Project **Yellow Hypergiants**
Long-term Monitoring of Rho Cassiopaie and HR 8752

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We want to establish an amateur long-term spectroscopic and photometric observation campaign to study the behavior of Rho Cassiopeia and later on HR 8752 on their track bluewards.

Aims

For **Rho Cas** there is a time decrease between the last three outbursts. This may be an indication for preparing the passage through the lower part of the Yellow Void. We want to check if this behavior is ongoing. Among other these outbursts leads to decrease of T_{eff} and decrease of the flux in Johnson B and V.
Therefor we plan to observe the temperature with use of the equivalent width ratio and line depth ratio of two Fe lines which is calibrated against a sample of 50 FGK supergiants from T_{eff} 4500 K to 7500 K.
Additional we want to study the spectral behavior of this star over a long time.

For using the EWR and LDR method **HR 8752** isn‘t so good situated at this time. There are only a few lines in the range of 6330Å to 6600Å (the wavelength range we cover with our equipment) Angstrom. So first we want search for correlations between the available lines and photometric data. If this will be successful, we plan to monitor HR 8752 in the same way as Rho Cas. In autumn we will start to monitor especially HR 8752 with CCD-photometry.

Instrumentation and needs

This study is developed with the common Lhires III spectroscope in mind. A spectral range coverage of 6300Å to 6600Å is requested. In particular it is essential to cover 6400Å to 6450Å.
The minimum resolution is R = 10.000 with an SNR of at least 100.
We request raw data, because all data will be reduced in the same way with help of a MIDAS Pipeline. This should avoid problems of using different software.

At the moment we can only accept long slit data, because we have no option to reduce Echelle data. If there is anyone who is familiar with reduction of such kind of data with MIDAS or IRAF we would be grateful for help.

For data reduction we need Flats, Bias, (Darks only if the quality of the CCD request them) and calibration-lamp data. To look for the mechanical stability of the setup with wavelength calibration in mind, one have to take a calibration image before and after the object lights. For every Observation there have to be at least 50 Bias and 40 Flats. Also we need further Information about the instrumentation and location of observation.
Below there are the detailed requirements.

Naming of the data
All data have to be stored in Fits format. The data must be named as shown. The star stands for the part you can write things you wish.
For example: Light_2018-05-04T22:56:09_006.fits

Science lights	→ Light_*.fits
Bias	→ Bias_*.fits
Flats	→ Flat_*.fits
calibration before	→ cal_001.fits
calibration after	→ cal_002.fits

Information about the data
For reduction, interpreting and error estimation we need further information about the data. We request this in .txt files.

Following information we need only once, or if anything changed:

- Name of the observer
- Telescope
- Spectrograph
- Calibration lamp
- Flat lamp
- coordinates of observation place
- Science camera
- Used camera gain

This information we need for every single observation:

- Mean UT date of observation in FITS conform notation: YYYY-MM-DDThh:mm:ss
- Information of unexpected events

Observation density
Goal is an observation density of one observation every five days. In a particular case we will need a temporal coverage as best as possible.

Information about campaign status
We plan to inform about the progress in blog format.

Professional Astronomers in this campaign
We get support from several astronomers. Mainly we work together with Anna Aret and Indrek Kolka from Tartu Observatory, Estonia. If we need, Indrek is ready to be the Principal Investigator.

Contact
If you are interested in contribution please contact Malin Moll or Christoph Quandt via PM in the spectroscopy forum https://forum.vdsastro.de/viewforum.php?f=38

Most necessary information about the target stars

Rho Cassiopaie	
Apparant visual magnitude	4.1 to 6.2
RA_2000	23,54,23.032
DEC_2000	+57,29,57.77

HR 8752	
Apparant visual magnitude	4.6 to 6.1
RA_2000	23,00,05.101
DEC_2000	+56,56,43.35

What is a yellow hypergiant?
Yellow hypergiants (from now YHGs) are very massive, luminous stars which have passed through the red-supergiant phase and now evolving bluewards. Their effective temperature changes between 4000° and 7000° Kelvin (Richard B. Sthothers and Chao-Wen Chin, 2001; A. Aret, M. Kraus, I. Kolka, and G. Maravelias, 2017). If these stars reaches a temperature over 7000 K they may sustain an outburst. This outburst leads to cooling down the effective temperature and a decrease of g eff. Then both will increase again. This is called bouncing against the Yellow Void. (H. Nieuwenhuijzen and C. de Jager; Astron. Astrophys. 353, 163–176 (2000))

At the proposal of A. van Genderen the name hypergiant was introduced instead of super-supergiant.
After de Jager (1998) one should use the symbol Ia+ instead of 0 or Ia0 for the YHGs, because these stars are not a separate luminosity class, but rather a special group of Ia-type stars.

There are two physical spectral characteristics to separate the class Ia+ from Ia type stars:

1. Spectra shows with Hα one or more broad emission lines.

2. Their absorption lines are clearly broader then Ia stars of similar spectral type and luminosity shows.

These two characteristics indicate that hypergiants are supergiants with strong and large photospheric motion and also extended atmospheres. This implies high mass loss rates. In particular the broader absorption lines are caused by microturbulent velocity.

With these two criterions hypergaints must not be mandatory the brightest stars of their spectral class and so there are indeed some Ia-type stars, which are brighter than Ia+ stars.

The considerations made above leads to the question, why two stars with similar bolometric luminosity and spectral class can behave so different. One is rather stable the other not.

De Jager said in his Review Paper (1998), that the answer has to be sought in the origin of the large-scale motion field and the physical relationship between large-scale photospheric motions and an extended envelope with an enhanced rate of mass loss, in relation to the star's evolution.

The yellow evolutionary void

This is a region in the HR-diagram from about 7,000 to 12,000 K, where the atmospheres of bluwards evolving stars become unstable. Stars found in that void are young redwards evolving stars.

- After de Jager 1998, it is a region where a negative density gradient arise. But according to mail traffic with Otmar Stahl this assumption is uncertain.
- Further the sum of all accelerations, also turbulence, wind and pulsation is zero or negative.
- The sonic point of the stellar wind is reached in or below photospheric levels.
- And at least $\Gamma 1 \leq 4/3$ point to a level of dynamic instability in the part of atmosphere.

H. Nieuwenhuijzen et al. (A&A 546, A105 (2012)) showed, that the yellow void consist of two regions: $3.8 \leq \log T_{eff} \leq 3.95$ and $4.05 \leq \log T_{eff} \leq 4.1$.

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