# The STELLA robotic observatory on Tenerife

Michael Weber

Leibniz-Institut for Astrophysics, An der Sternwarte 16,
Potsdam, Germany

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A. Künstler (PhD, XX Tri Doppler imaging)
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C. Allende Prieto (IAC, Stellar parameter pipeline)

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# Outline

- The STELLA observatory
- WiFSIP core science - SOCS
- SES core science - time series DI

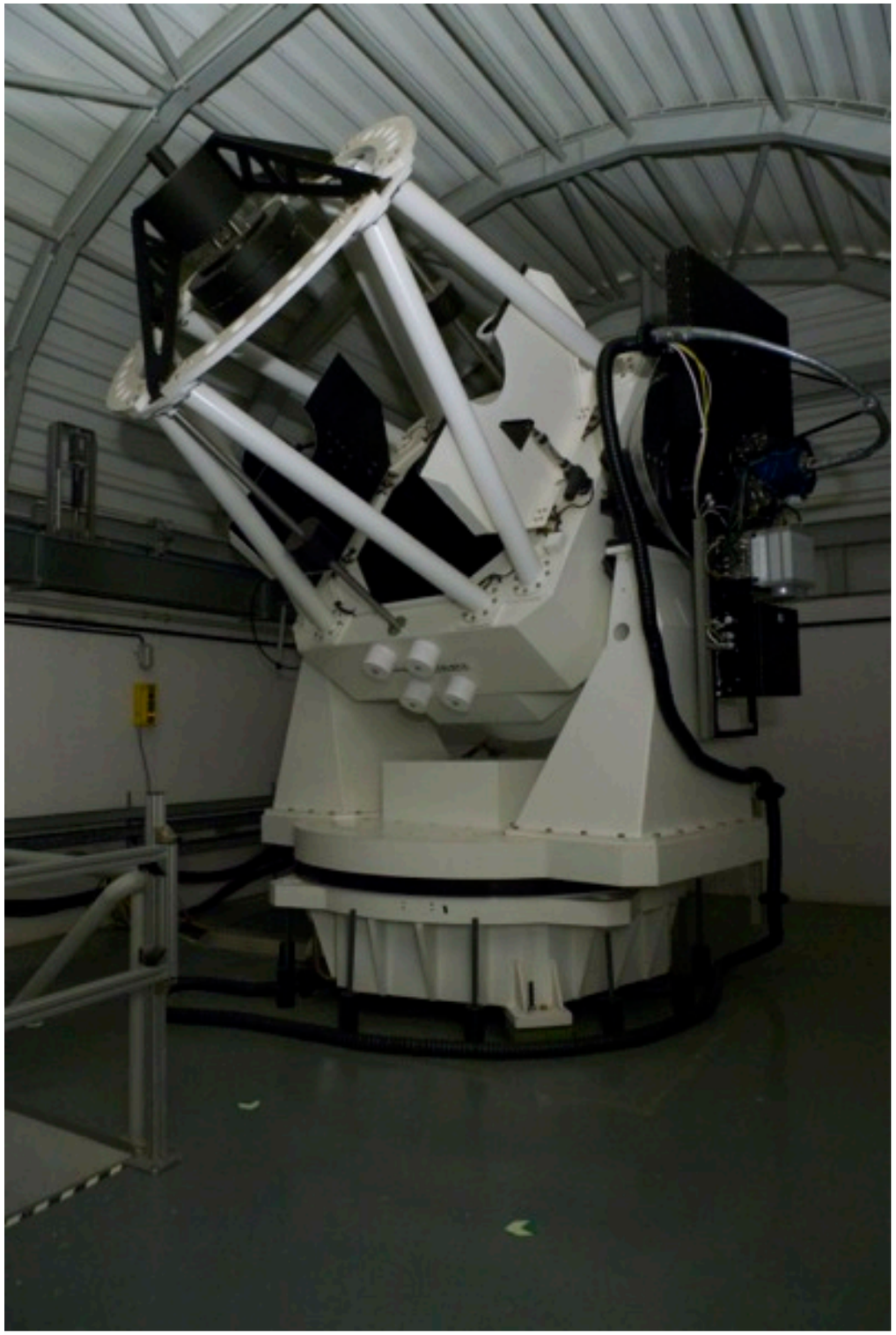
# STELLA

- A project for monitoring Stellar Activity
- Focus on observations with long time-lines (solar activity cycle is 22 years)
- High-resolution spectroscopy for Doppler imaging (resolving surface structures on rapidly rotating stars)
- Wide-field imager for photometric studies of active stars

  „SOCS“: STELLA open cluster survey: rotation periods & stellar parameters of stellar clusters vs. age
- Keep it simple: One instrument per telescope
- Mostly routine tasks, should be highly automated. No personal on site, automatic observations and data reduction.
- Should be able to accommodate special needs, e.g. targets of opportunities (GRBs), planetary transits, etc.

# The STELLA observatory

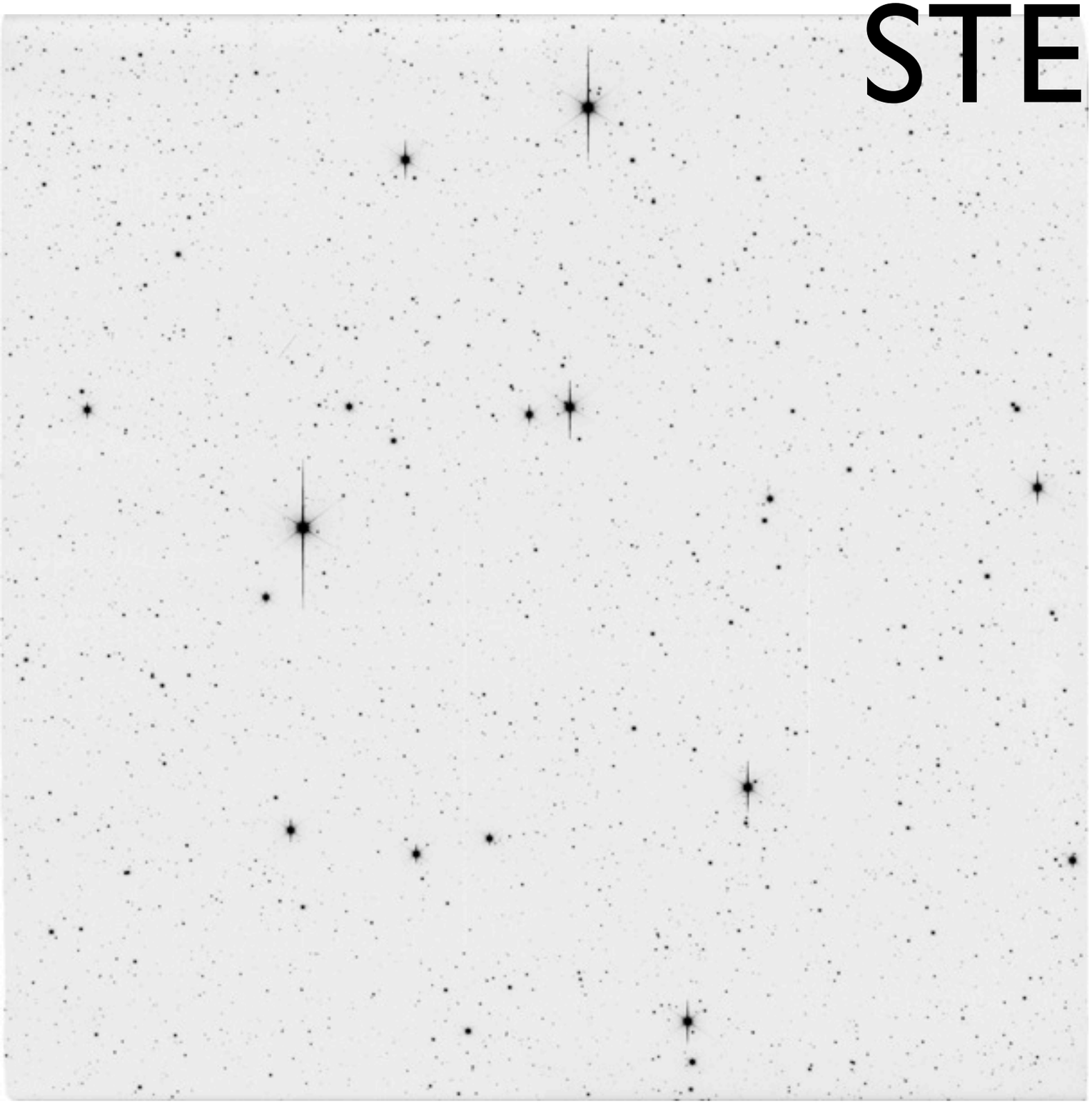
- Located at Teide observatory, Tenerife, 16°30′35” W 28°18′00”N, 2400m altitude
- Two telescopes in common enclosure, each with dedicated instrument
- Own weather stations, dust meter, cloud monitor for protection of the instruments



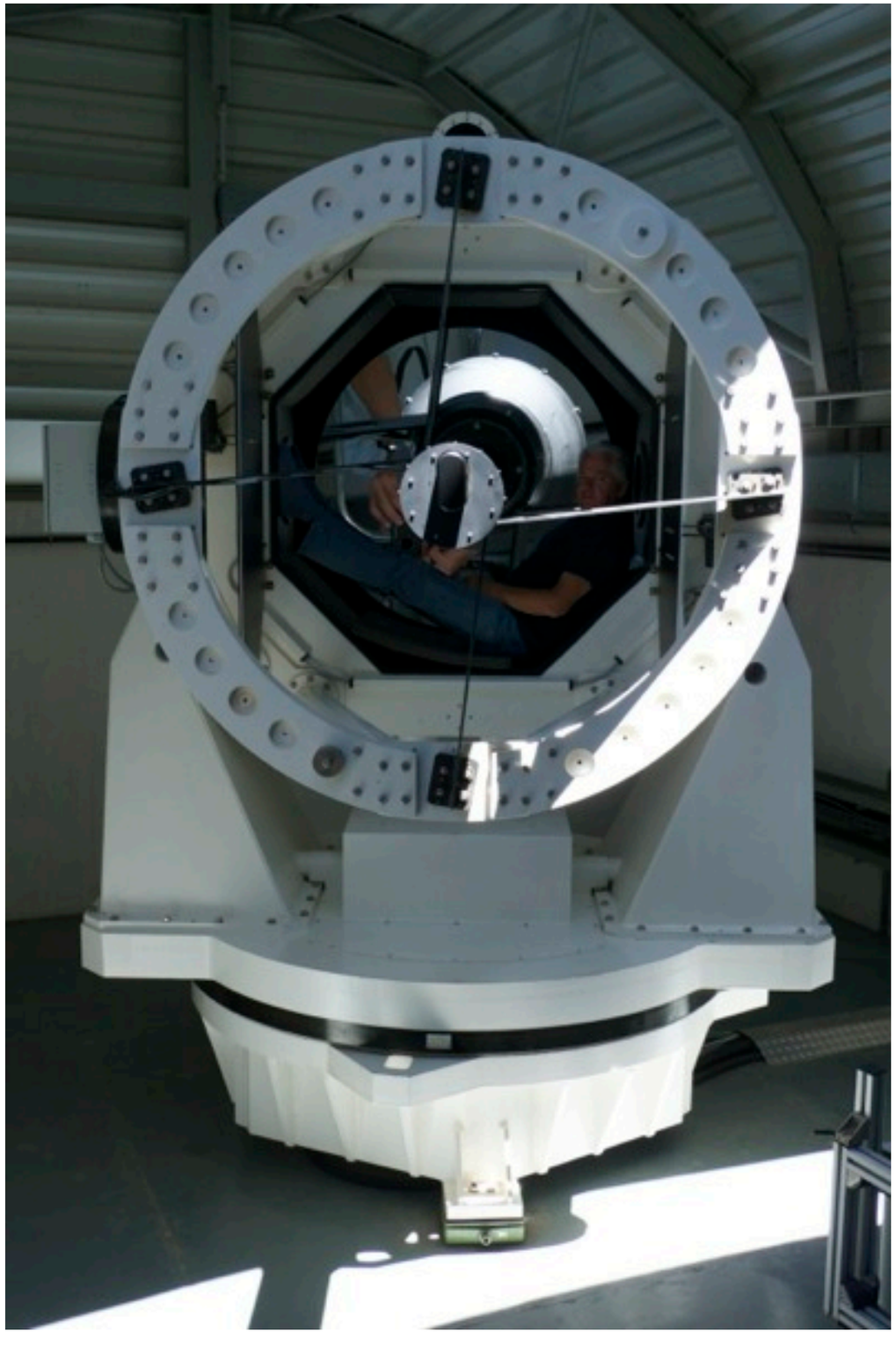
# STELLA/WiFSIP

- STELLA-1 telescope: 1.2m aperture, Alt/Az, Cassegrain f/8, 2 Nasmyth ports (fiber feed & imaging instrument)
- Acquisition & Guiding with auxiliary telescope (off-axis in preparation)
- Wide Field STELLA imaging Photometer (WiFSIP), 22‘ FOV
- Full Johnson/Sloan/Stromgren/Hα filters
- 4kx4k, 15µm, STA400 CCD detector, Magellan CCD controller with 15 s full-frame readout (4 amplifiers)
- Detector update coming soon (better cosmetics and thus better flat-field accuracy)

# STELLA/WiFSIP



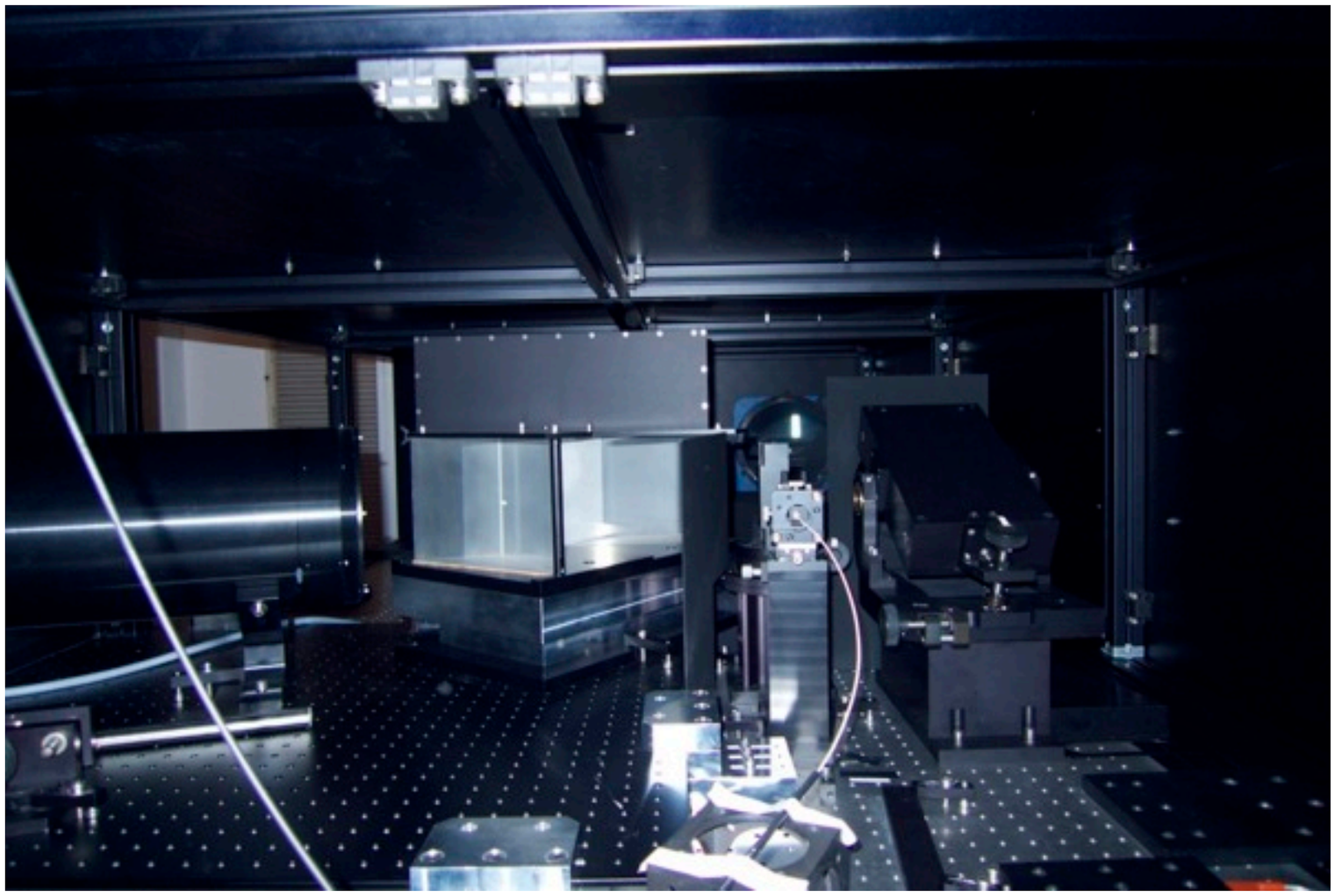
- NGC 7092, exposure time 40 s in Sloan r'(June 16, 2010)
- flat-fielding is the biggest headache currently (CCD)
- takes 2 days (2x morning, 2x evening twilight) to do flat fields in all filters
- Self-illuminating flat-field screen being tested at the 80cm RoboTel at AIP
- CCD has many wavelength sensitive coating defects, prohibits sub-mmag photometric accuracy



# STELLA/SES

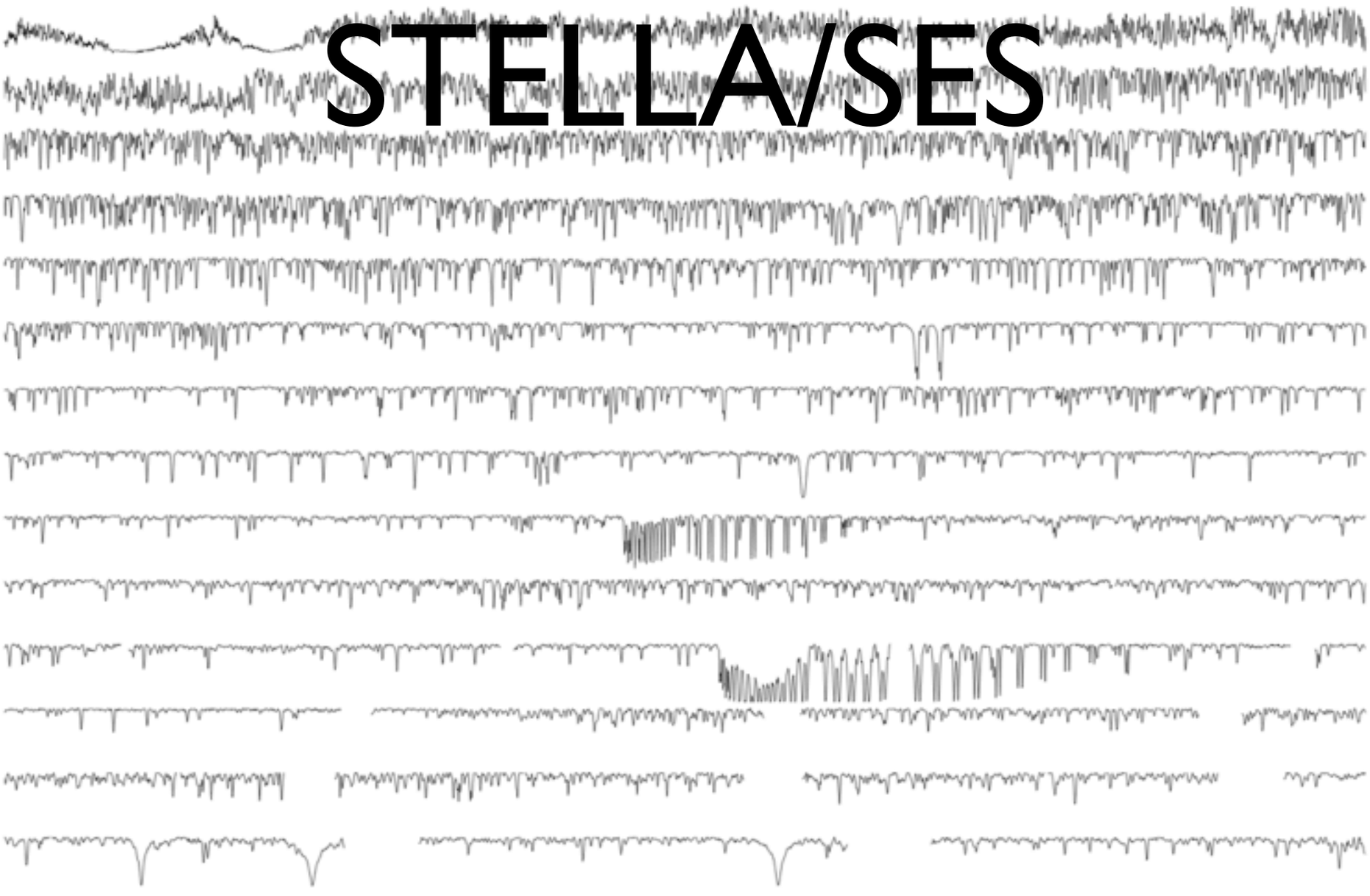
- STELLA-II telescope: 1.2m aperture, Alt/Az, spherical primary, prime-focus corrector f/8.4,
- Acquisition with auxiliary telescope
- Fine-acquisition & guiding with fast industrial firewire camera on 140µm pinhole mirror (in the future only acquisition)
- 4 fixed ADCs
- Fiber feed for STELLA échelle spectrograph (SES) using 50µm fiber with r=167µm lens at prime focus (≈ 3“ on sky aperture)
- Image slicer coming soon, then using 200µm pinhole and 72µm fiber

# STELLA SES



- Bench-mounted échelle spectrograph, R=55,000, 390 to 870nm wavelength coverage
- Temperature controlled room, SES inside an insulated box in that room
- 45s readout for 4-channel 4kx4k CCD using AIP-built Magellan controller
- coming soon: 2-way slicer + simultaneous calibration spectrum on each exposure

# STELLA/SES



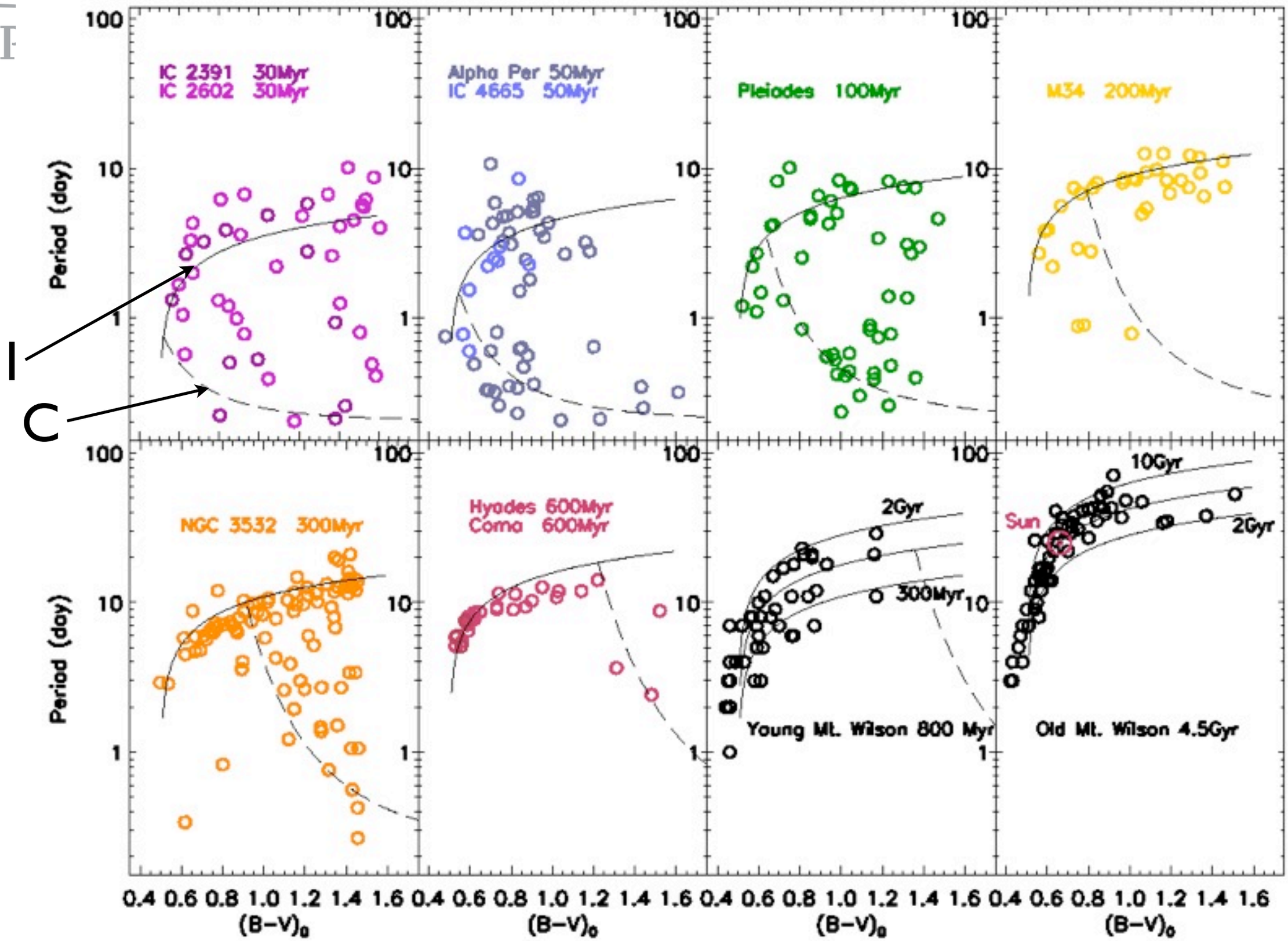
Full spectrum of HD 1 using the old optical camera & CCD detector (hence the inter-order gaps on the red end)

# WiFSIP Core science

- Main advantage of robotic telescopes is the time domain
- Combining Stellar Activity & Time series
- STELLA open custer survey:
  - ➡ Rotational Periods of open cluster stars
  - ➡ Age sequence of clusters delivers $\Delta P/\Delta t$

Outside of cluster-seasons general proposals like planetary transits.

# Heuristic interpretation of C-P diagrams (Barnes 03)



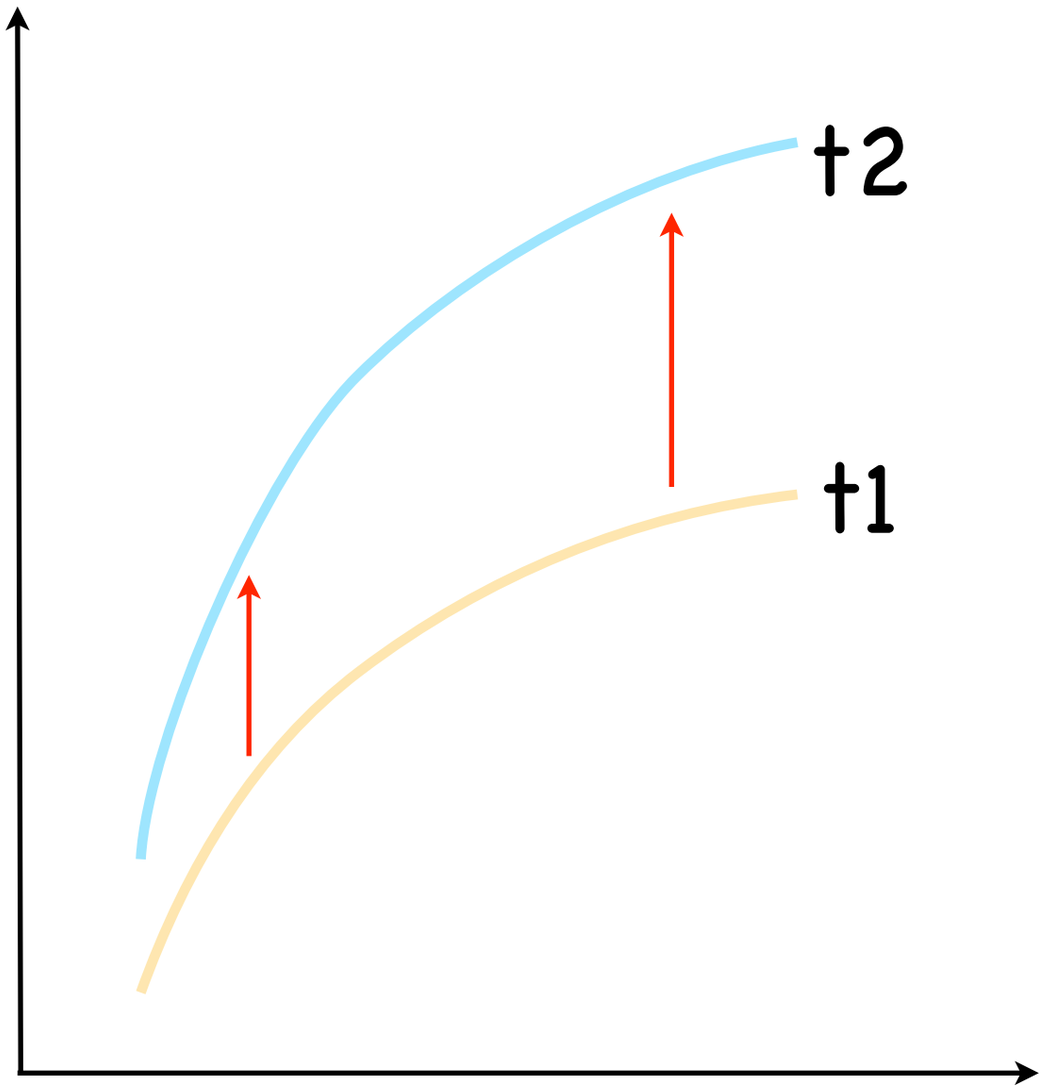
# I-type stars spin down Skumanich-style

$$P_I(B-V,t) = f(B-V).g(t)$$

$$g(t) = \sqrt{t}$$

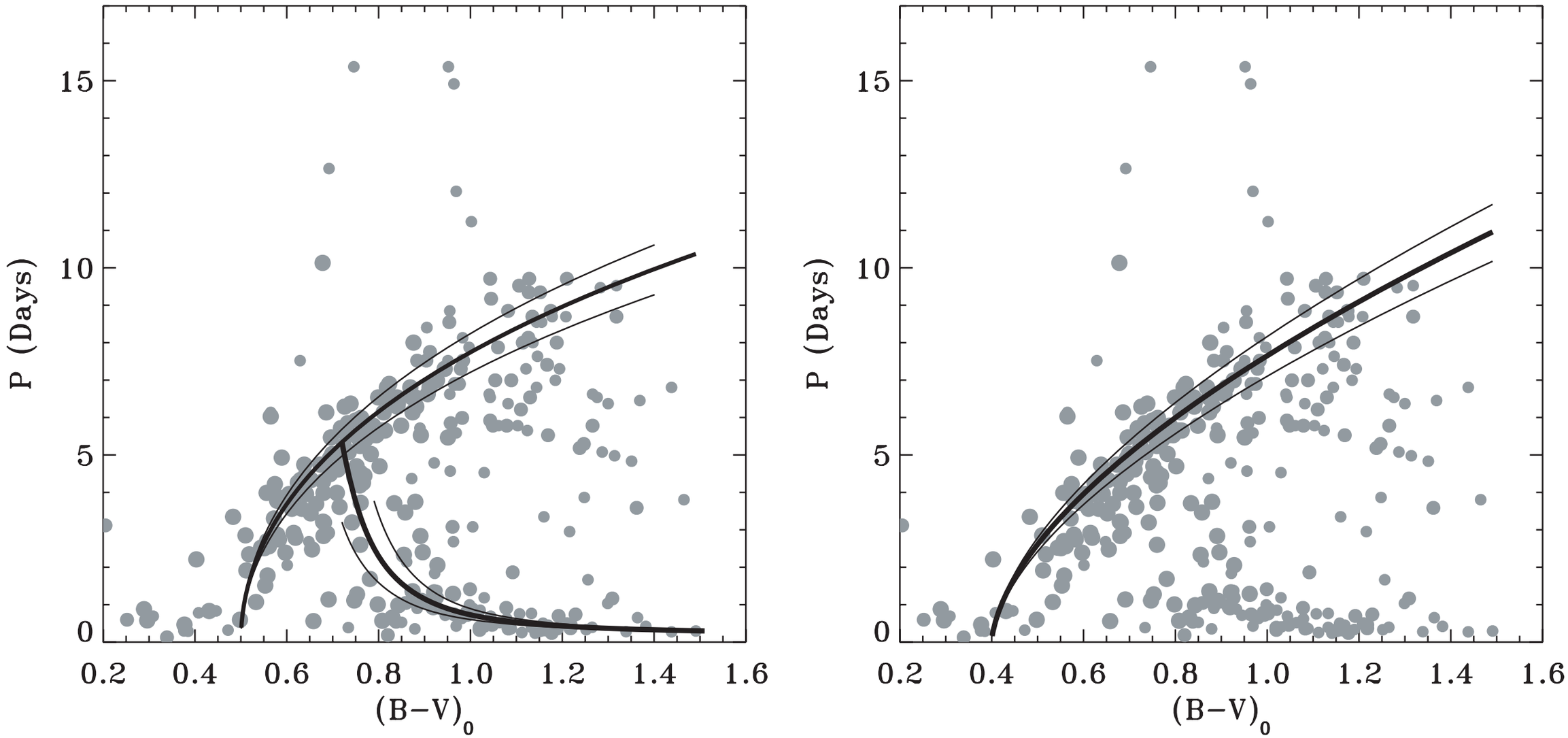
$$f(B-V) = a(B-V-c)^b$$

$$a,b,c = 0.778,0.519,0.4$$




(Barnes 2007, ApJ, 669, 1167)

# e.g. M35



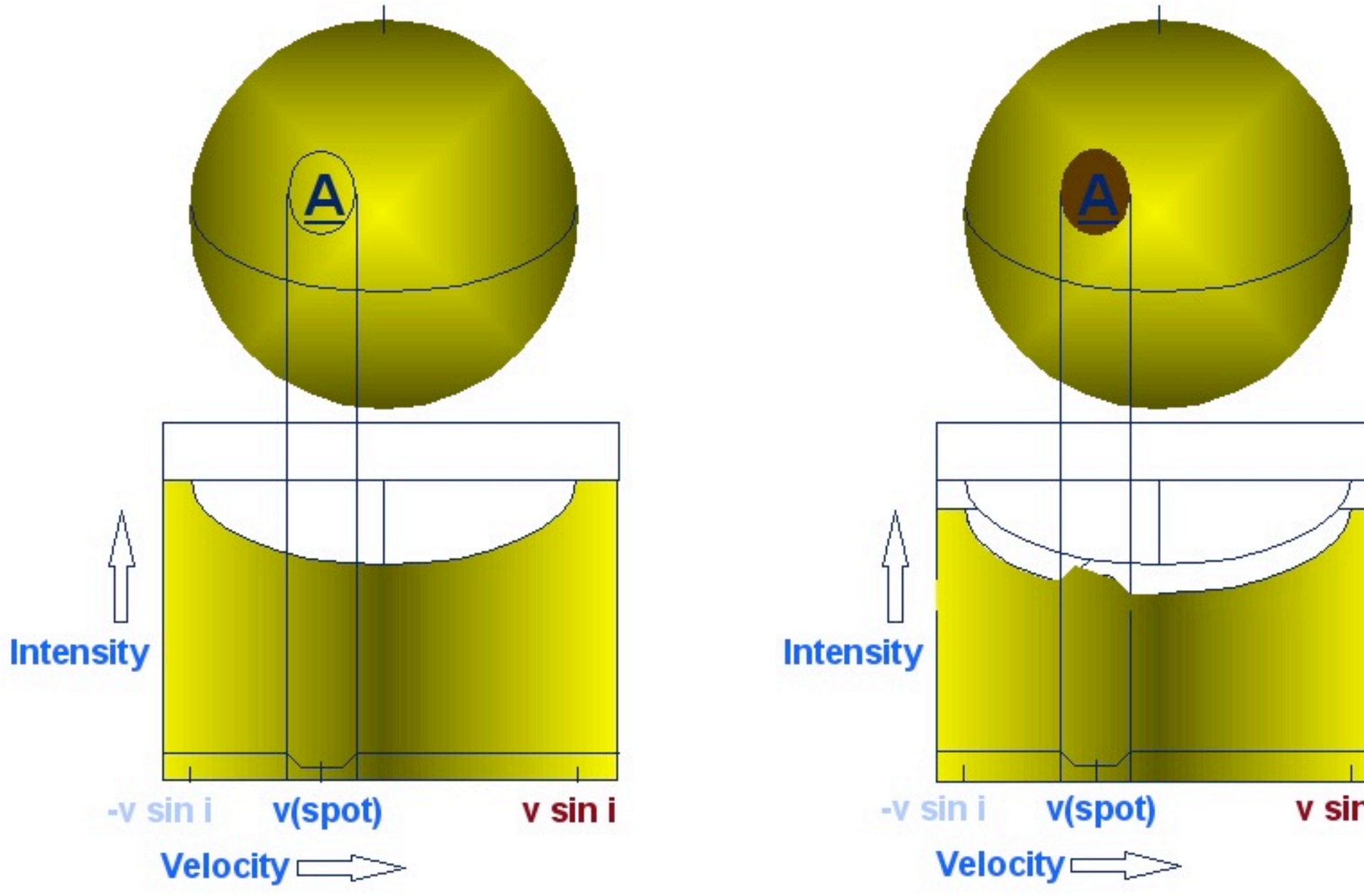

Barnes 2003/2007 age/rotation relation for 130/150/170 Myrs together with M35 data (Meibom et al. 2009)

# SES Core science

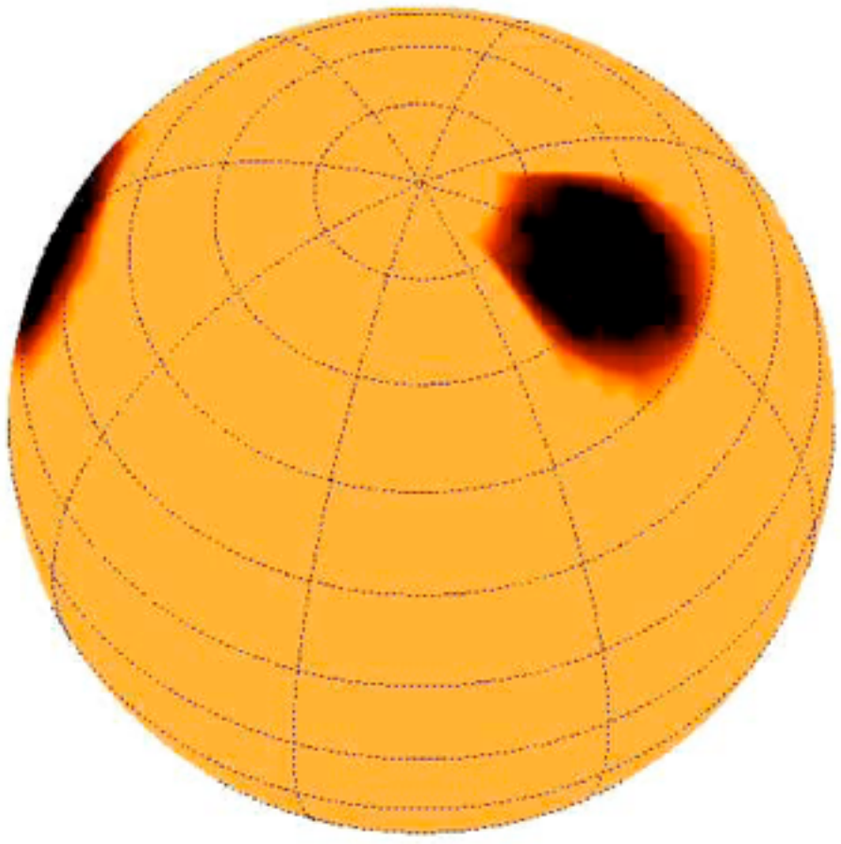
- Main advantage of robotic telescopes is the time domain
- Solar Activity has 11/22 year cycle period
- Time series Doppler imaging

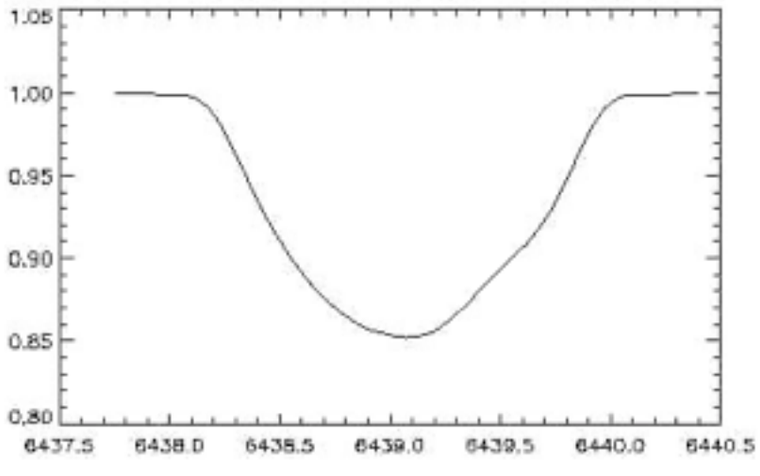
Rest of the time various projects like support of space or large telescope proposals, binary stars, cepheids, planetary transits,...

# Doppler imaging

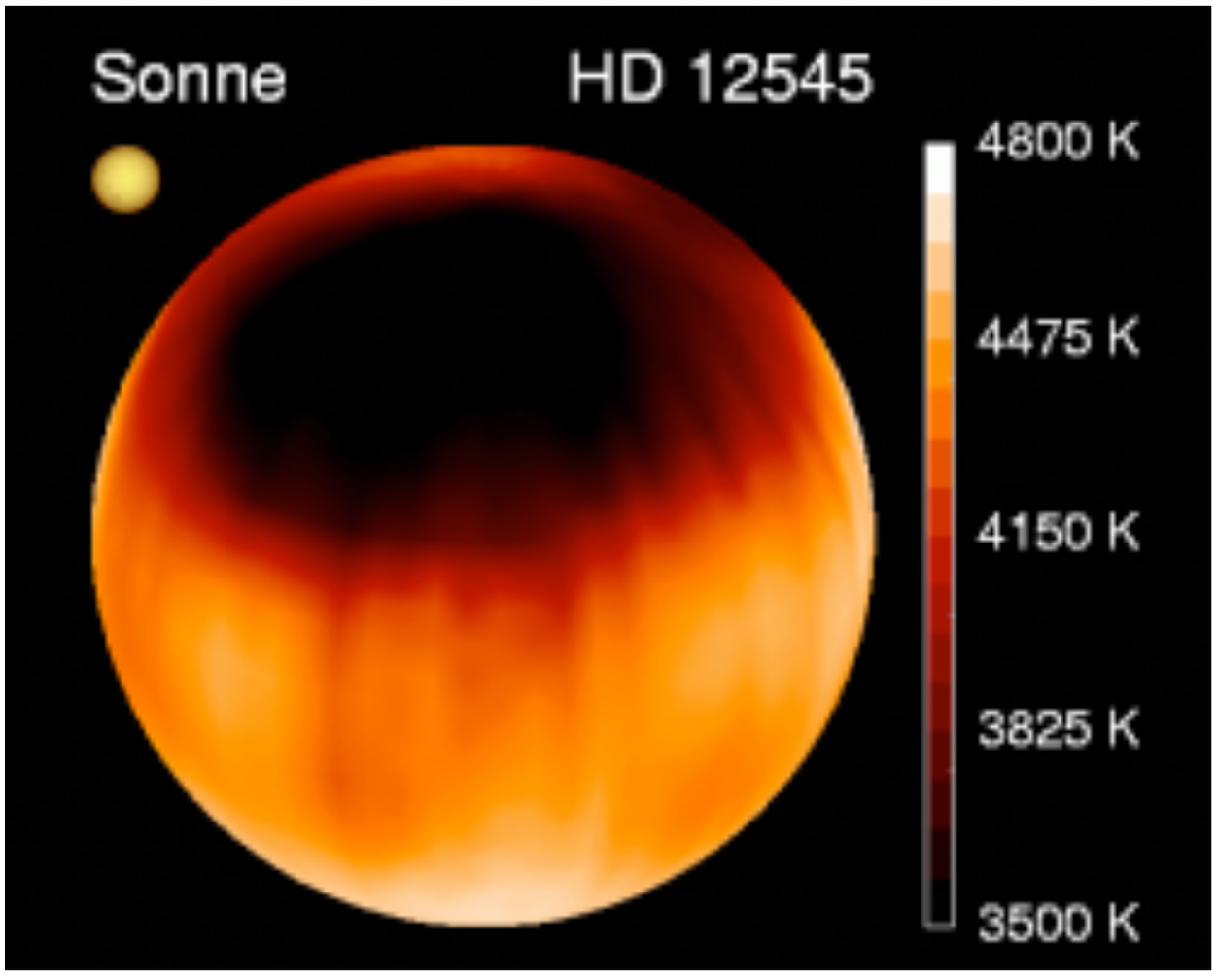


# Doppler imaging





# XX Tri




*Strassmeier et al. 1999*

- very active red giant
- 20 days period
- Observed once a day when possible
- aim is to get dynamic parameters: cycle period, differential rotation, spot decay rates (these are ingredients for dynamo/MHD calculations)
- PhD thesis A. Künstler

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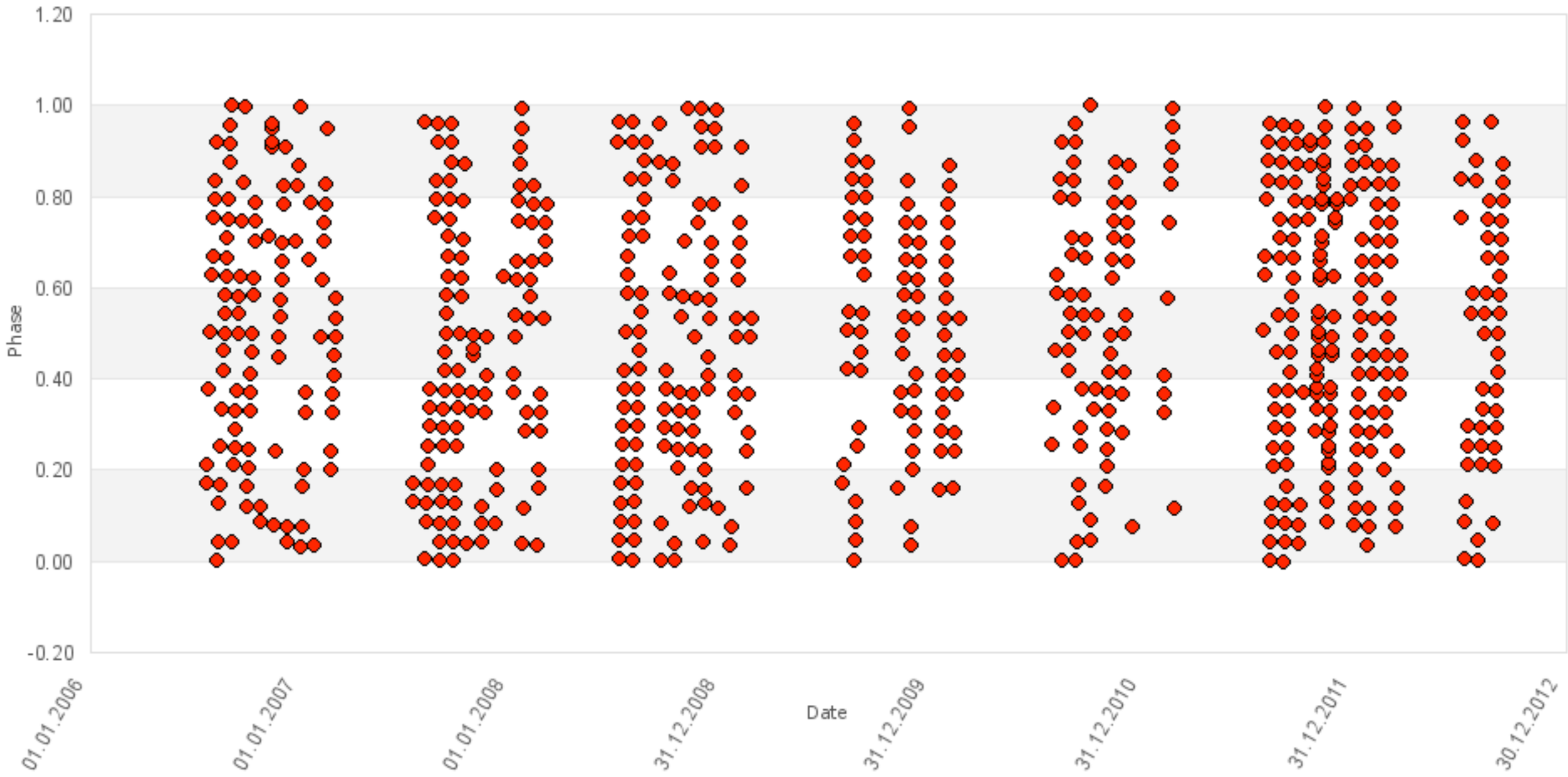
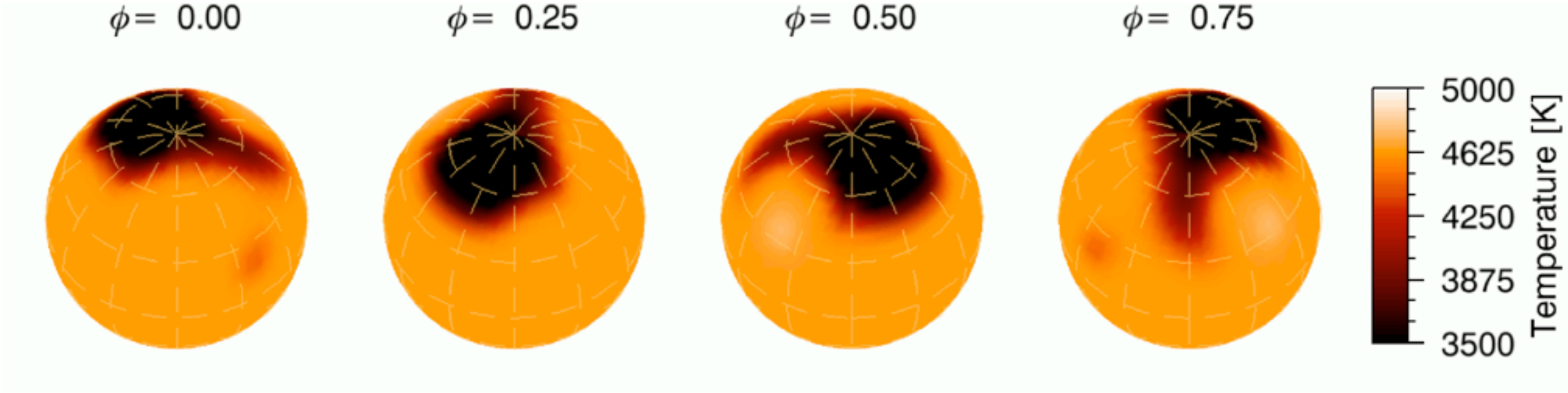
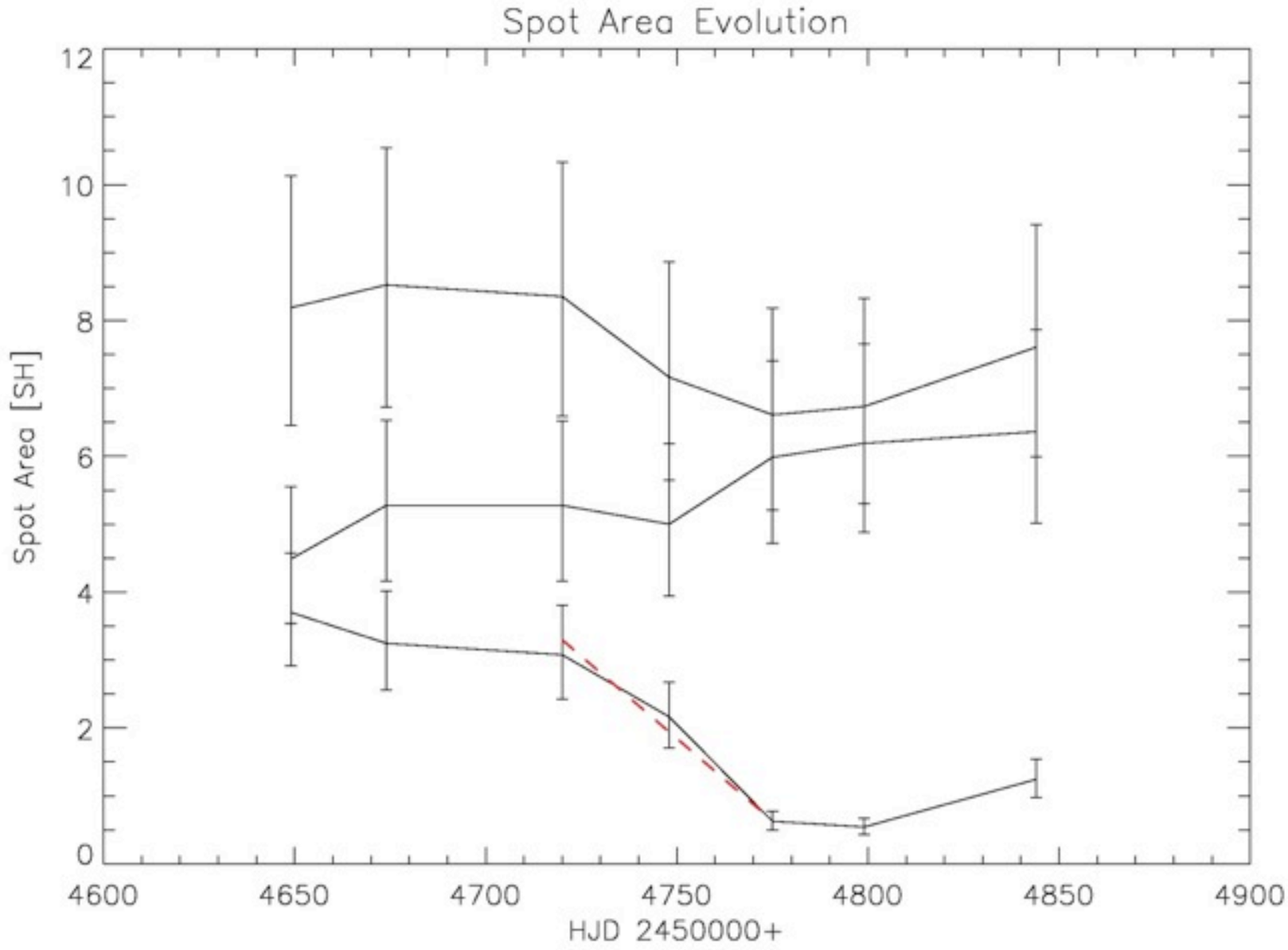



SES Phase vs. Date diagram: each dot is one observation




Time series Doppler images: observations of spot evolution




Observations of a decaying spot - estimate for a spot decay law

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