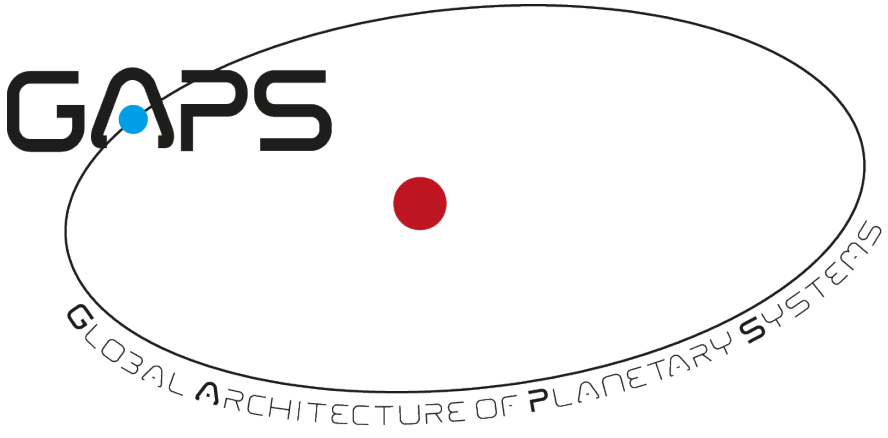


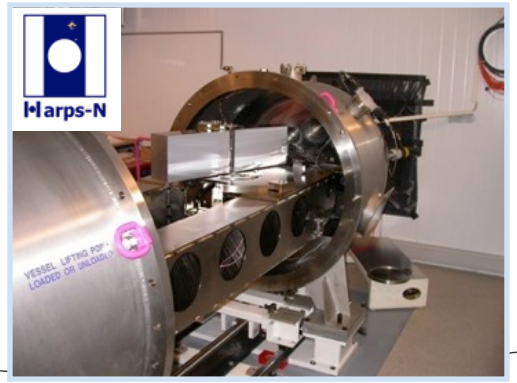
Search and characterization of young planets with GAPS

S. Benatti, S. Desidera, J. Alcalà,
K. Biazzo, I. Carleo & the YO Team

Protoplanetary disks
Osservatorio Astronomico di Roma,
Monte Porzio Catone (RM), Italy
25 - 28 June 2018

GAPS Global Architecture of Planetary Systems

- Collaboration among ~80 Italian scientists (+ external collaborators) in the exoplanets field since 2012
- Long-term radial velocities survey with HARPS-N@TNG
- Search and Characterization of the architectural properties of planetary systems



Objectives

- **Frequency** of exoplanets around M stars, metal poor stars, stars in open clusters
- Search for **additional low mass companions**
- **Characterization** through Rossiter-McLaughlin effect and Asteroseismology/SPI (star-planet interaction) and orbital refinement of known systems

A coordinated and solid Italian community for the Exoplanets study

- 17 "GAPS" papers
- 12 papers from collaboration (HADES, H-N GTO, …)
- Many others in preparation
- Results in line with previous RV surveys

5 years of GAPS observations: Quick look to the results

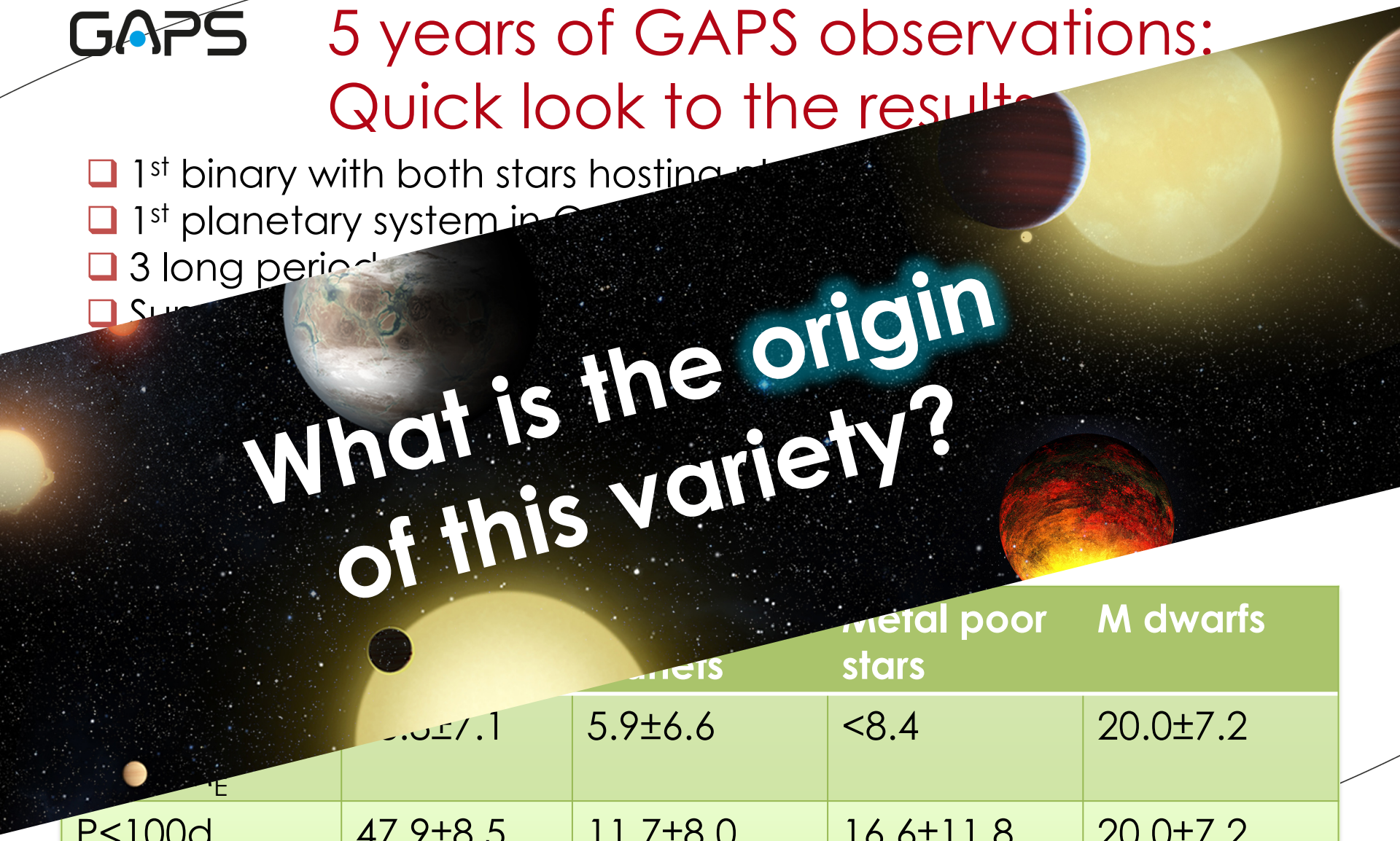
- 1st binary with **both stars** hosting planets
- 1st planetary system in **OC** star
- 3 **long period giant** planets with close companion (HJ or SE)
- **Super Earth** system around M dwarf
- Giant companion around **giant star** (GIARPS ante litteram)
- **SE** with one **temperate Saturn** + cold **Jupiter** mass companions
- 3 giant planets in open clusters
- Long period planet around **metal poor** star
- …

Planet frequency	Field G dwarfs	Stars with planets	Metal poor stars	M dwarfs
P<50d $M<30M_E$	38.8±7.1	5.9±6.6	<8.4	20.0±7.2
P<100d $M<30M_E$	47.9±8.5	11.7±8.0	16.6±11.8	20.0±7.2

To be updated!!

5 years of GAPS observations: Quick look to the results

- 1st binary with both stars hosting pl
- 1st planetary system in C
- 3 long period
- Su



			Metal poor stars	M dwarfs
$M<10M_E$	3.3±7.1	5.9±6.6	<8.4	20.0±7.2
P<100d $M<30M_E$	47.9±8.5	11.7±8.0	16.6±11.8	20.0±7.2

To be updated!!

Planets migration: hot Jupiters

Adapted from
Dawson & Asher Johnson 2018

Smooth disc migration

- small eccentricities
- spin-orbit alignments

High-eccentricity migration

- circular orbits + short periods/ eccentric orbits + long periods
- spin-orbit (mis)alignments

Planets migration: hot Jupiters

Adapted from
Dawson & Asher Johnson 2018

YOU MUST SEARCH FOR YOUNG PLANETS!

S in disc migration

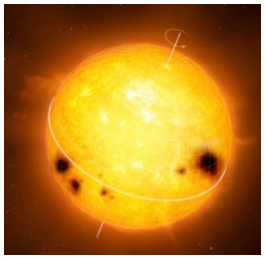
- small eccentricities
- spin-orbit alignments

High-eccentricity migration

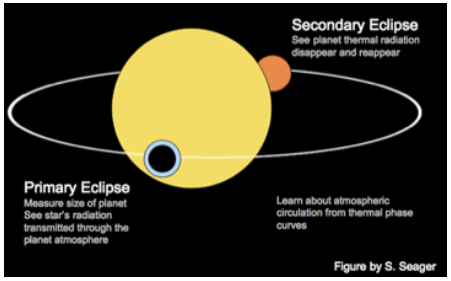
- circular orbits + short periods/ eccentric orbits + long periods
- spin-orbit (mis)alignments

The opportunity of

Planet detection



Young stars are very active: Simultaneous VIS-NIR observations allow to disentangle between RV "jitter" and Keplerian RV modulations



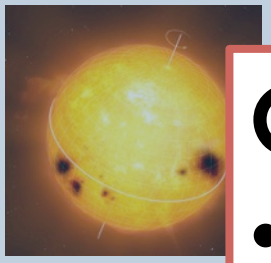
Characterization of planets atmosphere

Huge spectral range to search for the molecular compound of hot giant planets

Observables:

- ✓ Planet frequency around young stars + Orbital parameters to understand **how** do the planet migrated
- ✓ Atmospheric composition to understand **where** do the planets formed

The opportunity of



Planet detection

Young stars are very active: Simultaneous VIS-NIR
n RV

GAPS2 WPs:

- Young Objects (YO)
- Atmospheres (AT)

+ Super Earths in the Habitable Zone of M-dwarfs

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lanets

Observables:

- ✓ Planet frequency around young stars + Orbital parameters to understand **how** do the planet migrated
- ✓ Atmospheric composition to understand **where** do the planets formed

GAPS2 Young Objects program
Objectives and strategy

- Monitoring young (< 20 Myr) and intermediate age (< 700 Myr) stars to search for **hot Jupiters (HJ) in formation** or at the early stage of their **evolution** within the timescales of migration
- Confirm/Retract the apparent higher **frequency** of HJ around very young stars (age < 10 Myr, Donati+2016, Yu+2017)

- At least **50 epochs** for each target to retrieve Keplerian signals up to 5-10 times lower than the stellar activity jitter (possible with Gaussian processes)

Target selection criteria

1. Planet candidates program

2. Discovery program

- Intermediate age: robust data treatment
- Young: exploration of strategy and techniques
  - RV archives
  - known rotation period
  - "Small" vsini < 20 km/s

Taurus
Cepheus
Hyades
Coma
Upper Sco
Leonis
Ursa Major
AB Doradus

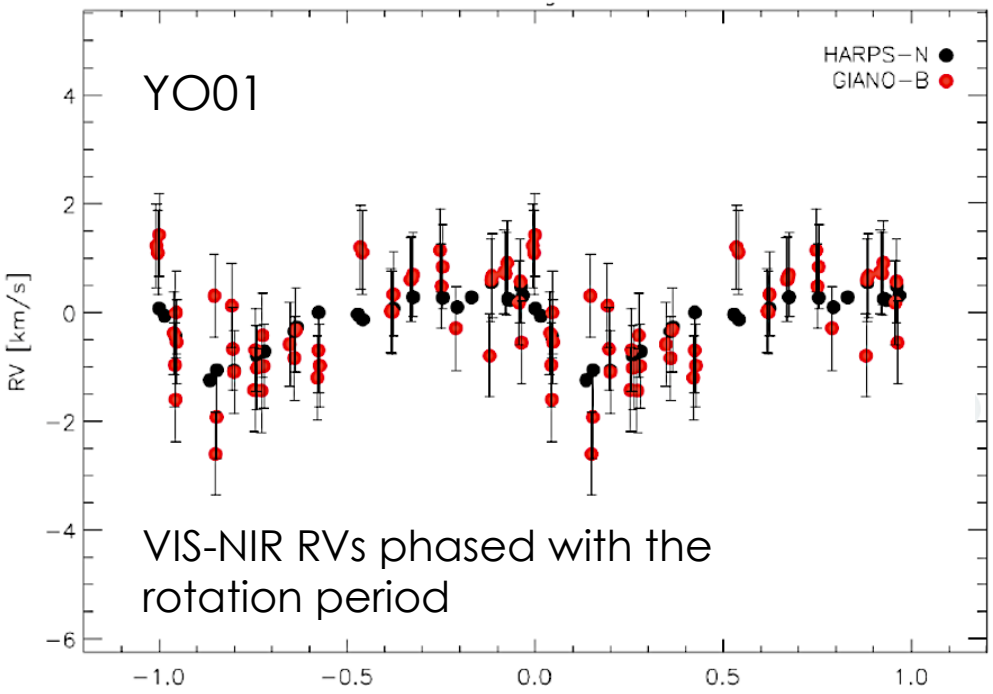
3. TESS Candidates (>2019)

The Young sample

Star	mag	Mass $M_\odot$	age	vsini [km/s]	P_{rot} [d]	Notes
YO01 M0 WTTS Taurus	V12.1 H8.6	1	2 Myr	30	2.7	Giant Planet claimed
YO15 K0 CTTS Upper Sco	V12.6 H6.7	0.9	~3 Myr	11	6.8	Giant Planet claimed
YO16 K3 WTTS Upper Sco	V12.1 H8.5	0.78	5-10 Myr	10	5.5	

very preliminary results…

YO01: Planet candidate in Taurus



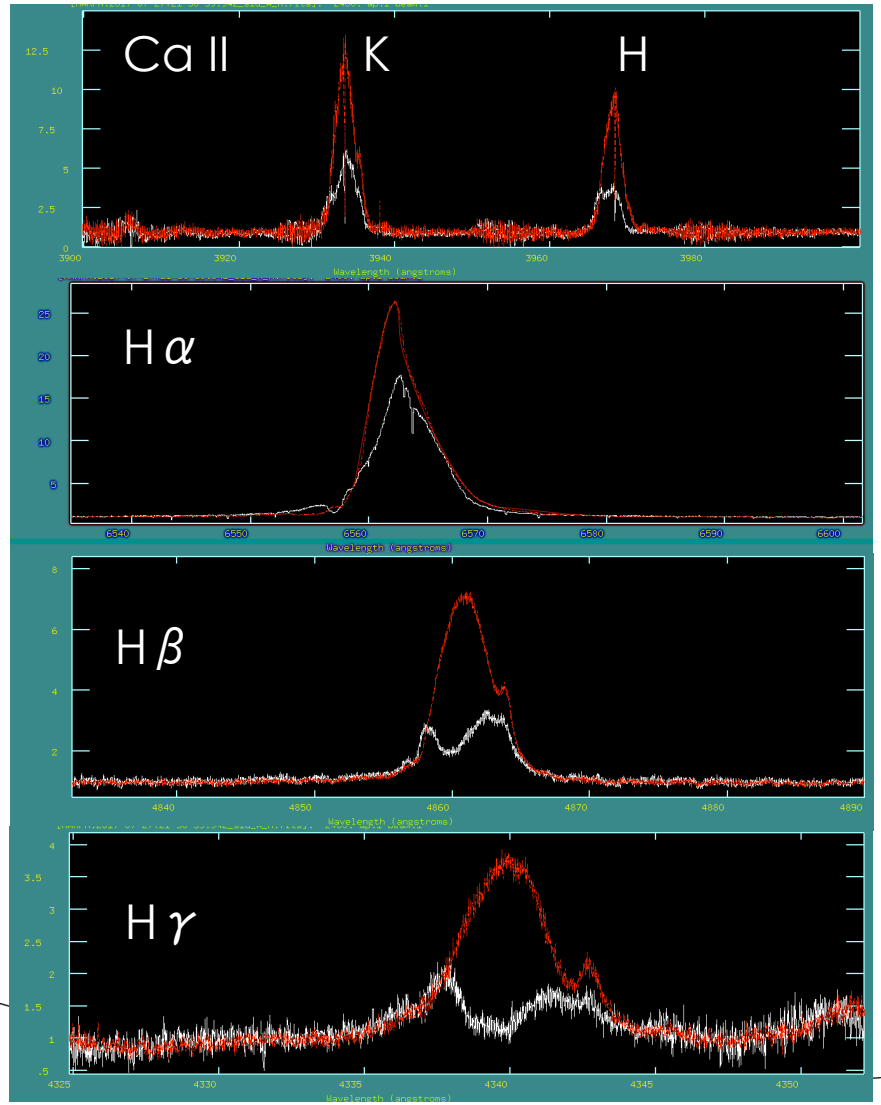
Not optimal sampling

Not enough for a clear detection of the planet signal

New observations foreseen in the next season

HARPS-N RV scatter: ~400 m/s
GIANO-B RV scatter: ~950 m/s

YO15: strong indication of accretion (Upper Sco)



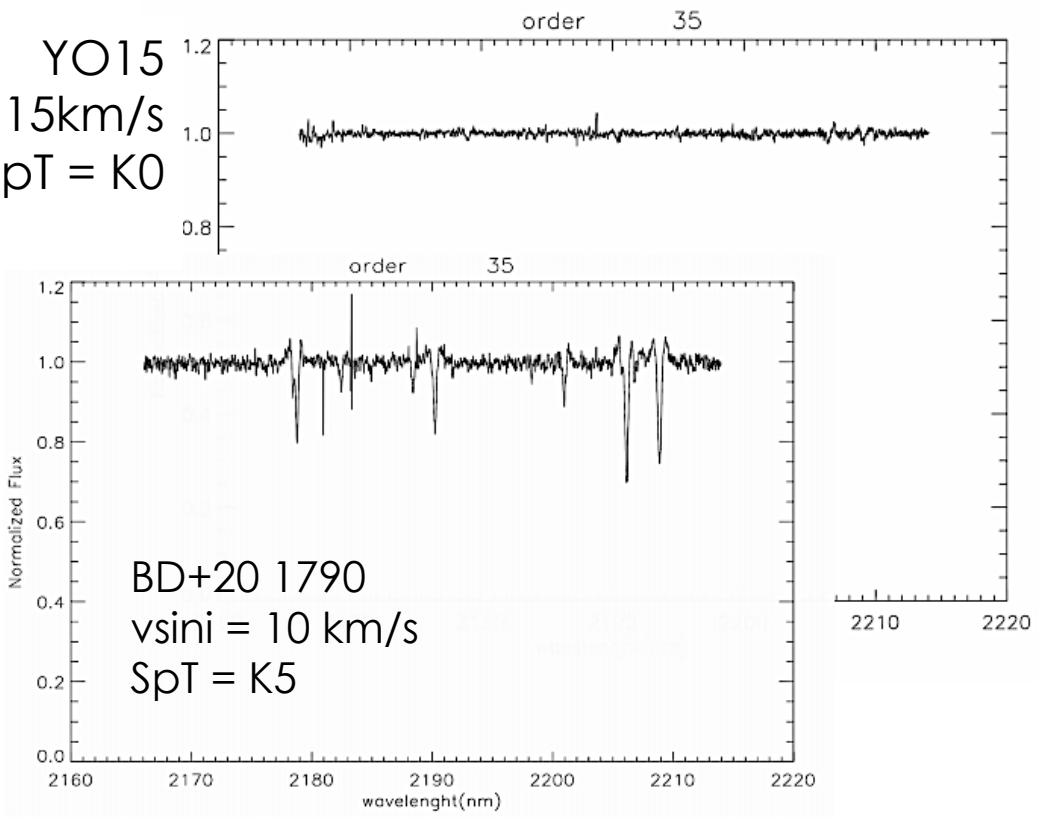
High variability of the main accreting diagnostics in ~ one week

$\Delta \log M_{acc} = 0.3$ dex for 1 $M_\odot$

Consistent with the variations in the CTTS (see discussion with J. Alcala' + talk L. Venuti)

YO15: discarded for planet search

YO15
vsini = 15km/s
SpT = K0

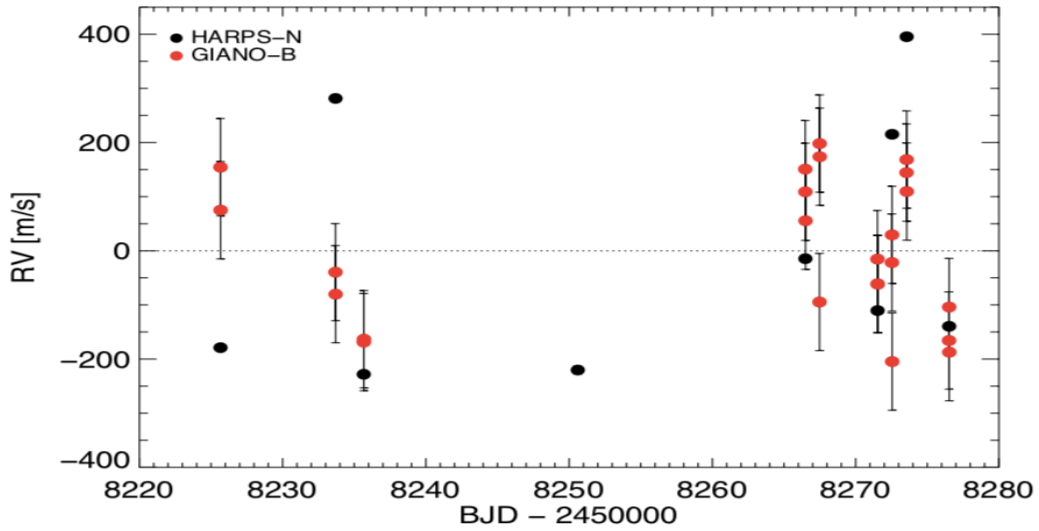


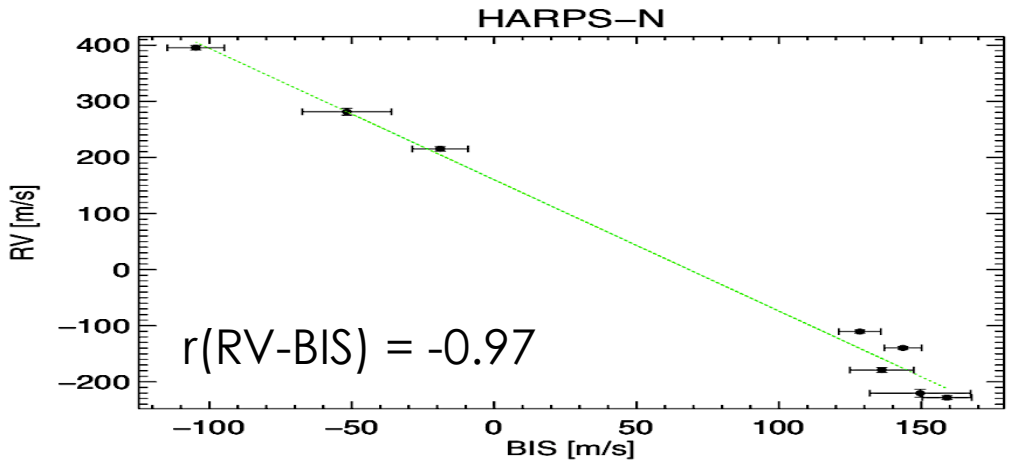
No photospheric lines:
- No parameters
- No lines useful for RV determination

CTTS are not suitable targets for RV search (talk by V. D'Orazi)

YO16 (WTTS in Upper Sco)

No accretion features detected



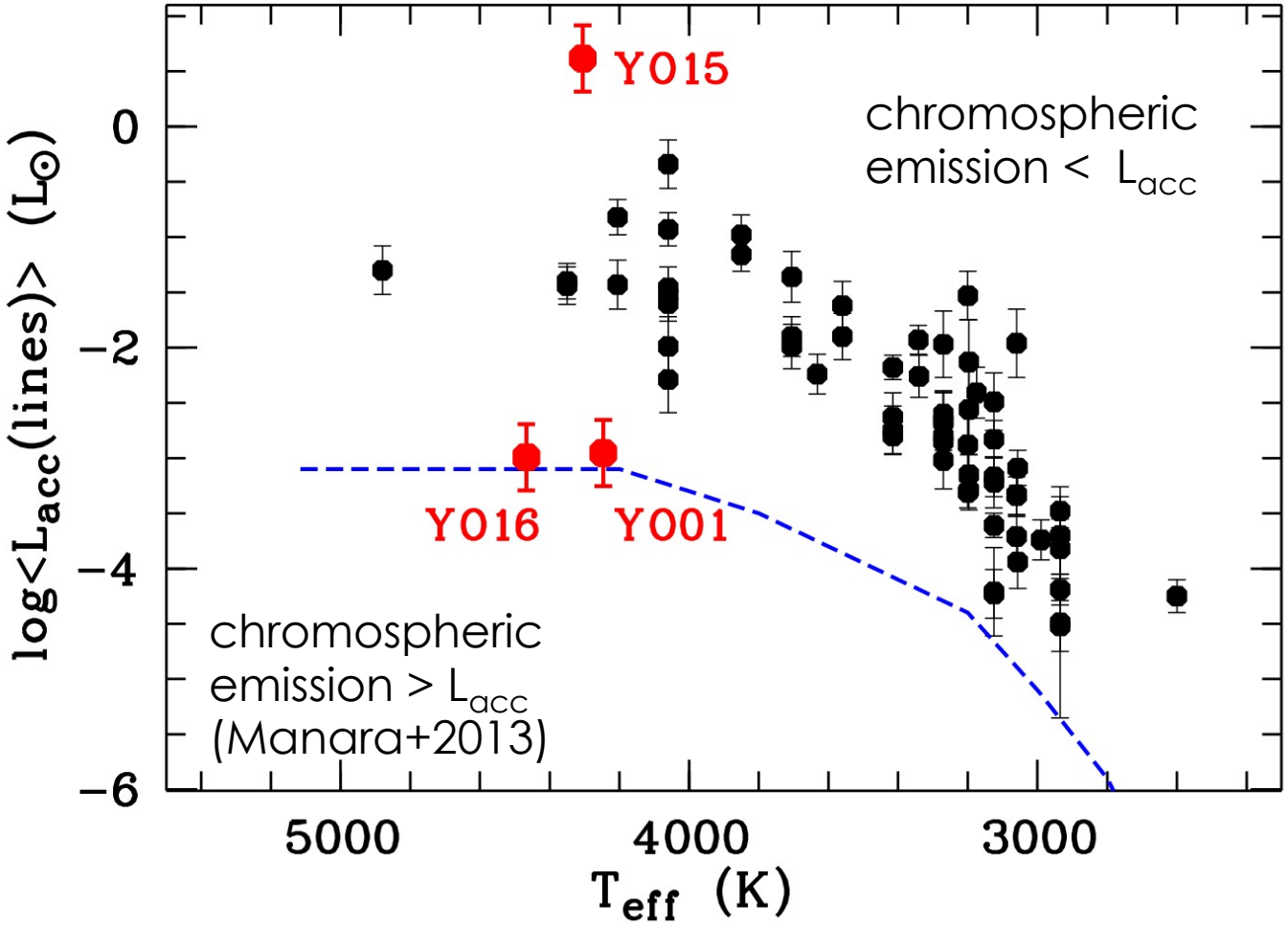


HARPS-N:
RV scatter: 236.2 m/s
RV mean error: 4.4 m/s
GIANO-B:
RV scatter: 130.9 m/s
RV mean error: 89.8 m/s
amplitude ratio:
VIS/NIR = 1.8

Too few and sparse RV data to search for rotation period

HARPS-N RV scatter from residuals: 24 m/s

Comparison with YSO in Lupus



Adapted from Alcala' et al. 2017

GAPS2 YO Perspectives

- After 3 semesters (1 with a "short" Pilot program + 2 as large program) GAPS2 will report to INAF to confirm the LP status (4 more years)
- More data are needed to enrich our time series
- ESO LP with HARPS submitted to complement YO
- Sinergy with GAIA DR2 (stellar parameters, membership)
- Future collaboration with the community working on protoplanetary disks??


Thank you!