Spectroscopy and monitoring with the robotic 1.2m telescope TIGRE in Guanajuato, Mex.

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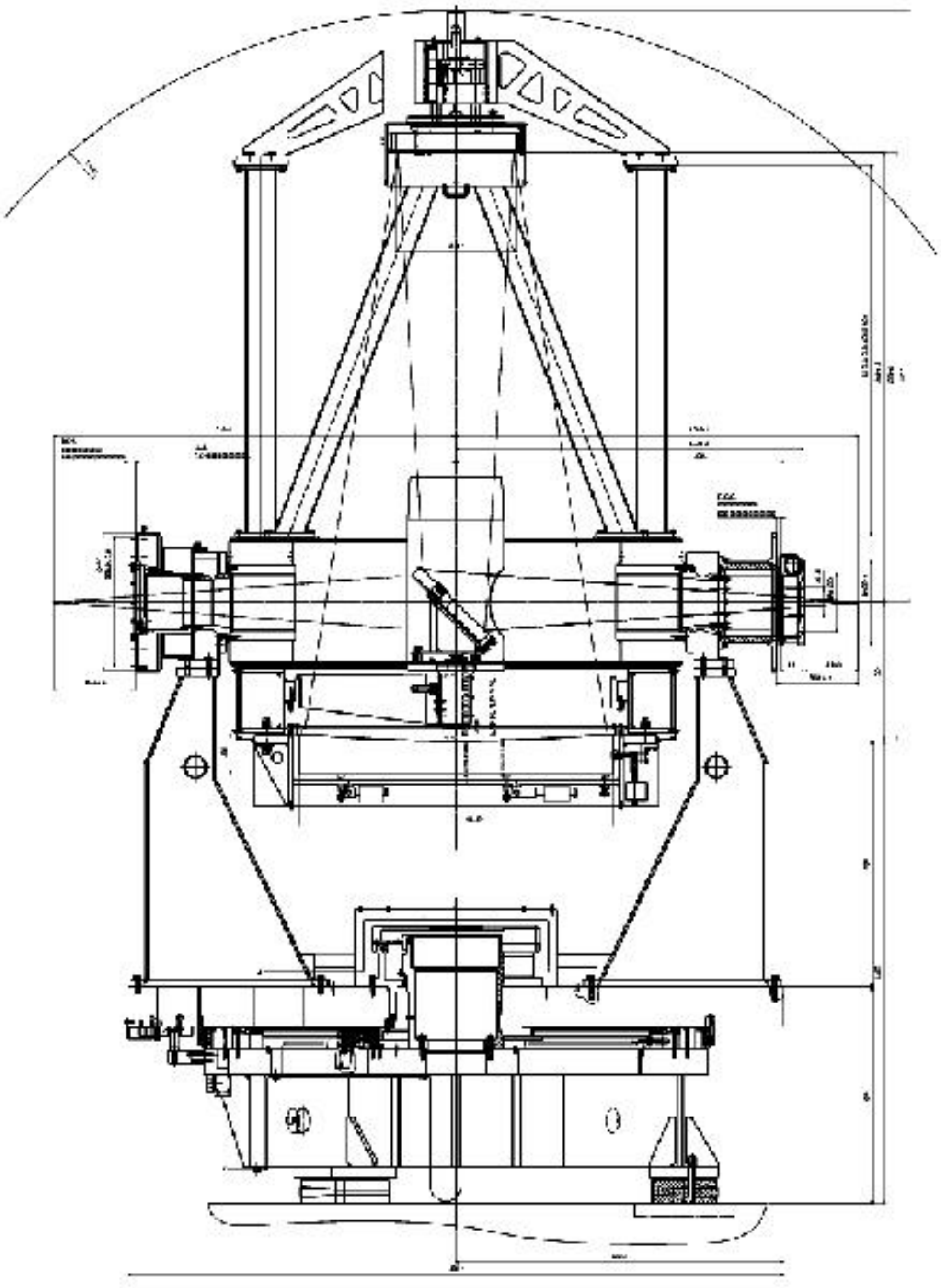
SONG-WS, 25th of Oct., 2018

March 2013:

Arrival and montage of the then HRT - now „TIGRE“



TIGRE: Technical Data

Company: Halfmann, GER

Mount: Alt-Az

Weight: 15 tons

Optics: Cassegrain-Nasmyth,
Zerodur (!), 1.2m f/8

Field of view: 7‘

Tracking accuracy: ~0.5“
(unguided !)

Pointing accuracy: ~3“

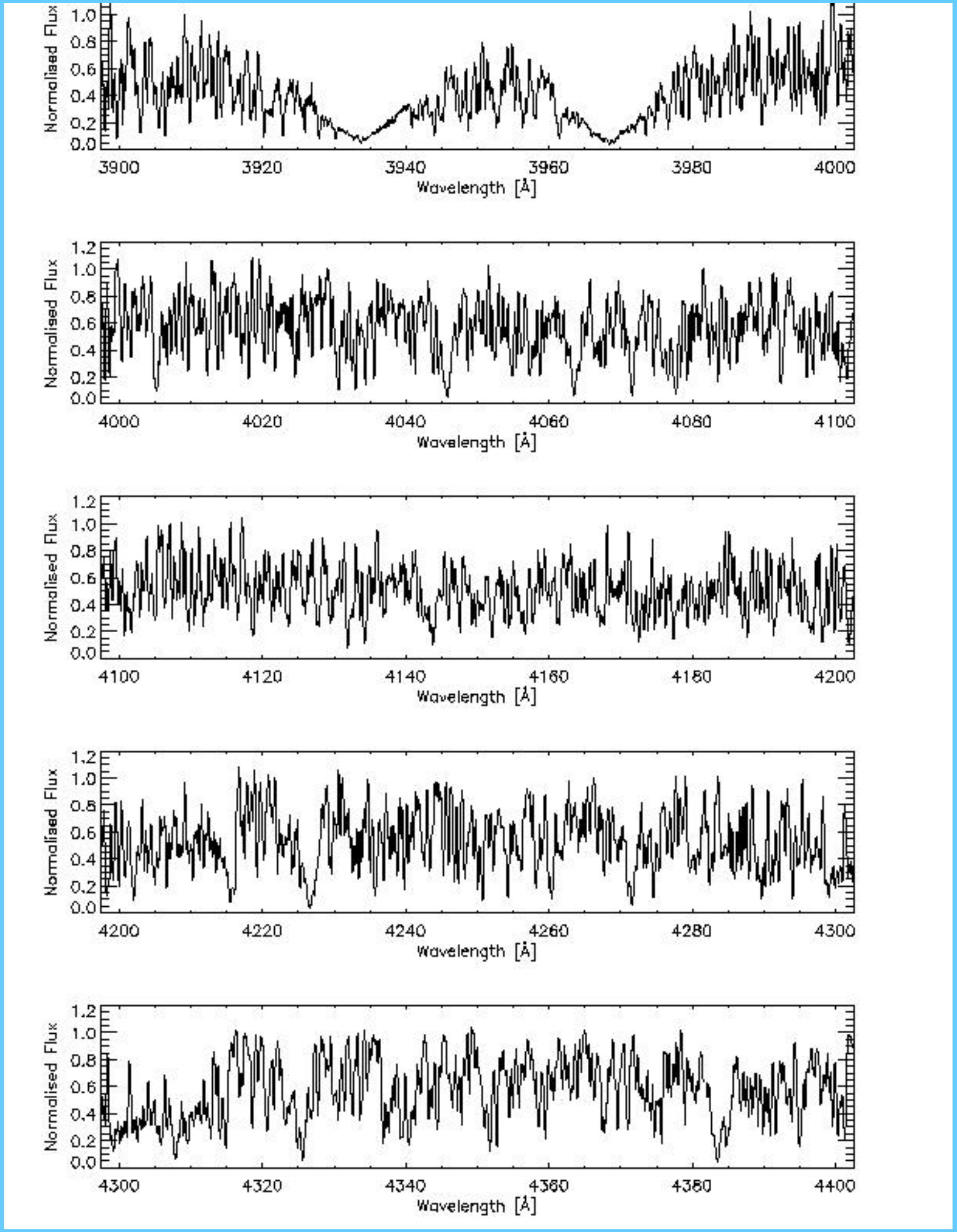
PI in Hbg: Juergen Schmitt

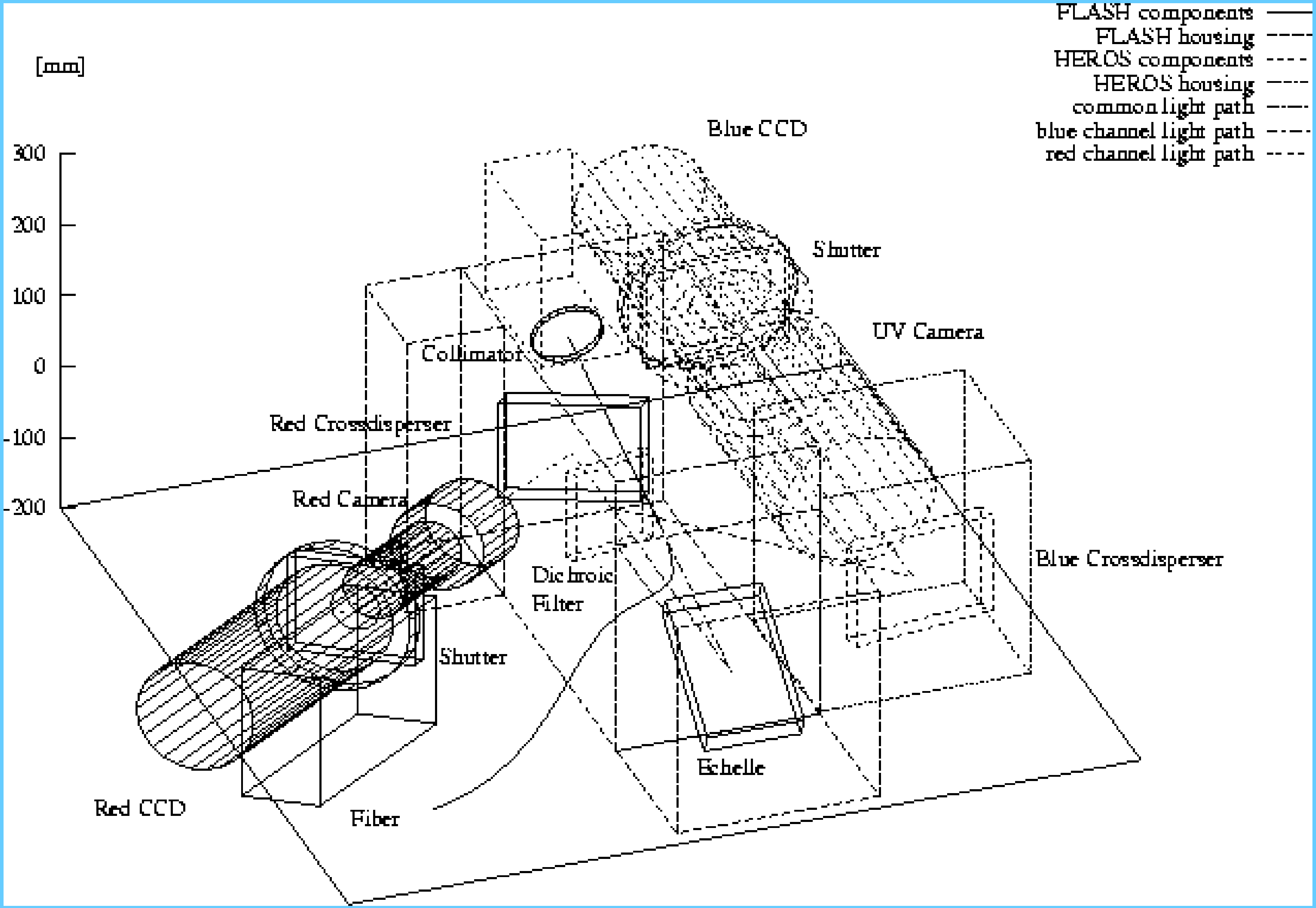
HEROS:

Fiber-fed double-channel echelle-spectrograph for 3700-8700 Angstr

Uniform resolution 20,000, stable (bench-)spectrograph (δv_rad < 100 m/2), fiber-coupled to Nasmyth-focus, once developed in Heidelberg, with new, large blue- & red-sensitive, cooled CCDs.

Of particular interest for our studies of chromospheric activity are the CaII H&K lines (see above, right).

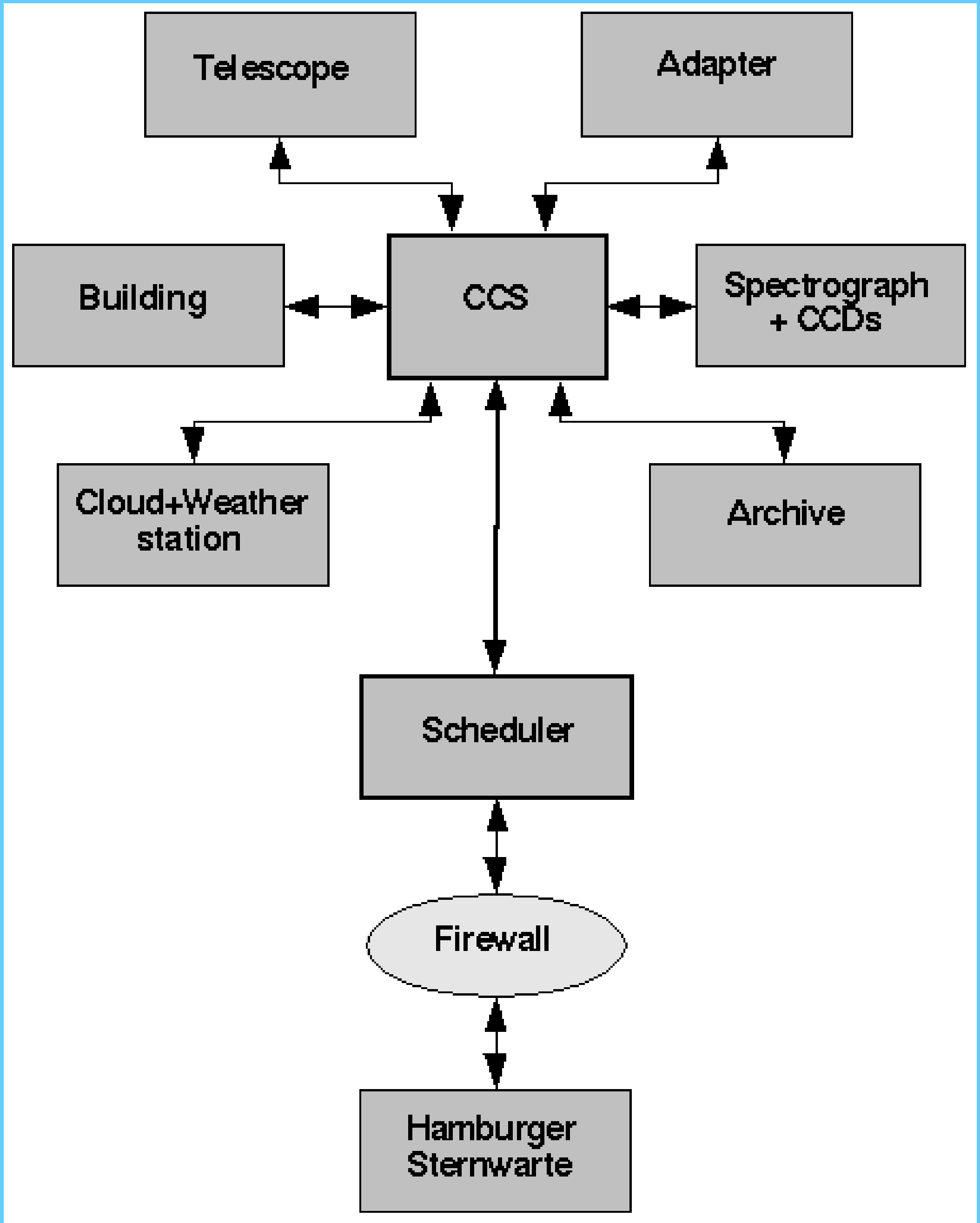




HEROS: Schematic drawing

HEROS:

The fiber-feed, aquisition &guiding adaptor of the spectrograph



HRT & HEROS:

control software schematics

Science-Philosophy of TIGRE:

- *dedicated: spectroscopic monitoring fills a strategic gap*

- *autonomous, robotic operation: low operation costs, also:*

- *accessible site with many nights sufficient for spectroscopy*

- *almost immediate (24hr) response to targets of opportunity*

- *efficient: automatic data-reduction pipeline and on-line archive for its users => fast observational data for students!*

- *international colaborations (with Univ. Hamburg and Liège) and foreign work-stays available to our UG students*

- *open to colaborations outside the 3 funding universities*

Key programmes:

- *stellar and solar activity monitoring (short- and long-term)*
- *novae and supernovae monitoring (short- to medium-term)*
- *very hot stars and binaries (short- to medium term variability) with winds*
- *exoplanet-hoststars and planet-star relationships (transit observations time-critical, others not)*

Our pet project - to continue O.C. Wilson's work

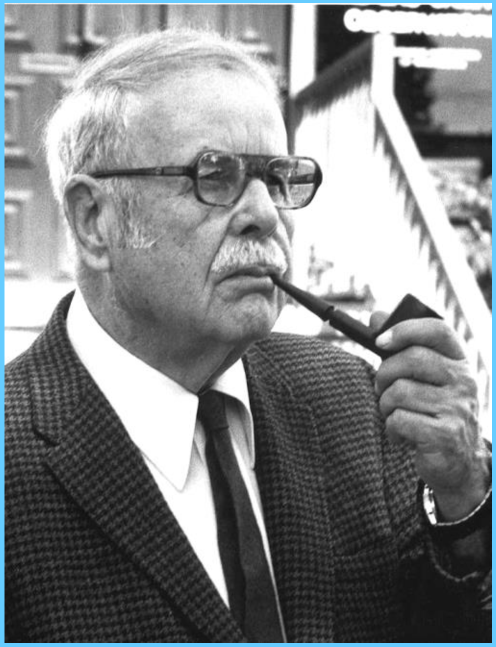
- *monitoring the Ca II K chromospheric emission variability, robotic telescope provides shorter cadence and efficiency*

- *sample: over 40 cool giants and >100 solar-type stars brighter than 7 mag, spectral type G-M, of different activity degrees*

- *also: „the Sun" (moonlight spectra), compared with MS F-K stars*

- *duration: Wilson team covered 1962 to 1992, only some follow-up by Lick and Lowell Obs. (Wright, Hall, ...), using OC's „S-index"*

- *we now wish to add 2 more decades (at least! :-) to probe the long timescales and find out which types of dynamo: mono-periodic, multiperiodic, chaotic?!*

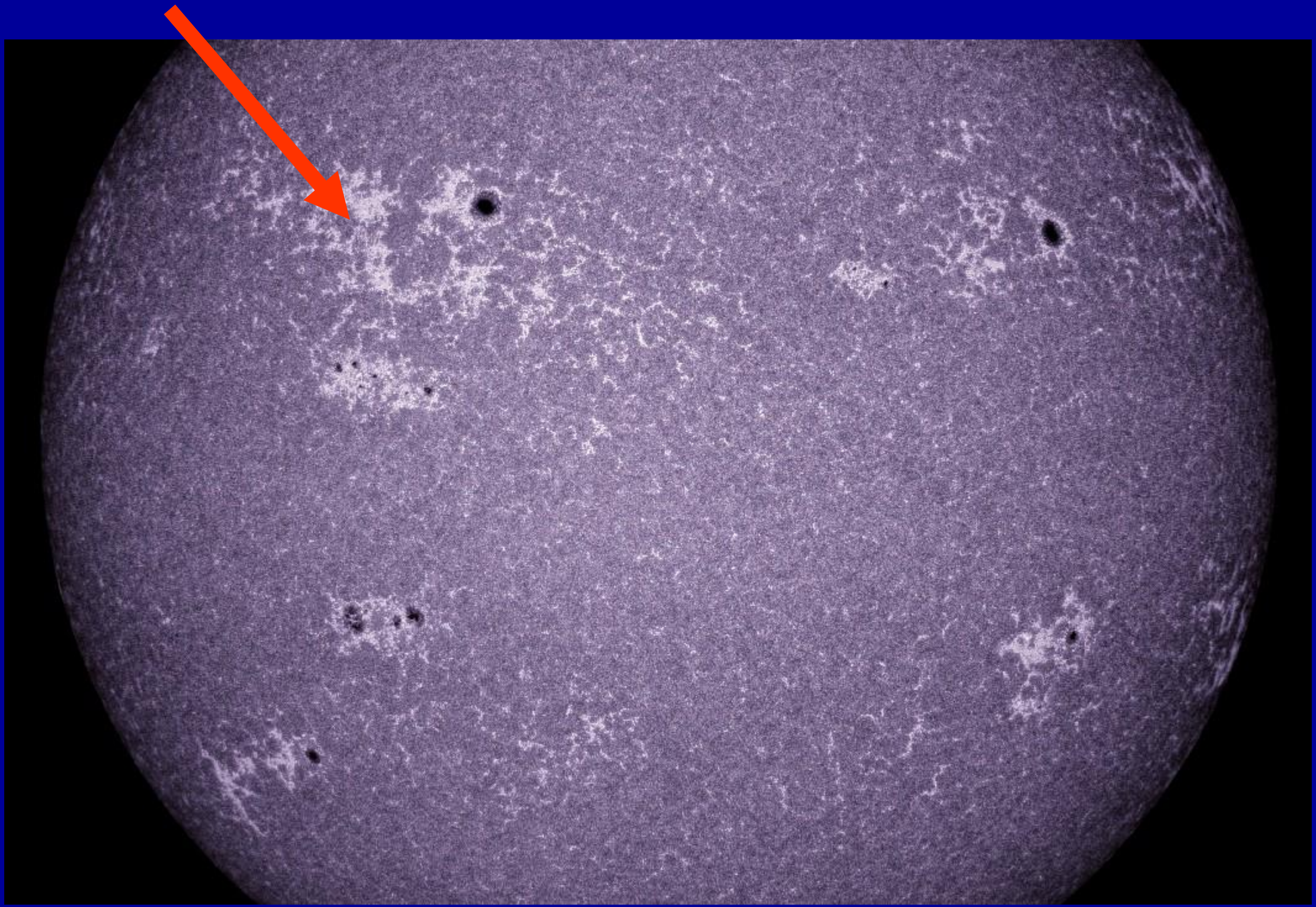


=> How does evolution of stellar activity work?

UV from solar faculae coincides with Ca II K emission

- *integral solar irradiation and visual flux change only by 0.1%*
- *but the output of ultraviolet light (λ=320-200nm) is dominated by active regions and changes by several % (and more)*

A good proxy is CaII K emission, forms at about same T_e!



The Mt. Wilson S-index to measure the CaII line emission (relative to the adjacent pseudocontinua):

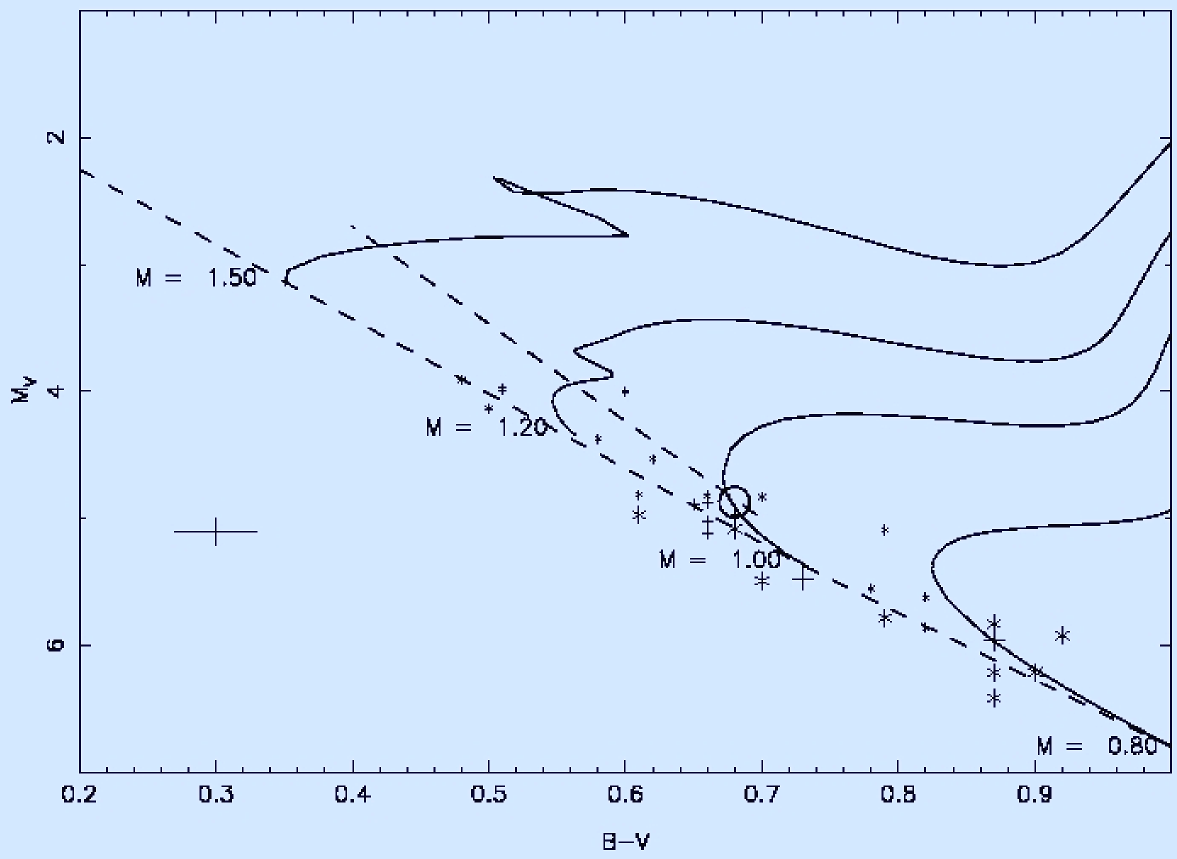
$$S = const.\ (F_H + F_K) / (F_R + F_V)$$

1 Angstr. wide line cores H&K / 20 Angstr. wide preudocontinua, as such S is independent of transparency. Calibration by standard stars.
=> Hence, S is of the order of the line core intensity over cont. intensity
Modern spectra: const. ~ 19, calibration by same set of stars as OCs

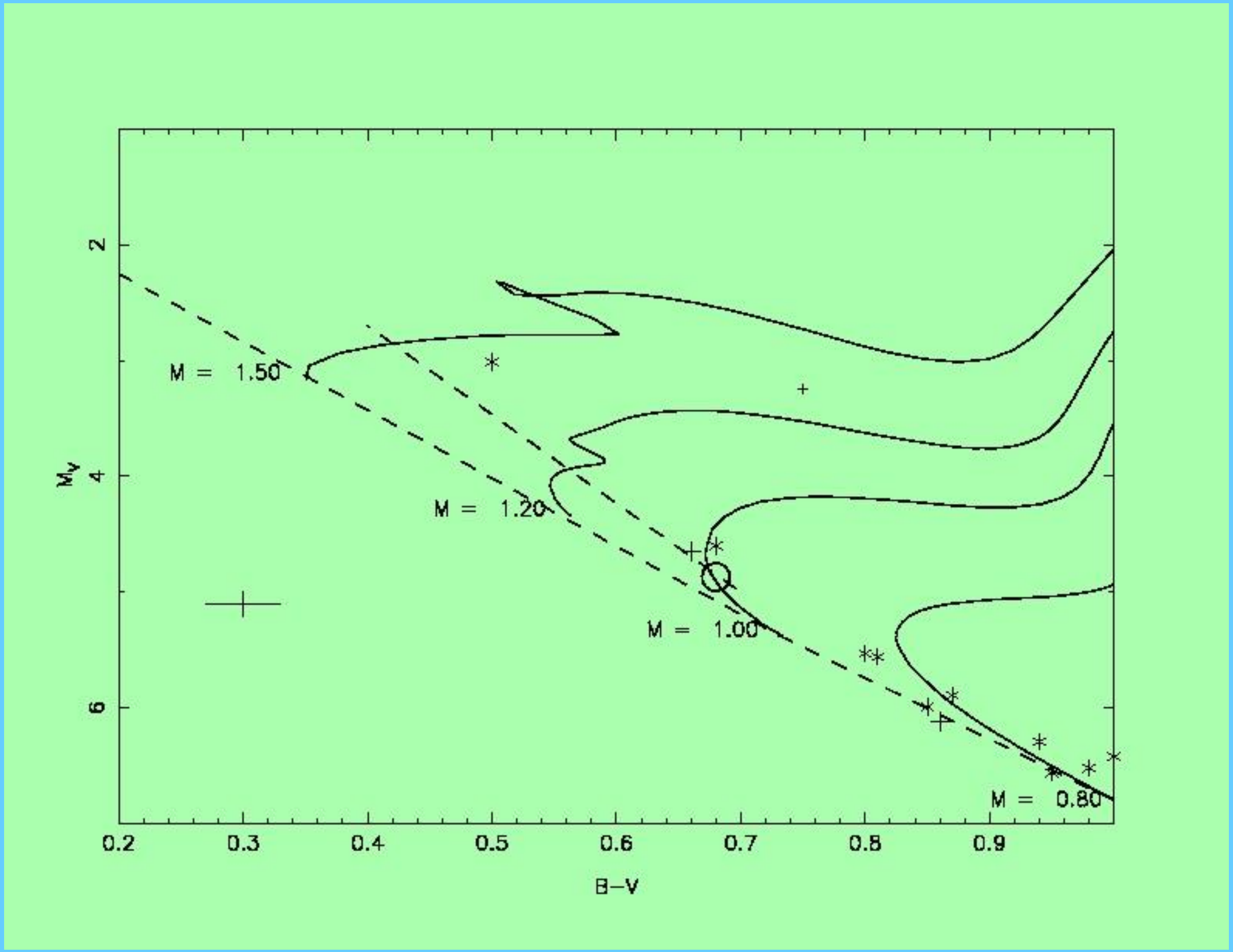
Advantages: S is independent of sky quality and calibration lamps,
best detection of even the smallest emission in the CaII core,
long time-line available (since 1960ies!!).

Disadvantages: - S does not directly compare with physical line fluxes!
- for supergiants, 1 Angstr. window is too narrow!!

Higly active Mt.Wilson MS-stars (S > 0.25 ... 0.5), Z-adjusted, over Z=0.02 evolution tracks on MS: Very young, scattered around the ZAMS (no surprise)

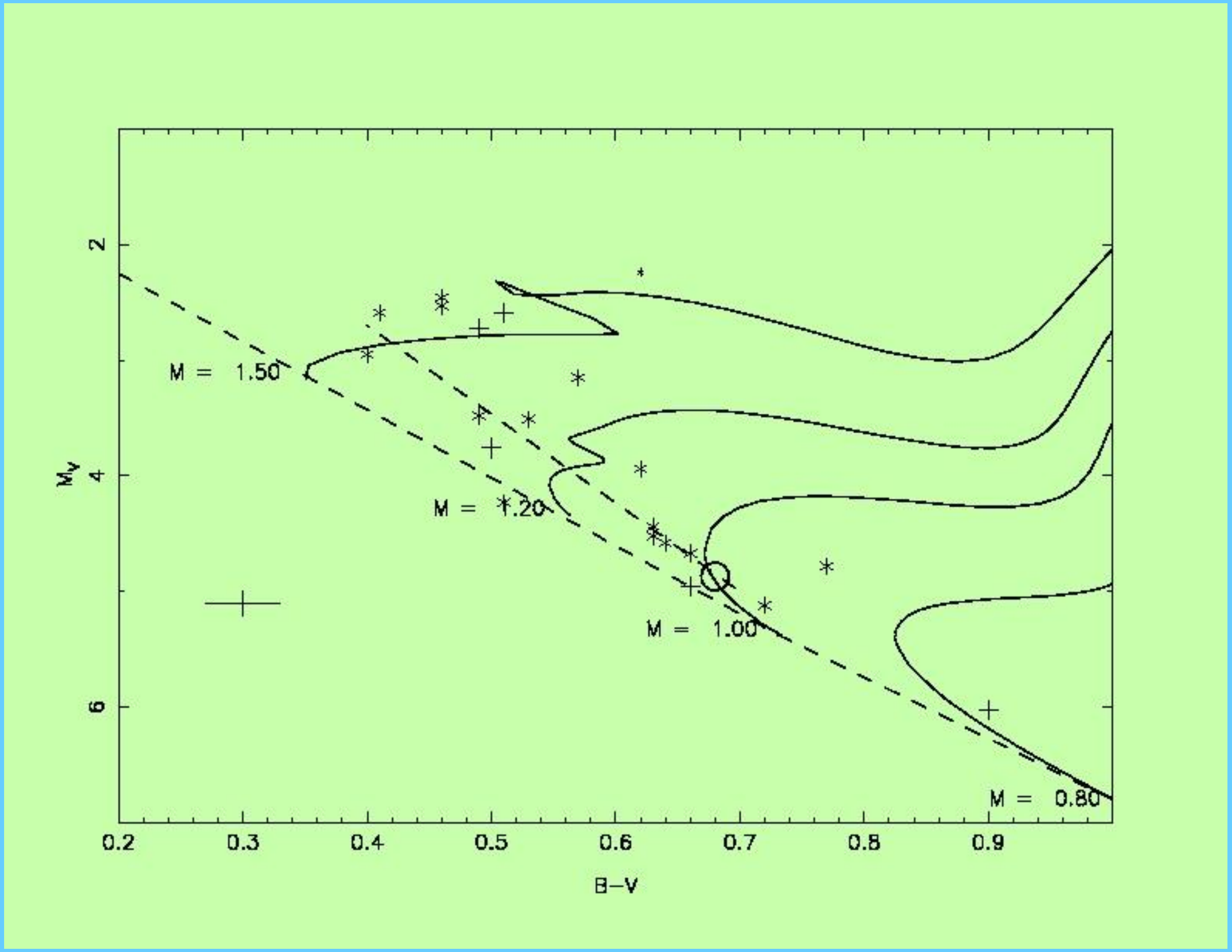


Moderate, cyclic Mt.Wilson MS-stars (0.17<S < 0.25), Z-adjusted, over Z=0.02 evolution tracks on MS: Surprise: mostly less massive than the Sun!! (~50% MS-lifetime)

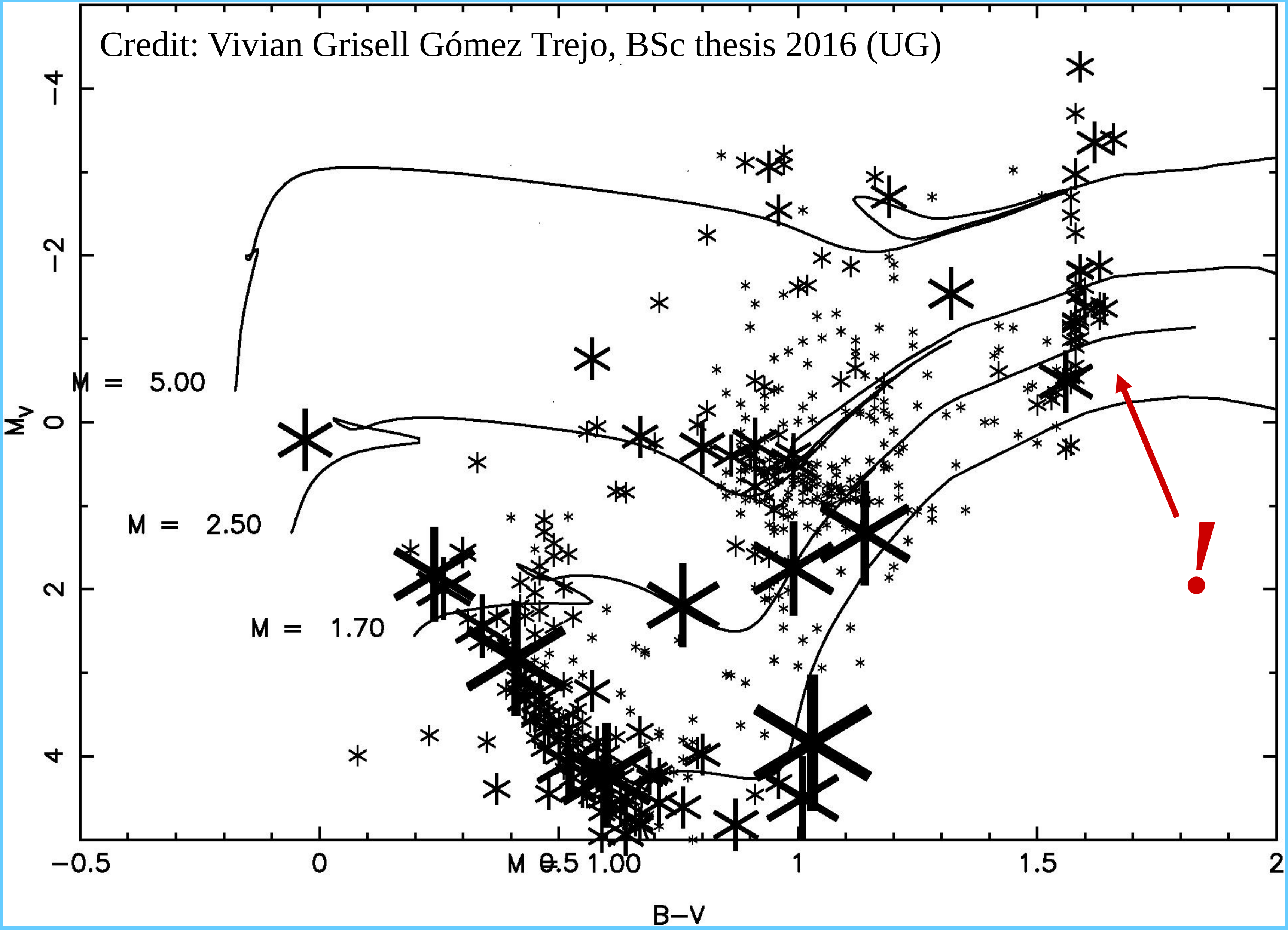


Moderate, „irregular“ Mt.Wilson MS-stars (0.17<S < 0.25), Z-adjusted, over Z=0.02 evolution tracks on MS: Evolved between 50% and 75% of their MS-lifetime

=> do F-stars have short-Period-branch cycles of 3-6 months??



S-values Duncan et al. 1991 for stars with parallax > 10 σ



TIGRE for confirming Exoplanet host-stars

The flexibility of the TIGRE observation scheduling (response possible within 24hrs, ToO can get highest priority to assure their observation, allows to confirm the physical nature of a transit event by detecting the Rositter-McLaughlin effect.

...and with their large spectral coverage TIGRE spectra are ideal to determine the physical properties of the hoststars


...but much work remains to be done.....
Gracias!

Deriving Physical Properties of Exoplanet hosts and other stars of interest:

TIGRE spectra cover wide range at high resolution (370-870 nm, R=20,000) => Best for deriving physical parameters T_eff, log g, [Fe/H] and other abundances. Analysis with iSpec and PHOENIX models

We can include such once-and-only, not time-ritical observations conveniently to fill in scheduling gaps, stars must be brighter than 10.5 mag and DE>-30°

First „highlight" publications (my favourites):

- *the TIGRE concept* **(Schmitt et al. 2014, AN 335, pp.787-796)**
- *Nova Del 2013* **(De Gennaro Aquino et al. 2015, A&A 581, A134, 79pp)**
- *SN-2014J in M82* **(Jack et al. 2015, MNRAS 451, pp.4104-4113)**
- *Nova Sgr 2015* **No. 2** **(Jack et al. 2016, MNRAS, submitted)**
- *hot supergiants (Oe stars)* **(Rauw et al. 2015, A&A 575, A99, Rauw et al. 2015, A&A 580, A59)**
- *spectroscopic binaries* **(Schmitt et al 2016, A&A 586, A104)**
- *solar twins: activity and ages* **(Mittag et al. 2016, A&A, in print)**
- *solar-like stars, rotation* **(Hempelmann et al. 2016, A&A 586, A14)**
- *low solar activity cycle 24* **(KPS et al. 2017, MNRAS 470, p.276ff)**
- *activity evolution of cool giants* **(KPS et al. 2018, MNRAS in print)**