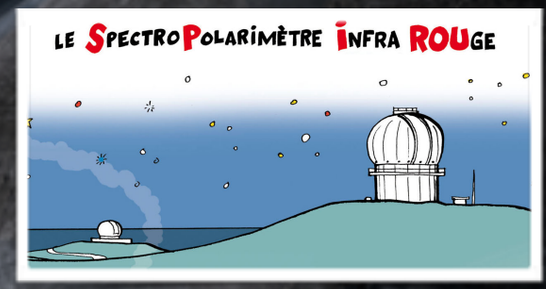

- **studying Earth-mass planets around M dwarfs**
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Sun

M dwarfs

exoplanets.org | 6/29/2015

Mass of Star [Solar Mass]

1

0.1

habitable zone (HZ)

0.01

0.1

1

10

Semi-Major Axis [Astronomical Units (AU)]

Planet Mass [Earth Mass]

10^3

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Sun

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exoplanets.org | 6/29/2015

very few HZ super Earths

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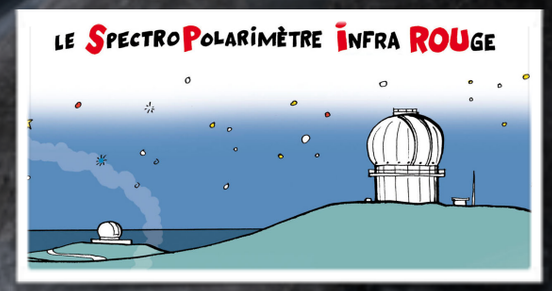
SPIRou @ CFHT

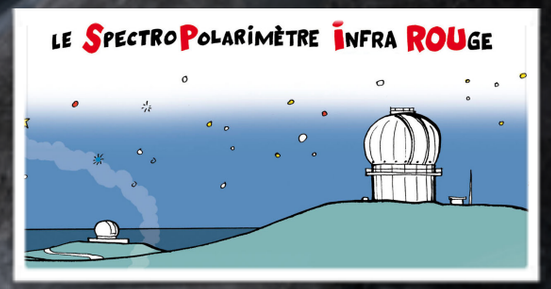
observing red dwarfs in the nIR



- **surveying ~380 nearby M dwarfs in the nIR**
  - 80% of stars in the galaxy & in the solar neighborhood
  - habitable exoEarths much easier to detect

SPIRou @ CFHT

observing red dwarfs in the nIR

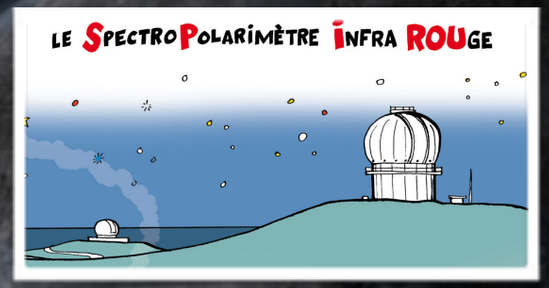


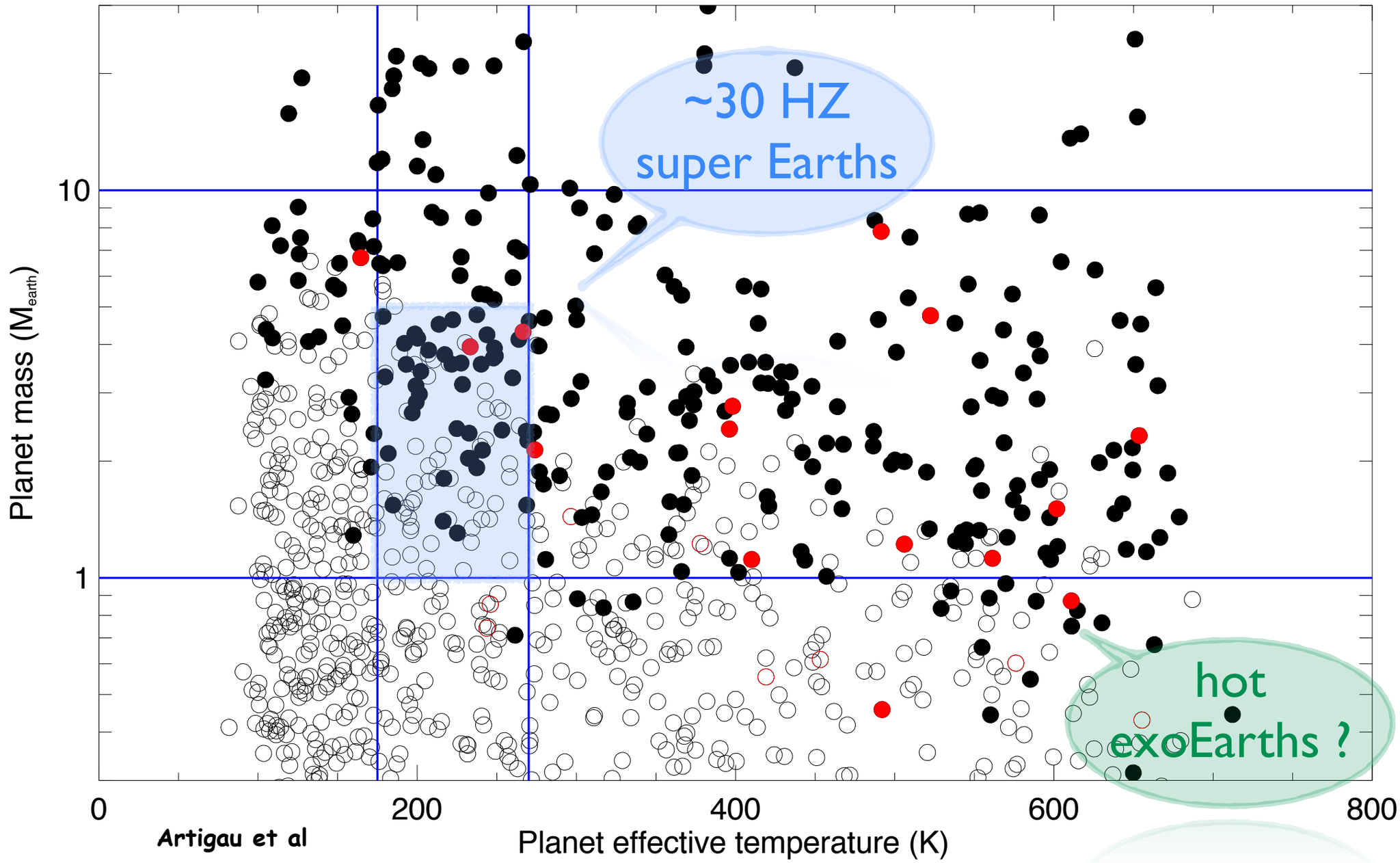
- **surveying ~380 nearby M dwarfs in the nIR**
  80% of stars in the galaxy & in the solar neighborhood
  habitable

- **nIR velocimetry & spectropolarimetry of ~330 M dwarfs**
  detect & characterize ~180 superEarths, ~30 of which in HZ
  ➾ estimate occurrence frequency of habitable planets in solar neighborhood
  ➾ synergies w/ CHEOPS, SPHERE & GAIA
  use **spectropolarimetry** to model activity, magnetic field & RV jitter
  ➾ improve detection threshold & characterization of habitability

SPIRou @ CFHT

MC simulation of planet search





SPIRou @ CFHT

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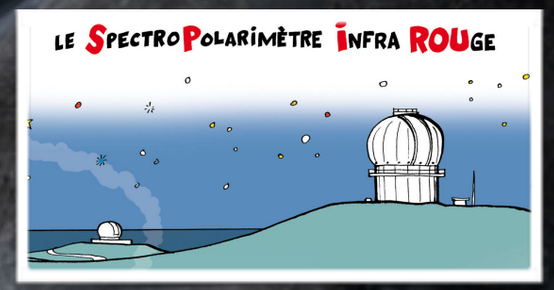

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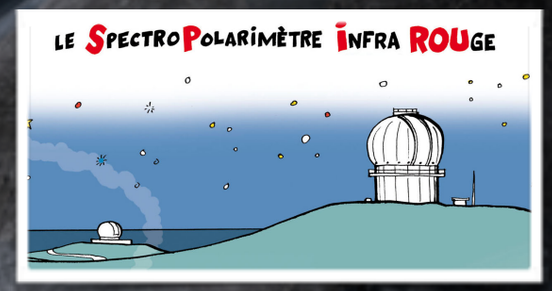
- **follow-up of ~50 transiting planet candidates**
  establish planetary nature of candidates & estimate average planet density
  - best candidates fromTESS, ExTrA and later on PLATO
  - search for atmospheric **markers** in nearest HZ exoEarths w/ JWST & E-ELT

SPIRou @ CFHT

observing red dwarfs in the nIR



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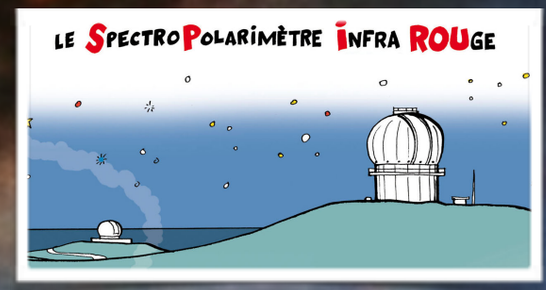
- **magnetic fields of M dwarfs**
  dynamo processes / bistability in fully-convective bodies
  impact of stellar / planetary magnetic fields on planet habitability

SPIRou @ CFHT

exploring nearby habitable worlds



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magnetic topologies of young protostars (class I, cTTSs, wTTSs)
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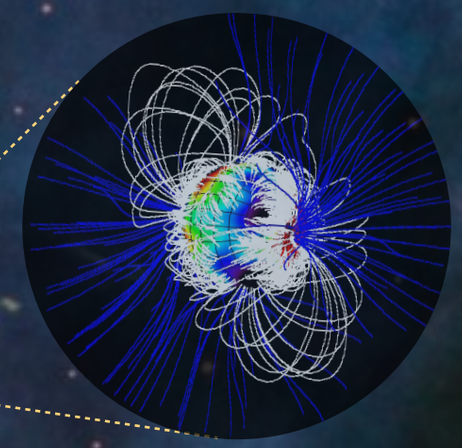
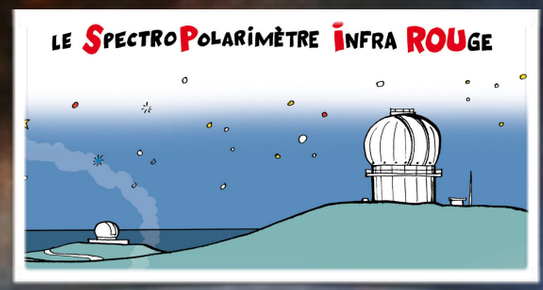
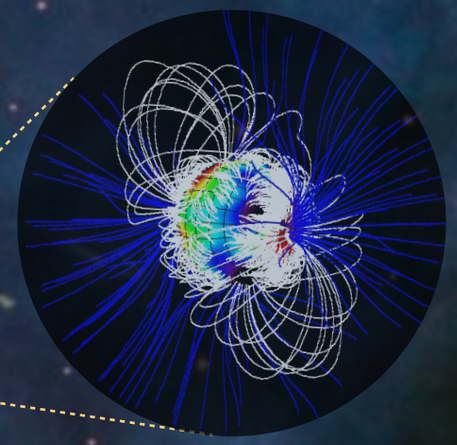


SPIRou @ CFHT

investigating star & planet formation



- **focussing on class-I, -II (cTTSs) & -III (wTTSs) PMS stars**
  - magnetic field of star & disc modifies accretion & outflows
  - impacts internal structure & rotation of stars
  - impacts formation, migration & survival of planets



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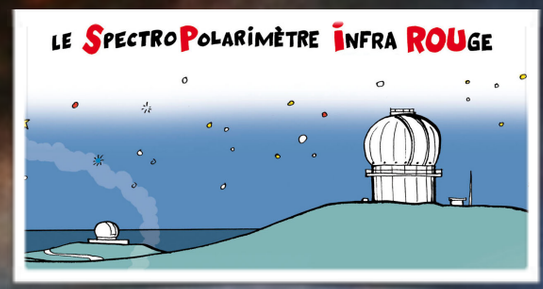

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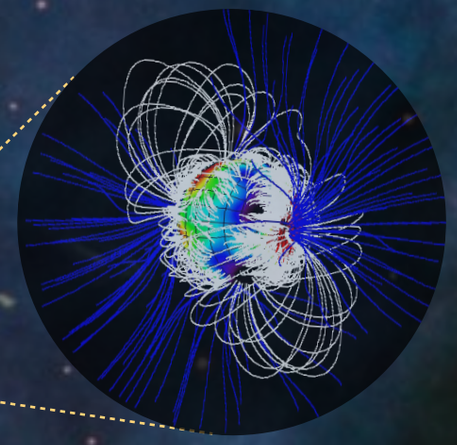
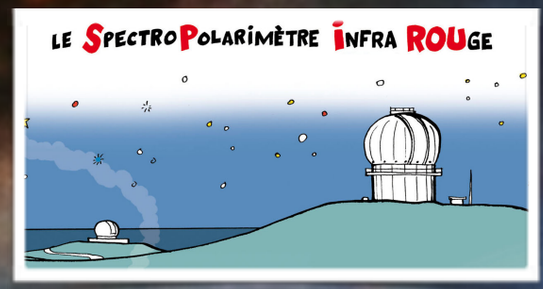
- **nIR spectropolarimetry of ~140 PMS stars**
  - model magnetic topologies of ~20 class-I (embedded) protostars, ~40 cTTSs & ~80 wTTSs in nearby SFRs (e.g., TW Hya, Tau/Aur, ρ Oph, ONC, Lupus)
  - ➸ origin & evolution of field, impact on star & planet formation
  - ➸ synergies with ALMA & JWST



SPIRou @ CFHT

investigating star & planet formation



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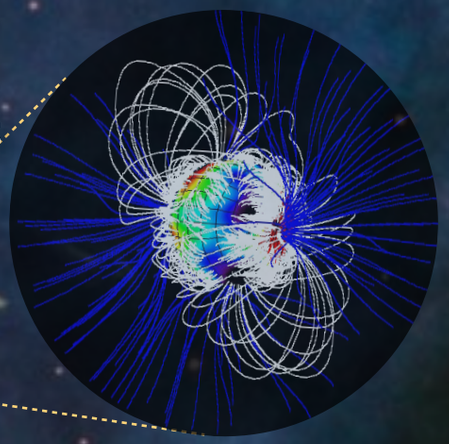
velocimetry of wTTSs

model activity & activity jitter of wTTSs w/ & search for hot Jupiters

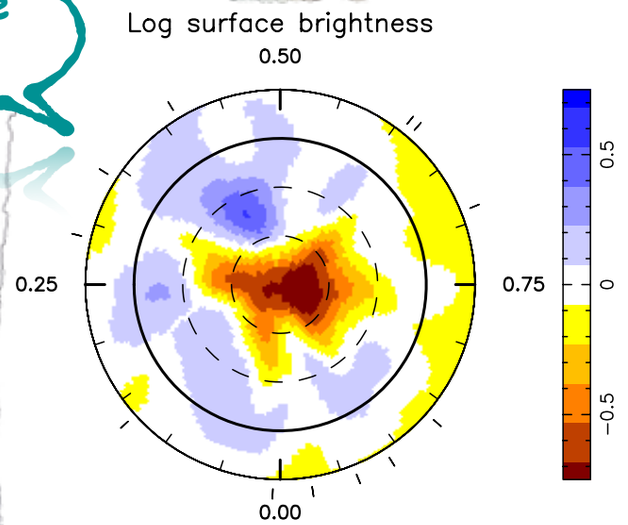
- formation / migration / survival of giant planets
- synergies with SPHERE & ALMA

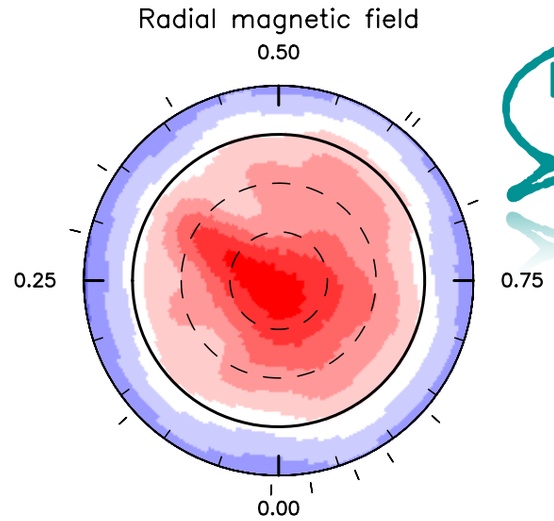


hot Jupiters around young Suns

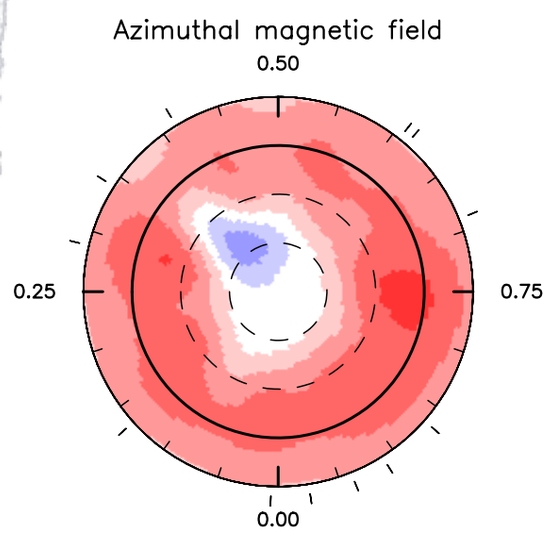
modeling the activity & RV curves of T Tauri stars

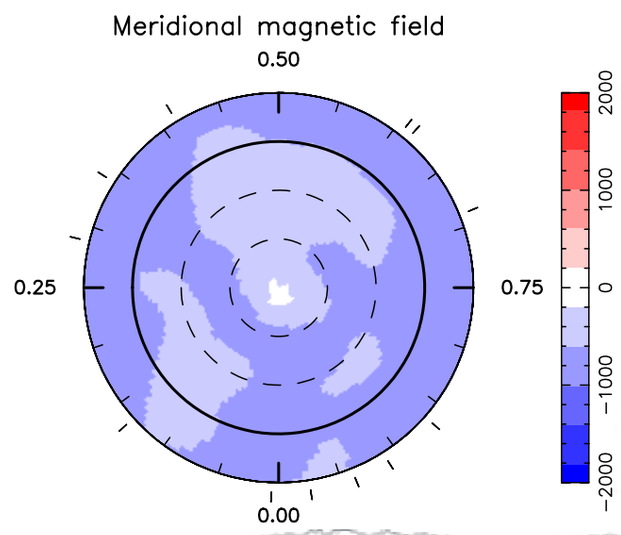
surface spots





large-scale B field





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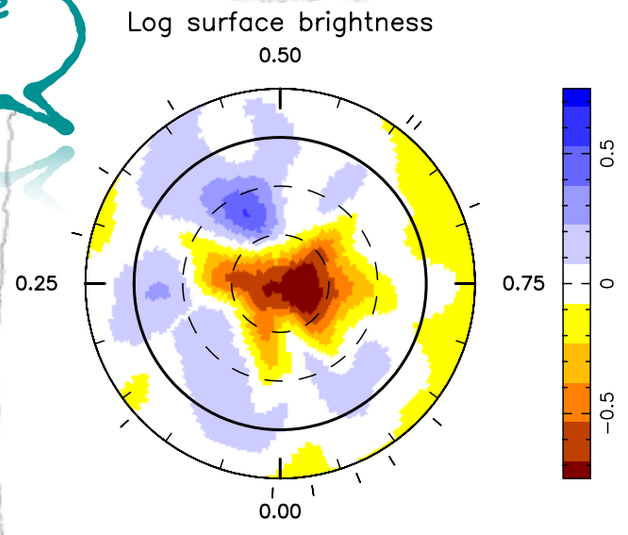

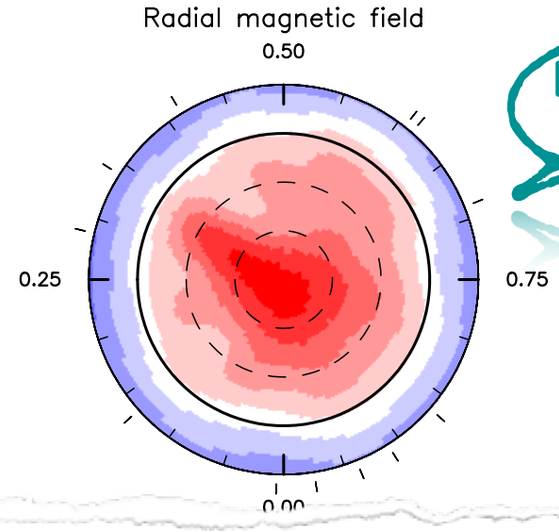

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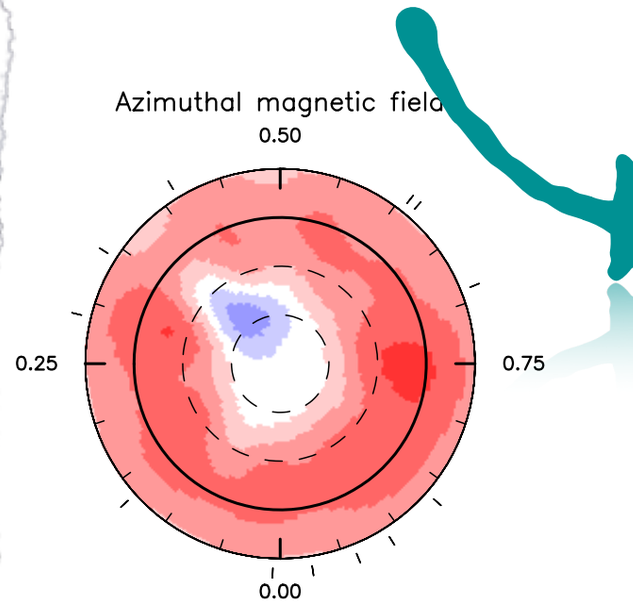

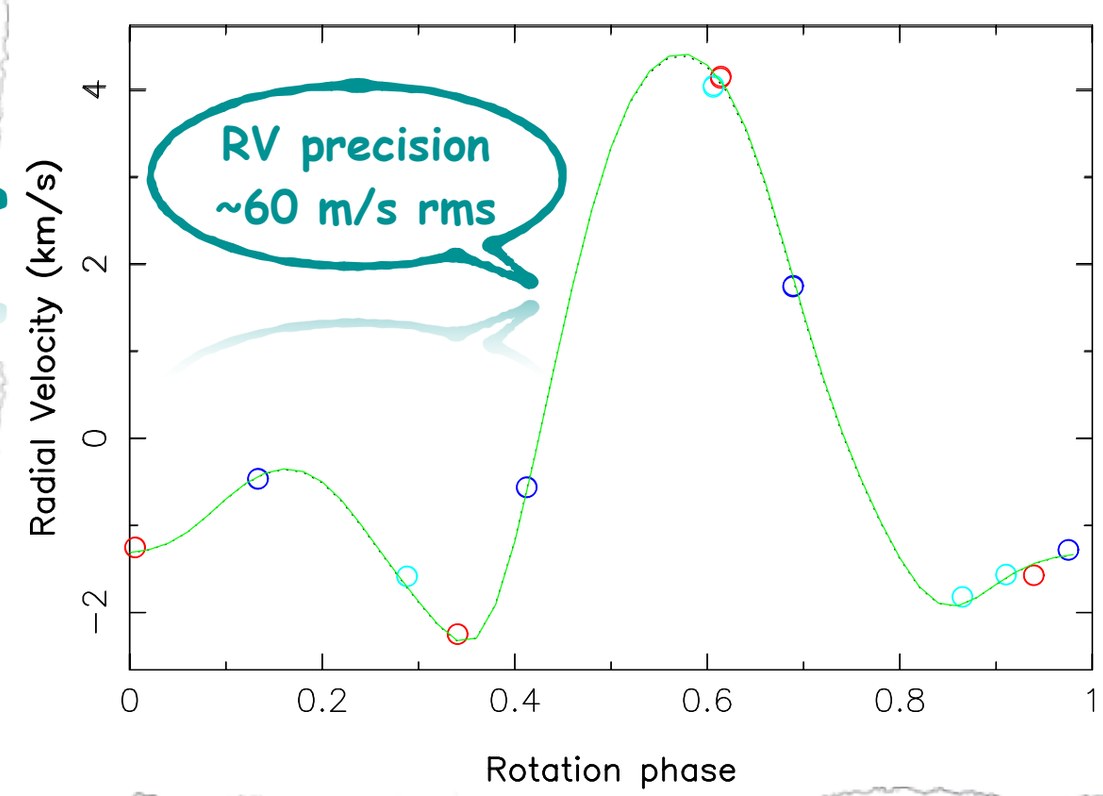

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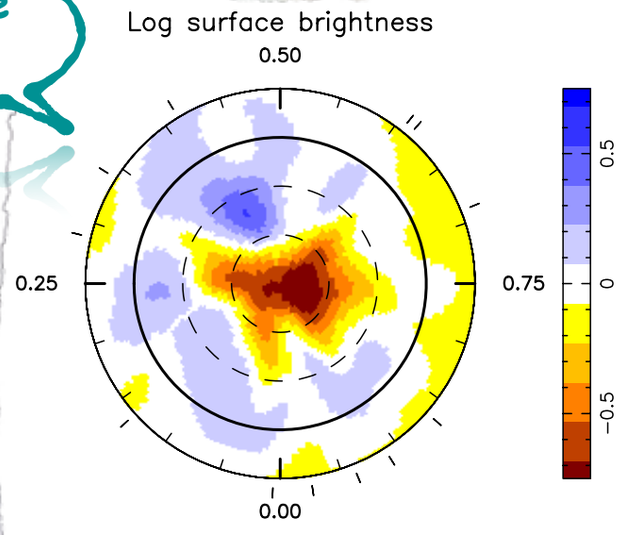

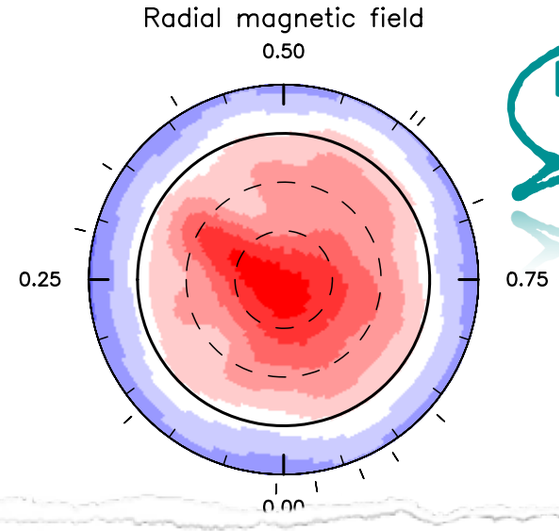

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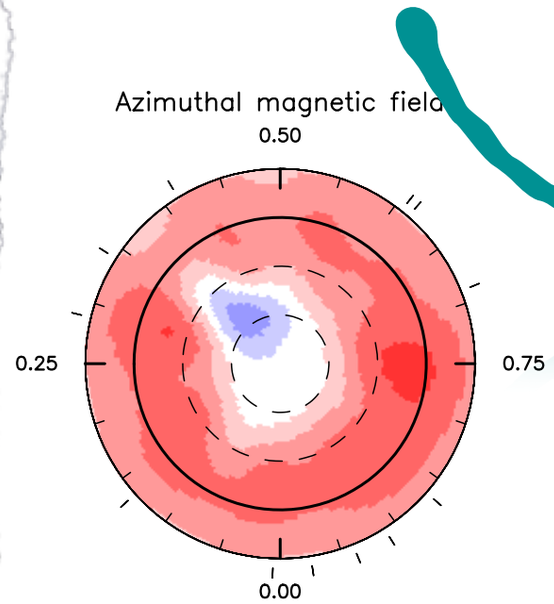

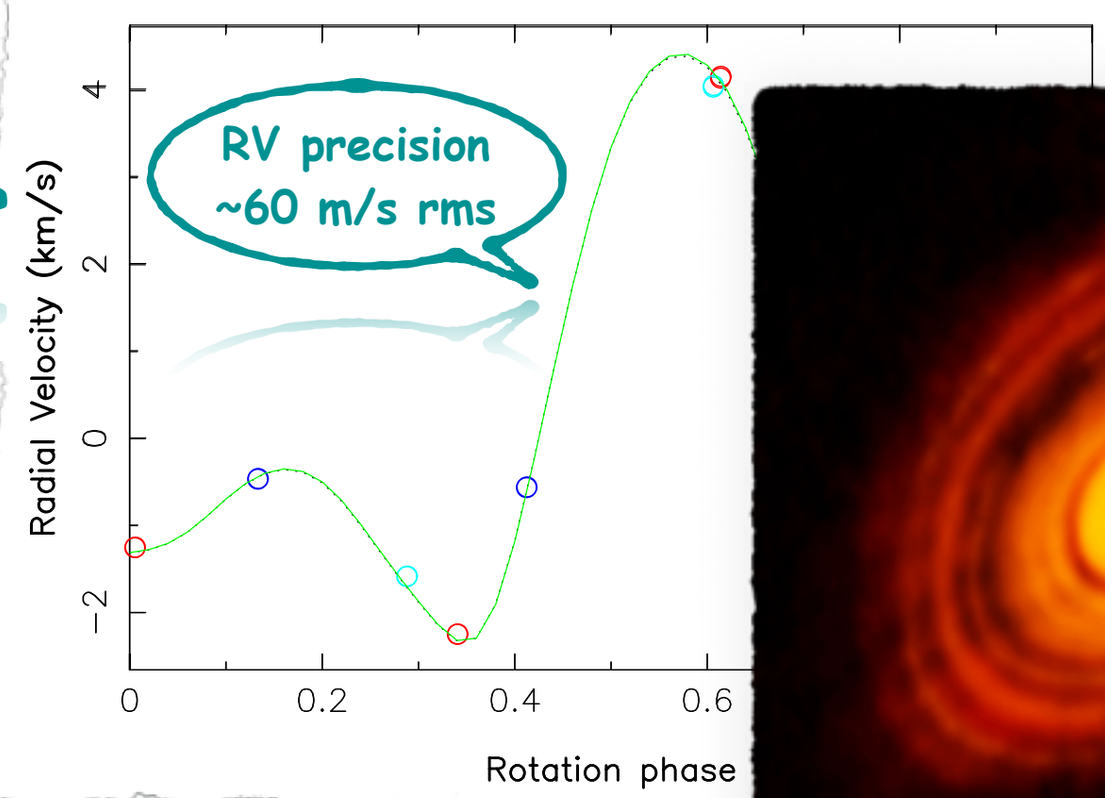

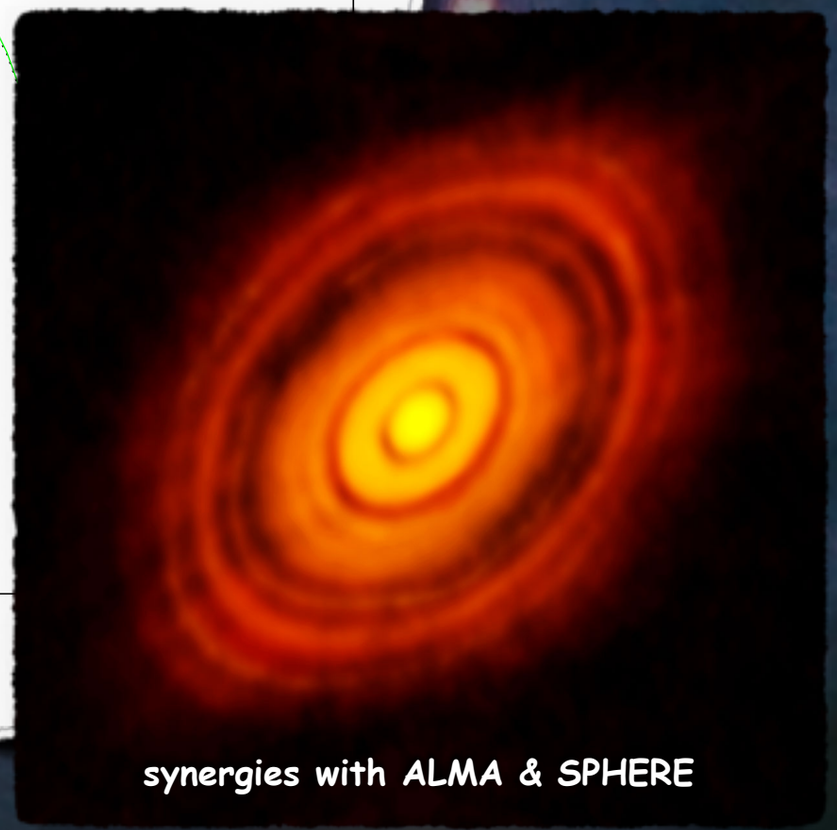

synergies with ALMA & SPHERE

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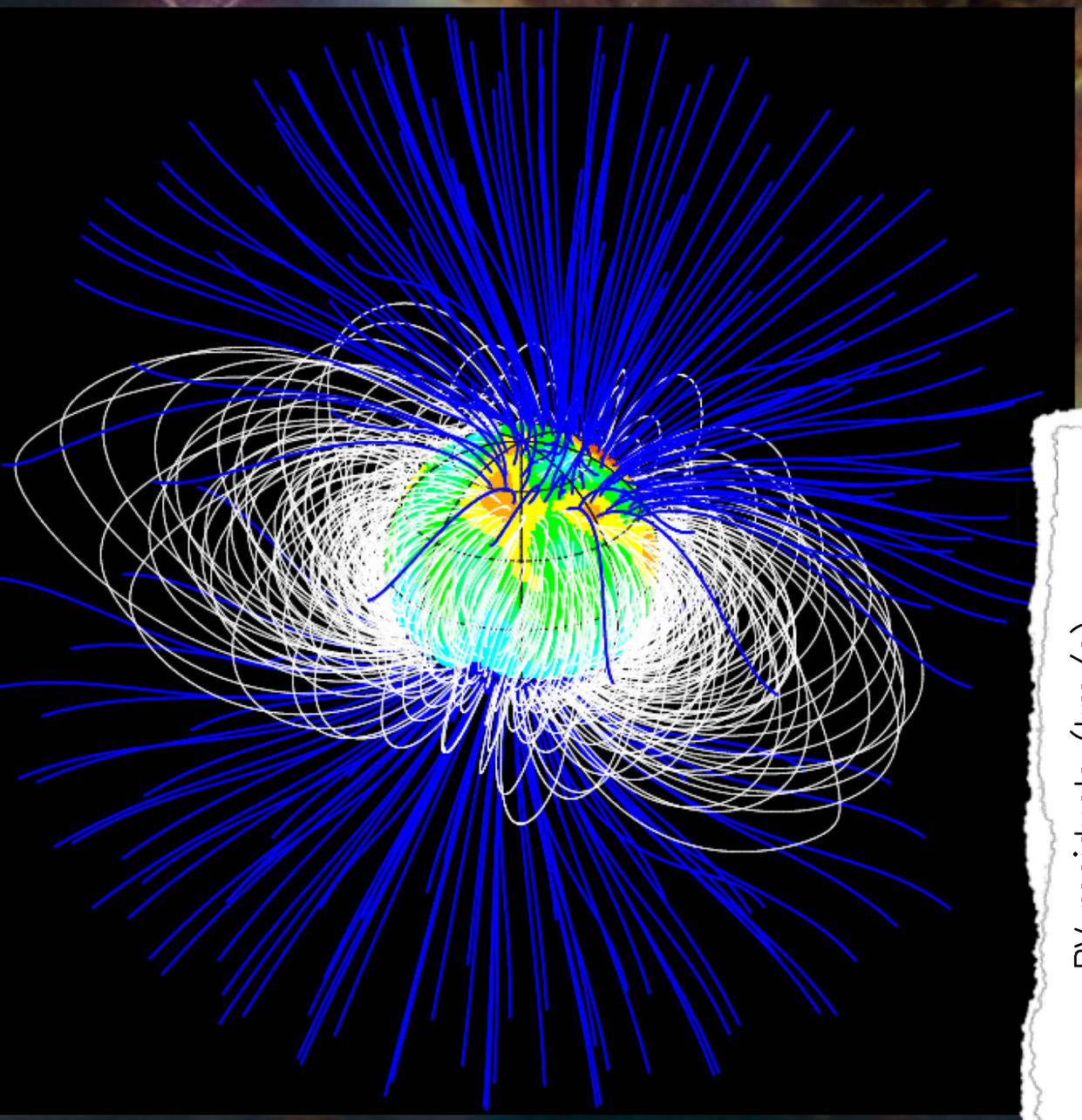
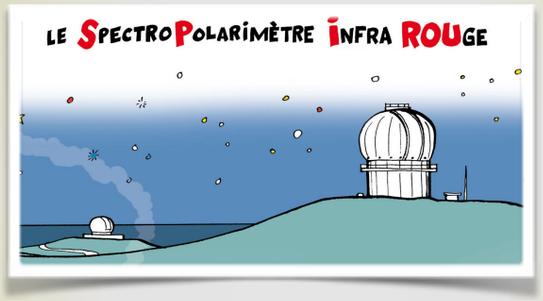


SPIRou @ CFHT

additional science goals



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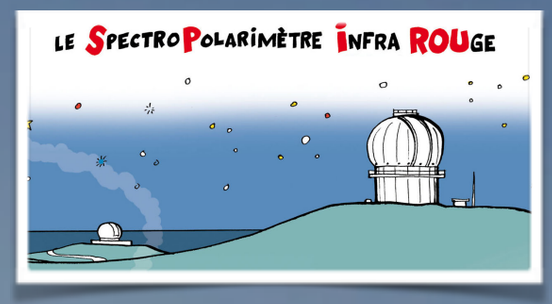
  - weather patterns on brown dwarfs
  - properties & formation of massive stars
  - exoplanet & solar-system planet atmospheres

SPIRou @ CFHT

instrument performances

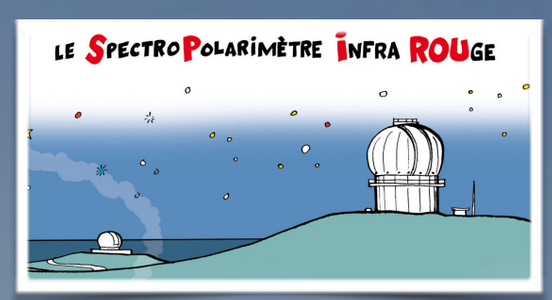


main science requirements

simultaneous wavelength domain: 0.98 - 2.35 µm (YJHK bands)
spectral resolution: 75 000 / RV precision: 1 m/s
circular & linear achromatic polarimetry
S/N~100 (per 2.3 km/s bin) @ H~11.0 in ~1 hr exposure

SPIRou @ CFHT

instrument performances



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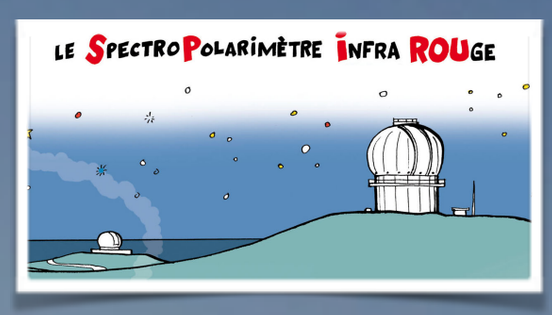
instrumental concept & schedule

Cassegrain unit w/ polarimeter ➾ heritage from ESPaDOnS & HARPS
fluoride optical fibers & pupil slicer (compatible with RV precision)
cryogenic spectrograph cooled down @ 80 K and stable @ 2 mK
first light @ CFHT: 2017 ➾ in phase with TESS & JWST

SPIRou @ CFHT

instrument performances



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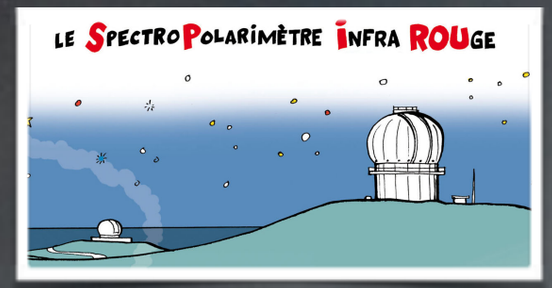
nIR bonus in instrument sensitivity

3+ mag gain in velocimetry vs HARPS for M dwarfs
↬ **outperform ESPRESSO@VLT for M dwarfs**
5+ mag gain in spectropolarimetry vs ESPaDOnS for M dwarfs & TTSs
↬ **10x more efficient than CRIRES+@VLT**

SPIRou science

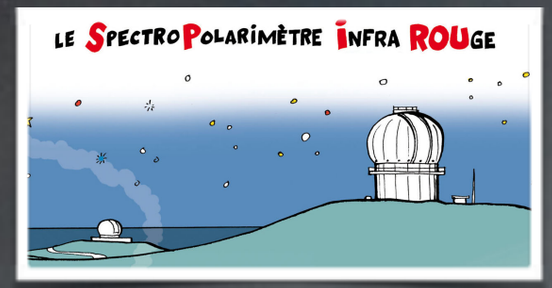
short- & long-term prospects



- **the worldwide SPIRou Science Consortium**
  - 100+ scientists from 10+ institutes in France, Canada, Brazil, Taiwan, Switzerland & Portugal
  - ➪ science community structured in ~25 working groups

SPIRou science

short- & long-term prospects



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the 500-night SPIRou Legacy Survey @ CFHT

Planet Search (275n) + Transit Follow-up (100n) + PMS star survey (125n)

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- final proposal to be submitted to TAC by 2017

SPIRou science

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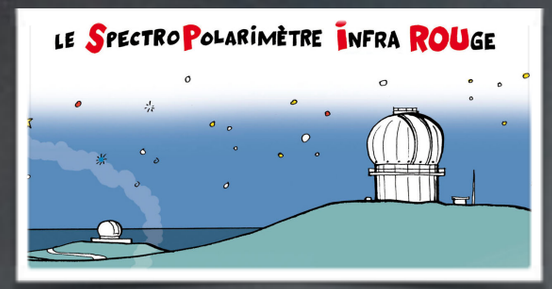

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SPIRou clones & complementary surveys

SPIRou-S in southern hemisphere funded by Canada / CFI (2018)

SPIP @ 2m TBL (Pic du Midi) funded by Région Midi Pyrénées (2019)

➾ improved synergies with TESS, JWST, ALMA, PLATO (2024) & E-ELT (2025+)

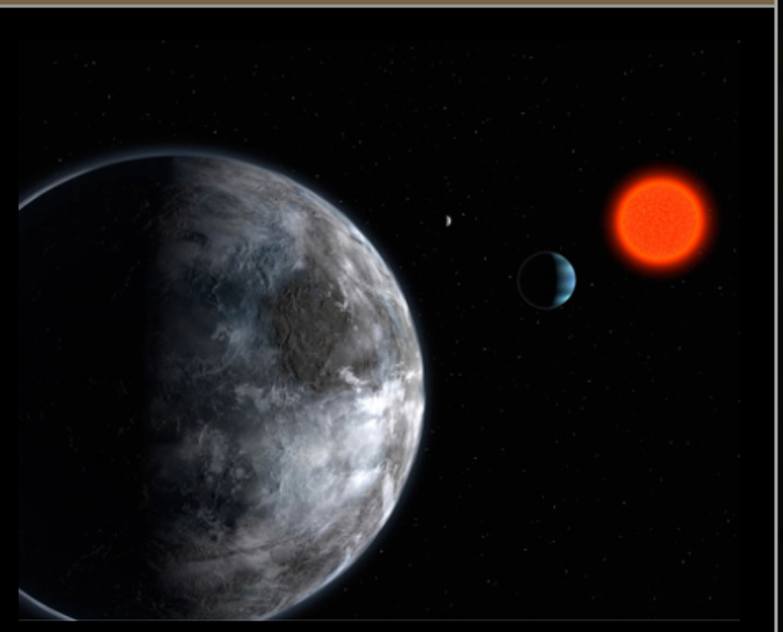
SPiRou

News & Discoveries

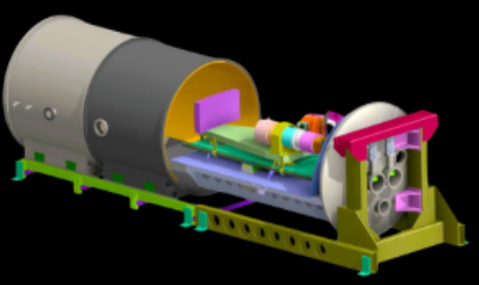
2015 June : SPIRou parabolic mirror in construction

The Zerodur blank of the main SPIRou parabolic mirror is being controlled at SESO

Science



Instrument



Observations