
(wikimedia)

# TIGRE and other robotic telescopes

# = I, Robot =

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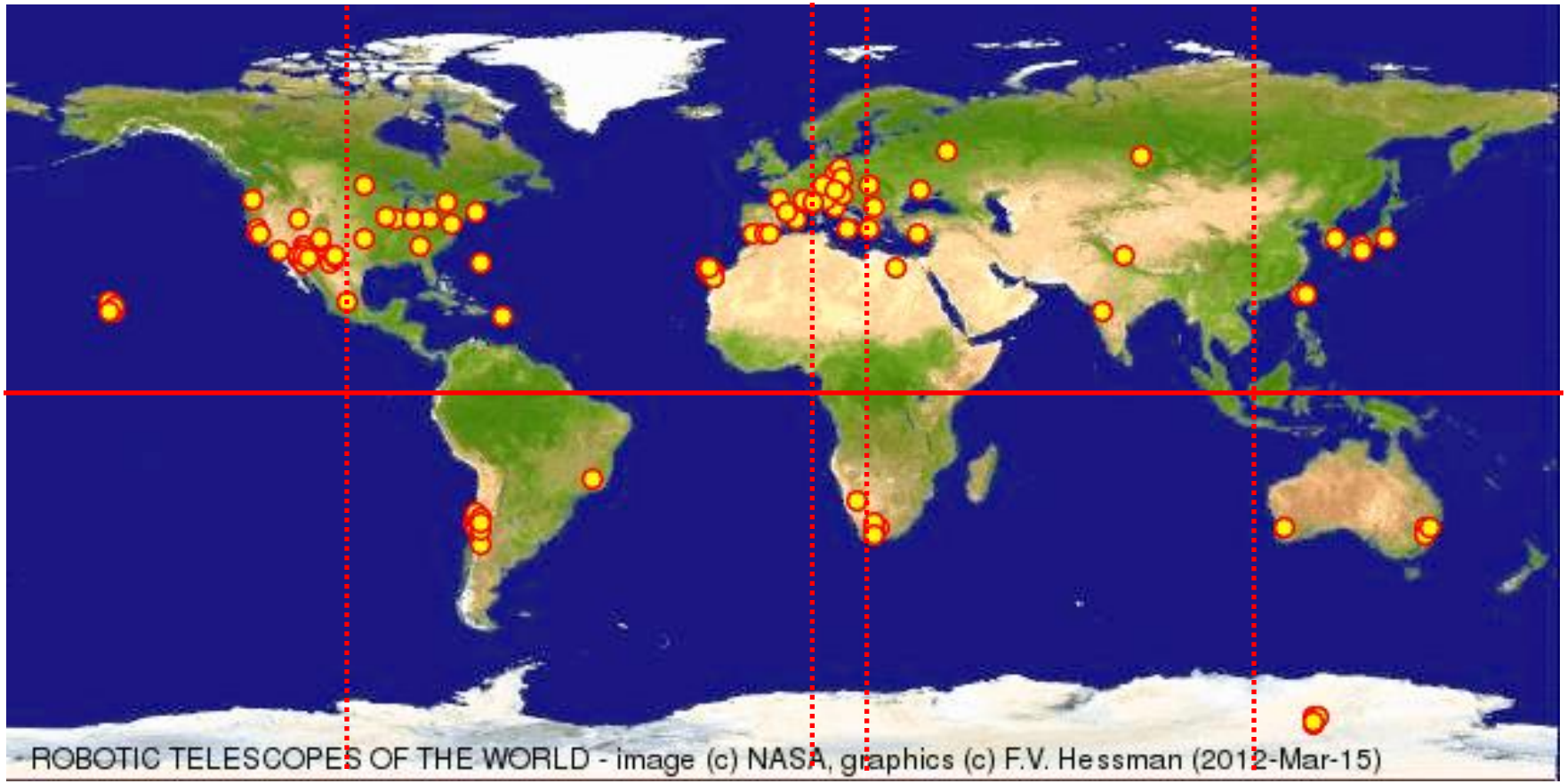
Hamburg -- December 2016

# Outline

- Spectroscopy robots -- an overview
- Stellar active regions – what you always wanted to know …

# Robotic observatories all over the world




(www.astro.physik.uni-goettingen.de/~hessman/MONET/)

# Robotic observatories

## List of Robotic Telescopes [ edit ] (Wikipedia 2016 December)

See below for further information on these professional robotic telescopes:

- TRAPPIST, 60 cm, La Silla, Chile.
- Super-LOTIS, 60 cm, Steward Observatory on Kitt Peak, Arizona, USA.
- Liverpool Telescope (robotic telescope), 2.0 m, on La Palma, Canary Islands
  - Faulkes Telescope North, 2.0 m, Haleakala Observatory, Hawaii
  - Faulkes Telescope South, Siding Spring Observatory, New South Wales, Austr
  - RoboNet, multiple locations
- Automated Planet Finder, 2.4 m, Lick Observatory on Mount Hamilton, California, U
- Slooh telescopes, various sizes & locations.
- Rapid Eye Mount telescope, 60 cm, La Silla, Chile
- TAROT-South robotic observatory, 25 cm, La Silla, Chile
- Bradford Robotic Telescope, 35.5 cm, Teide Observatory, Canary Islands
- Warner and Swasey Observatory#Nassau Station Robotic Observatory, 91 cm, W
  Ohio, USA
- Observatorio Astronómico de La Sagra, 3× 45 cm, Granada, Spain
- ROTSE-IIIb, 45 cm, McDonald Observatory, Texas, USA

- MONET N+S (1.2 m, Texas, USA + SAAO)
- SONG (1.0 m, Tenerife)
- SpectraBot (1.25 m, Indiana USA )
- STELLA I (1.2 m, Tenerife)
- Tenessee Spectroscopic Survey Tel. (2.1 m, Arizona, USA)
- TIGRE (1.2m, Guanajuato, Mexico)

| Description | Number of Ref.'s | Percentage |
|---|---|---|
| Gamma-Ray Bursts | 35 | 21.0% |
| Service observations | 27 | 16.2% |
| Photometric monitoring | 16 | 9.6% |
| Education | 21 | 12.6% |
| All-sky surveys | 15 | 9.0% |
| Exoplanet searches | 21 | 12.6% |
| Supernovae search | 11 | 6.6% |
| Asteroids | 10 | 6.0% |
| Spectroscopy | 4 | 2.4% |
| Astrometry | 4 | 2.4% |
| AGN, Quasars | 4 | 2.4% |
| (Micro-)Lensing | 1 | 0.6% |
| Other uses | 8 | 4.8% |
| aperture ≤ 0.25m | 93 | 37.8% |
| 0.25 < aperture ≤ 0.50m | 88 | 35.8% |
| 0.50 < aperture ≤ 0.75m | 17 | 6.9% |
| 0.75 < aperture ≤ 1.00m | 23 | 9.3% |
| 1.00 < aperture ≤ 1.25m | 7 | 2.8% |
| aperture > 1.25m | 18 | 7.3% |
| Proposed | 2 | 1.6% |
| Funded | 2 | 1.6% |
| Under construction | 16 | 12.6% |
| Being commissioned | 25 | 19.7% |
| In operation | 82 | 64.6% |

(www.astro.physik.uni-goettingen.de/~hessman/MONET/)

# TIGRE and STELLA


| TIGRE - HEROS | STELLA - SES |
|---|---|
| 3500 - 5600 A<br>5800 – 8800 A | 3880 – 7200 A<br>(- 8820 A) |
| R = 20000<br>(15 km/s) | R = 55000<br>(5.5 km/s) |
| 21° N 2300m<br>V = 10 mag 1800 sec<br>→ S/N 100 | 28° N 2400m<br>Weber, Granzer, Strassmeier & Woche 2008, SPIE 7019 |

STELLA's Key Science Projects

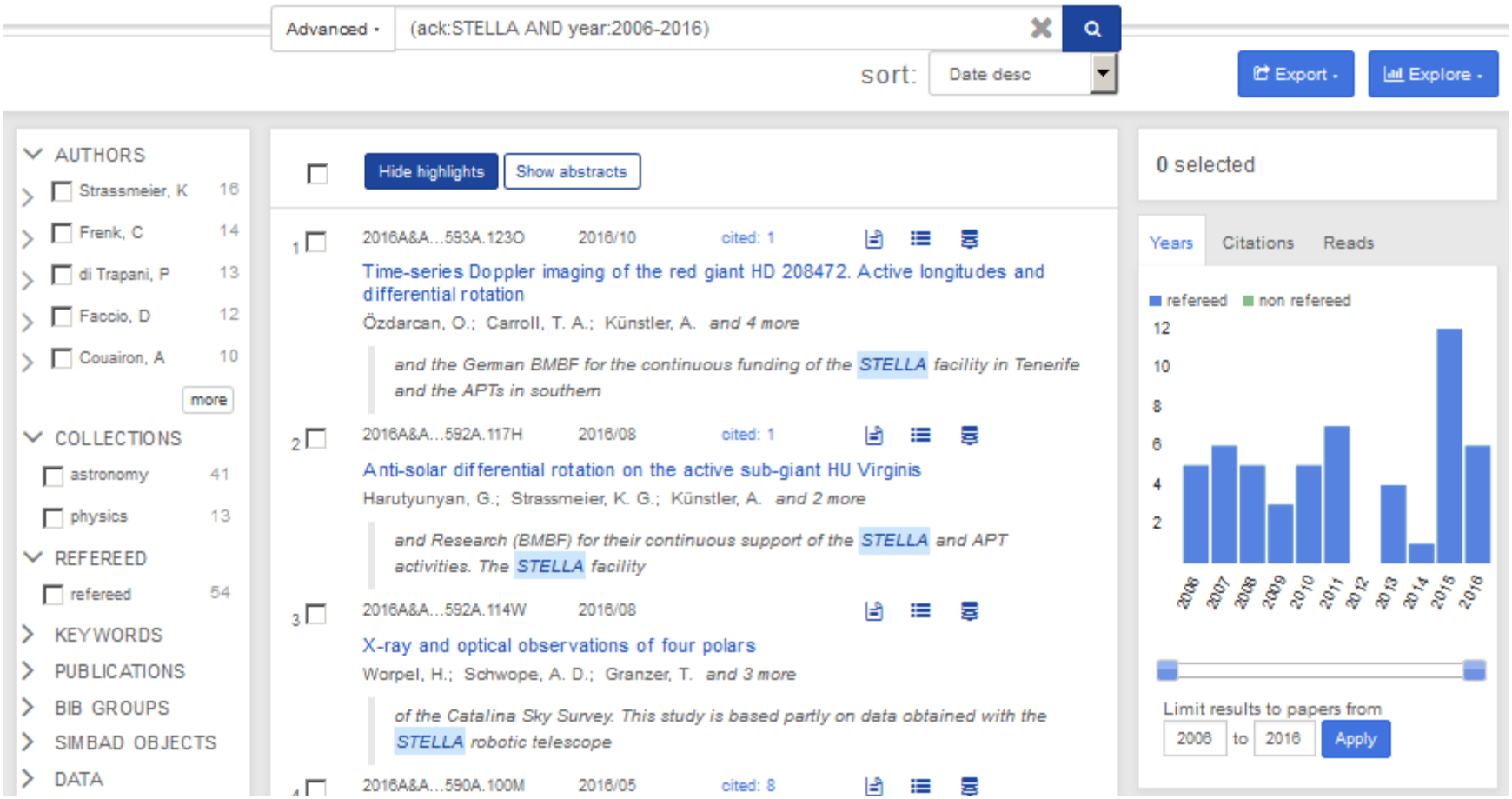
**Time-series Doppler Imaging** (T. Carroll+)

e.g Künstler+ 2015, Spot evolution on the red giant star XX Triangulum. A starspot-decay analysis …

**The STELLA Open Cluster Survey** (S. Barnes+)

e.g. Strassmeier+ 2015, Stellar rotation, binarity, and lithium in the open cluster IC 4756

# STELLA's publications (ADS Bumblebee)




Missing: e.g. Sablowski+ 2016, AN 337,

Comparing modal noise and FRD of circular and non-circular cross-section fibres

Up to 2014 see also http://www.aip.de/en/research/facilities/stella/publications

# TIGRE's publications (ADS Bumblebee)

8 results

Advanced · (ack:TIGRE AND year:2006-2016)

sort: Date desc

Export · Explore ·

AUTHORS
- Rauw, G 7
- Gonzalez-Perez, J 6
- Hempelmann, A 6
- Mittag, M 6
- Schmitt, J 6

more

COLLECTIONS
- astronomy 8

REFEREED
- refereed 8

KEYWORDS
PUBLICATIONS
BIB GROUPS
SIMBAD OBJECTS
DATA
VIZIER TABLES
GRANTS
PUBLICATION TYPE

Hide highlights | Show abstracts

1 2016A&A...594A..82R 2016/10
X-ray and optical spectroscopy of the massive young open cluster IC 1805
Rauw, G.; Nazé, Y.

> *(Belspo). The TIGRE facility is funded and operated by the universities of Hamburg, Guanajuato and Liège.*

2 2016A&A...586A.104S 2016/02 cited: 1
The α CrB binary system: A new radial velocity curve, apsidal motion, and the alignment of rotation and orbit axes
Schmitt, J. H. M. M.; Schröder, K. -P.; Rauw, G. *and 6 more*

> *helped this paper. We acknowledge the continued support by various partners who helped to realize TIGRE.*

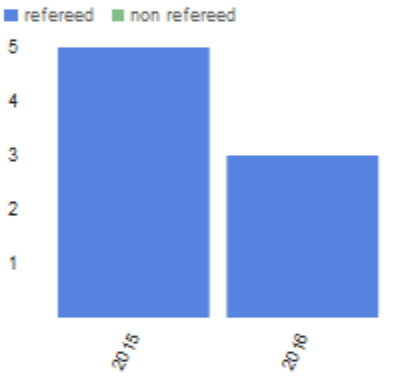
3 2016A&A...586A..14H 2016/02
Measuring rotation periods of solar-like stars using TIGRE. A study of periodic CaII H+K S-index variability
Hempelmann, A.; Mittag, M.; Gonzalez-Perez, J. N. *and 3 more*

> *We acknowledge the continued support by various partners who helped to realize TIGRE. Firstly,*

4 2015A&A...581A.134D 2015/09 cited: 1
High spectral resolution monitoring of Nova V339 Delphini with TIGRE
De Gennaro Aquino, I.; Schröder, K. -P.; Mittag, M. *and 8 more*

0 selected

Years | Citations | Reads



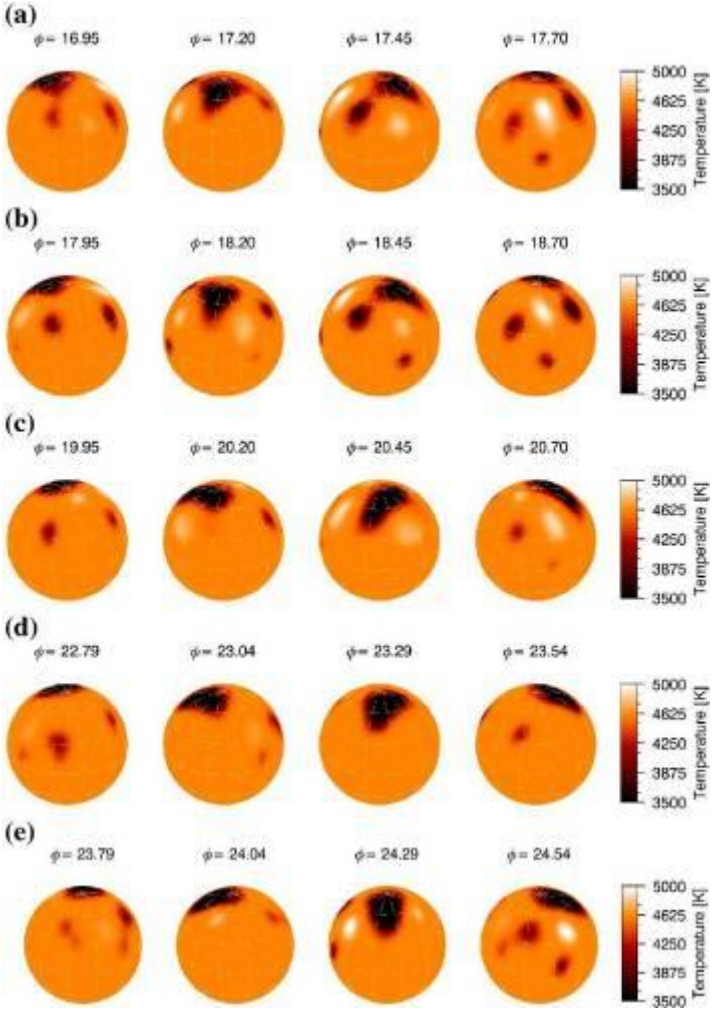

Limit results to papers from 2015 to 2016 Apply

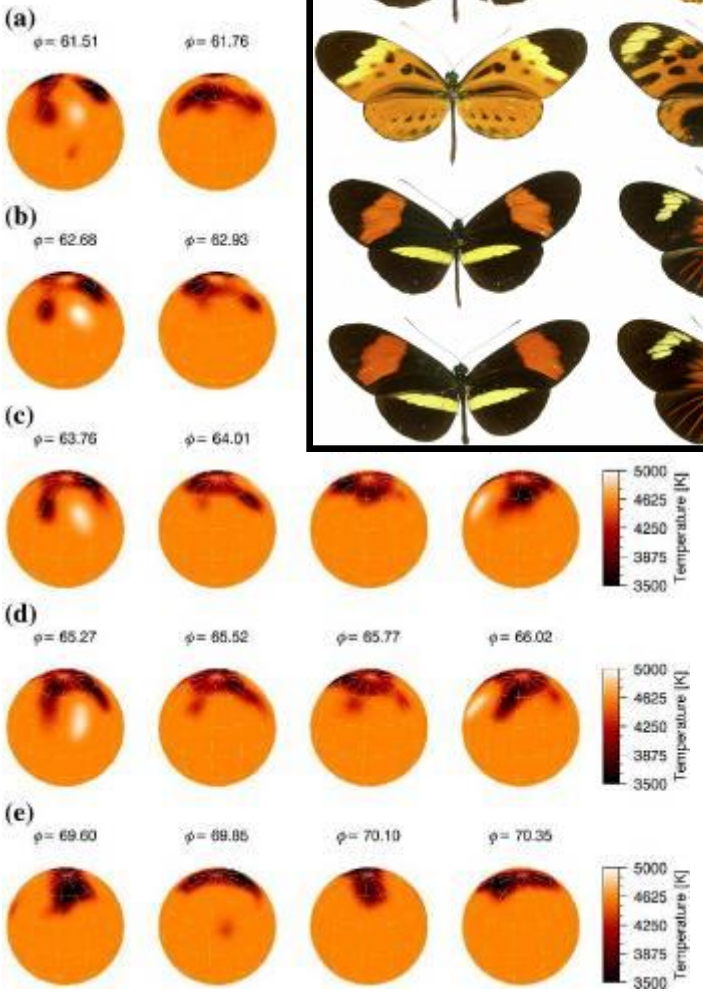
# Active Regions
# = Unresolved issues =

# „Great is the power of steady misrepresentation“

## Active region evolution

(wikimedia)

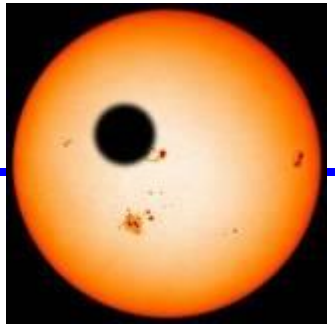


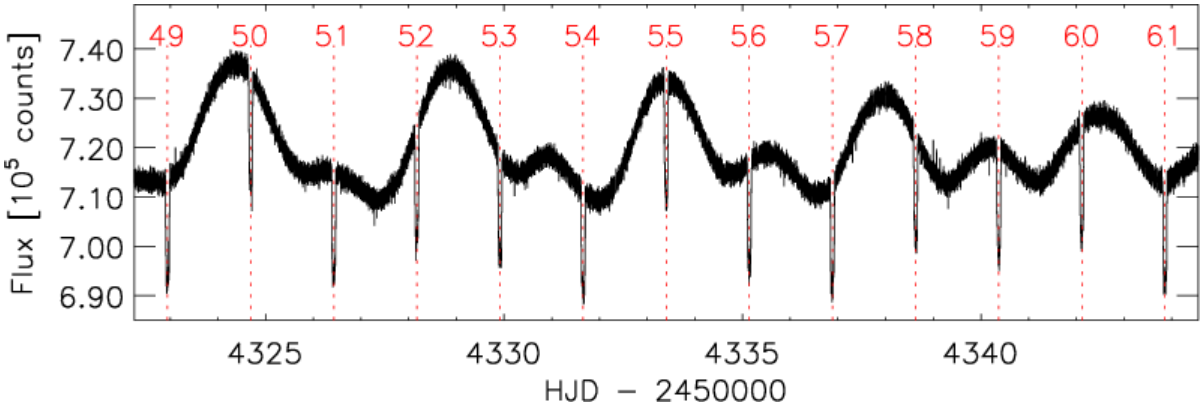



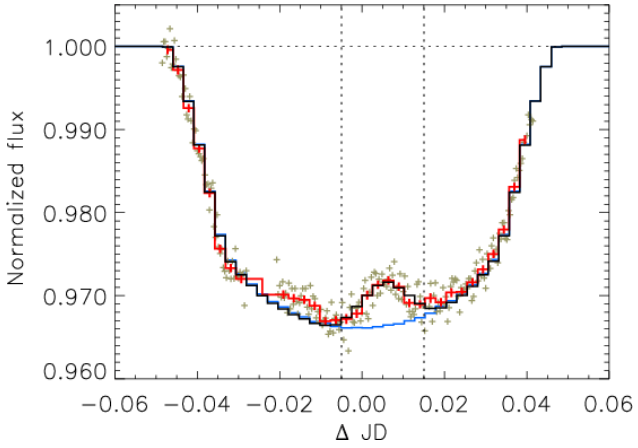

**XX Tri (K1 III + K V, V= 8.4 mag  P= 24 days) – 2006/7 vs. 2011/12**

(Künstler, Carroll & Strassmeier 2015, A&A 578)

# „As fast as thou shalt wane, so fast thou growest “:
# The ephemeral nature of active regions





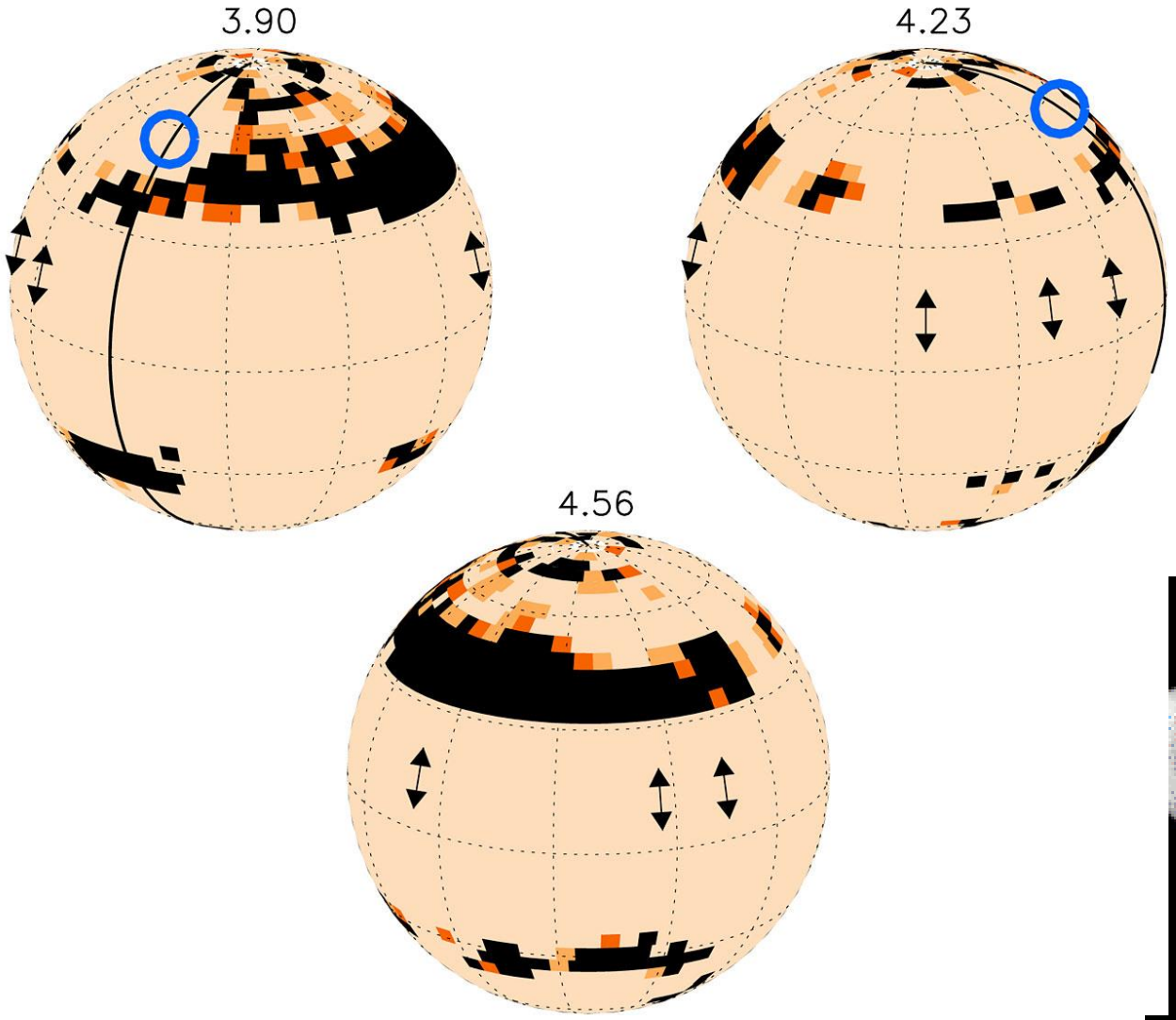




## CoRoT-2
## … a typical example?

Wolter, Schmitt+ 2008
Huber+, 2009
Schröter+, 2011
Czesla+, 2012

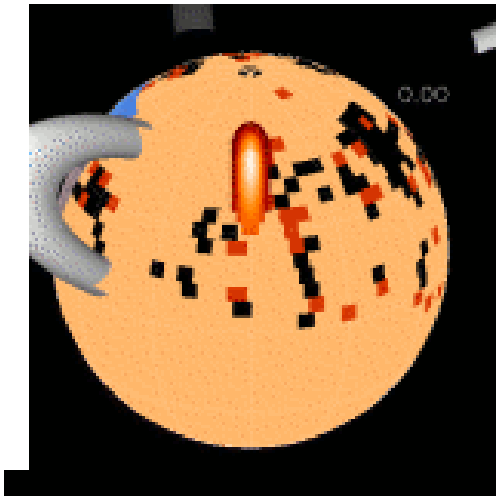
## „There must be more to life than starspots“

# Doppler tomography -- including the upper atmosphere



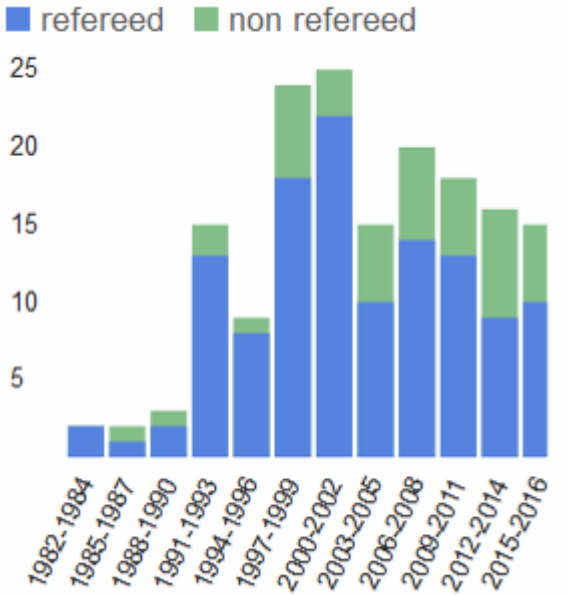

**BO Mic (Speedy Mic)**

Wolter+ 2008,
Günther+, 2013,
Lalitha+ 2013
Wolter+ 2014

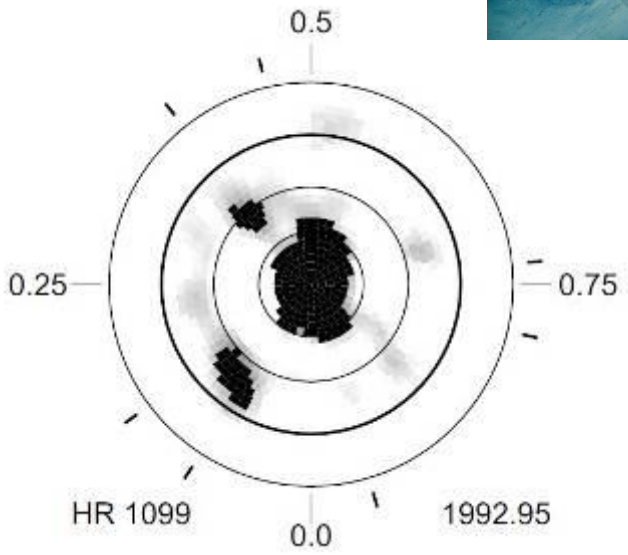


# „It‘s a long way to the top“
# The persistent enigma of polar spots

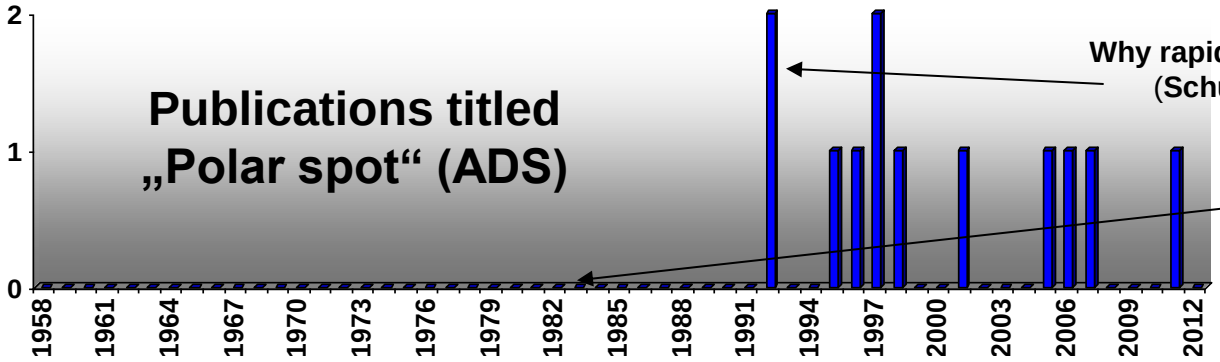

(wikimedia)




**abstract: „polar spot“**
(ADS)




**HR 1099 1981-92**
(Vogt, Hatzes et al. 1999, ApJS 121)




**Why rapid rotators have polar spots (Schüssler & Solanki 1992, A&A 264)**

**“.. a spot which essentially straddles the pole” BY Dra, HR 1099 (Vogt 1981, Vogt & Penrod 1983)**

# Conclusions


(wikimedia)

- Few robotic observatories focus on high-resolution spectroscopy
- STELLA's science concentrates on long-term Doppler imaging and open cluster surveys

- How do active regions ‚work' ?
- What about polar active regions?


(wikimedia)


(wikimedia)

- What will we, TIGRE, focus on, say, 2017 to 2022 ?

# APPENDIX

# STELLA / SES Spectroscopy 2006 - 2012

## RV

- Binaries: Short period eclipsing etc.
- White dwarf binaries (?)
- Hyades membership
- δ Scuti variables
- Cepheids

## Balmer lines

- Variations in metal-poor stars
- ~ CP-stars
- ~ OB-stars (short-term)
- Hot star mass loss

## Doppler Imaging

- Candidate searches
- Simultaneous with „large facilities“
- Long-term spot evolution

Ongoing programs (as of 2/2012)
www.aip.de/stella/wwwui/users.php

## Miscellaneous

- GRB follow-up (incl. ToO)
- CP-stars (Chemically peculiar)
- Zeeman splitting
- Convection in giant stars

## Refereed science publications

**2010:**

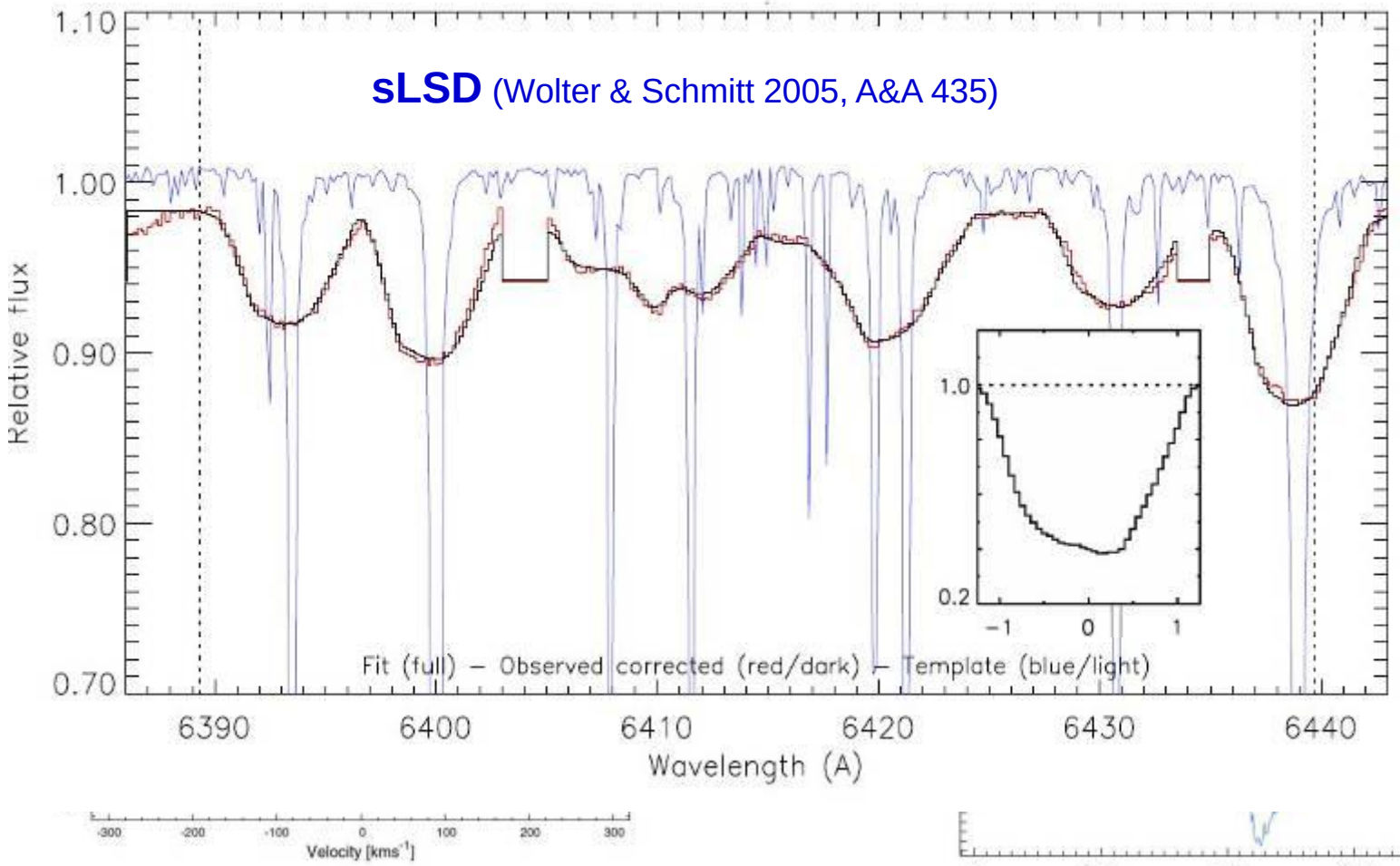
- SbI-detection and orbit of HD 1
- DI and activity of 31 Com
- () Abundance spots and magn. fields of AR Aur (HgMn eclipsing binary)

**2011:**

- Capella‘s orbit revisited
- Binary Orbit and chromospheric emission variations of HD 123351

# Line profile deconvolution – LSD, pLSD, sLSD, iLSD, …

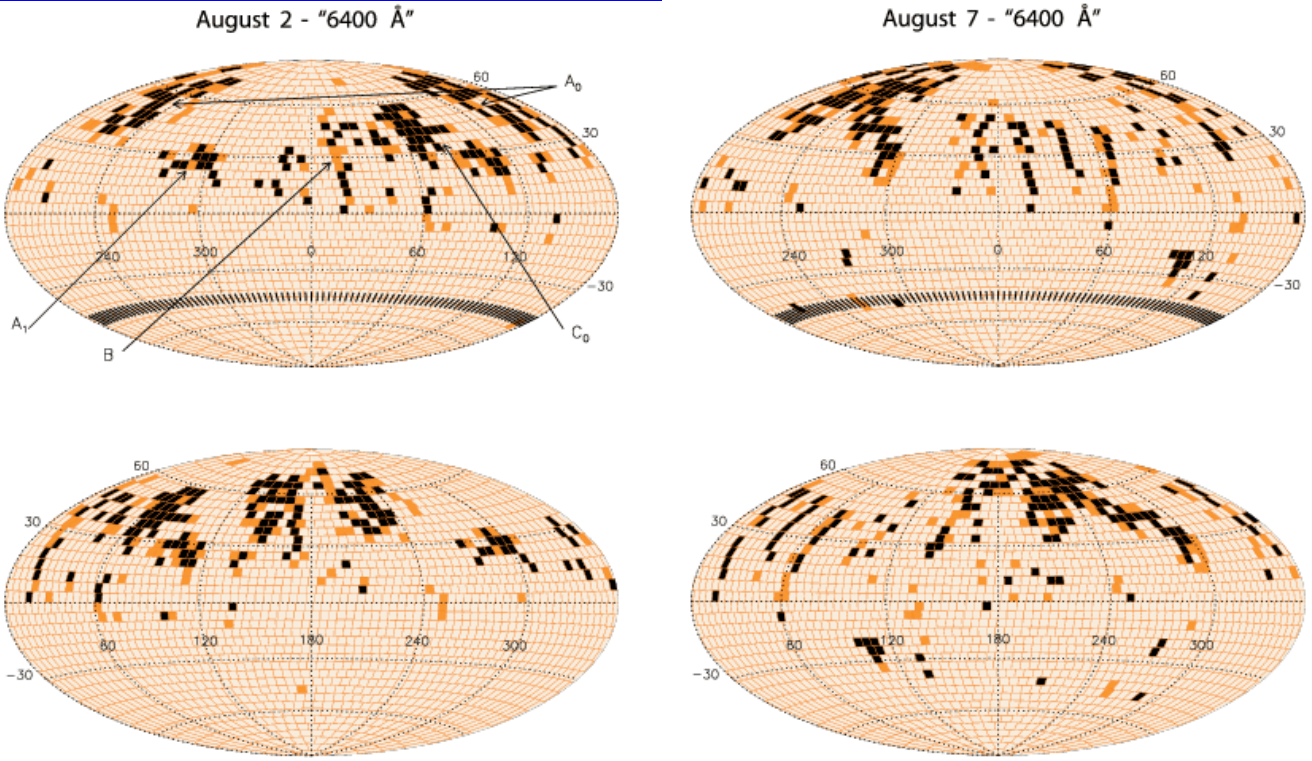
„Least-squares-deconvolution“



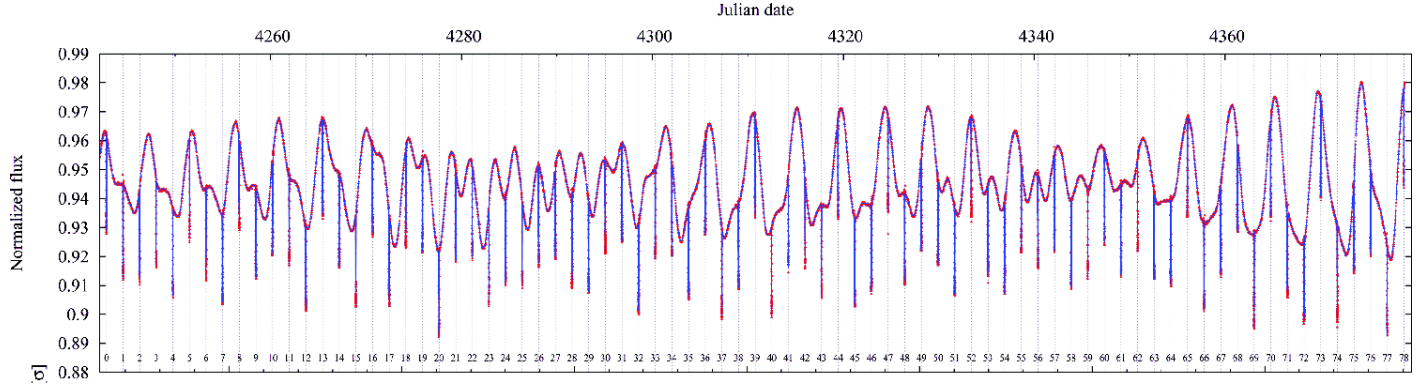

**LSD** (Barnes 2004, MNRAS 348;
Donati et. al 1997, MNRAS 291;
Rucinski et al . 1992, AJ 104)

**iLSD** (Khochukhov et al. 2010, A&A 524)

# DI: Evolution of starspots




**BO Mic (Speedy Mic)**
(Wolter & Schmitt 2005)




**CoRoT 2**
(Huber+ 2010)