Monitoring of the ejection behavior of Rho Cas
Line flux and radial velocity of the Hα double peak emission

The ejection behavior typical for the current development status of the star is described by Klochkova et al. "***Changes of the optical spectrum of the hypergiant ρ Cas due to a shell ejection in 2013***" (Astronomy Reports, 2018, vol. 62,) highlighted among other things in the Hα area.

Our previous observation efforts to describe scientifically relevant radial velocities and emission fluxes in the Hα range do not seem to me from today's point of view and especially in view of our previous monitoring, to correspond to the research goals of professional astronomy. According to Klochkova et al. we have also concentrated on the ejection process in the Hα range, because photospherical ejections are evidently particularly easy to detect in this spectral range. As before, our main focus is therefore still on the intensity behavior of the blue- and red-shifted Hα emissions, but now supplemented on their radial velocity behavior (RV), which is why all the spectra provided by all observers involved in the Hα emission line profile have been re-evaluated. Attached are two self-explanatory diagrams for the flux behavior of both emissions (Fig. 1) and their radial velocities (Fig. 2).

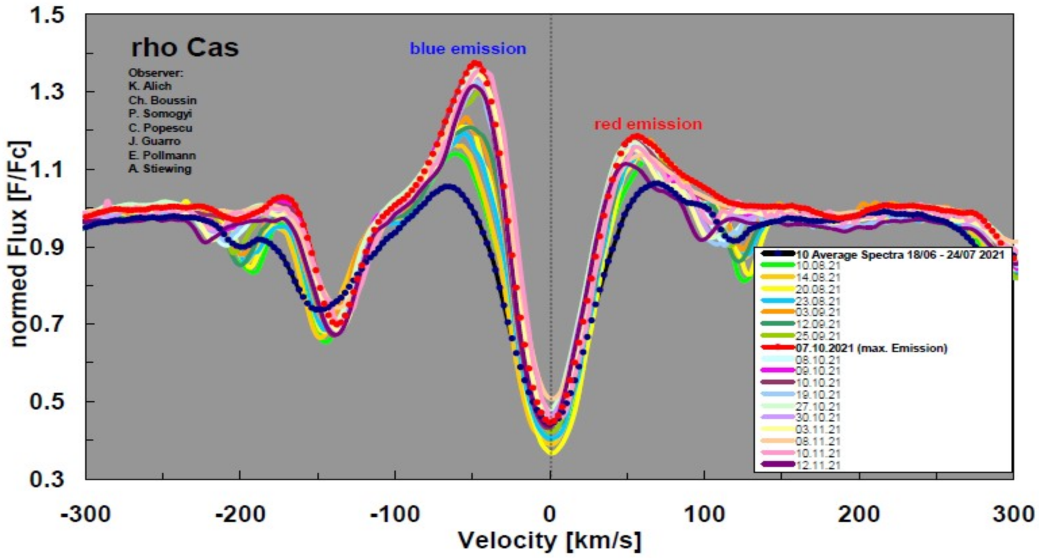

Fig. 1: Hα line flux monitoring from 08/2021 to 11/2021

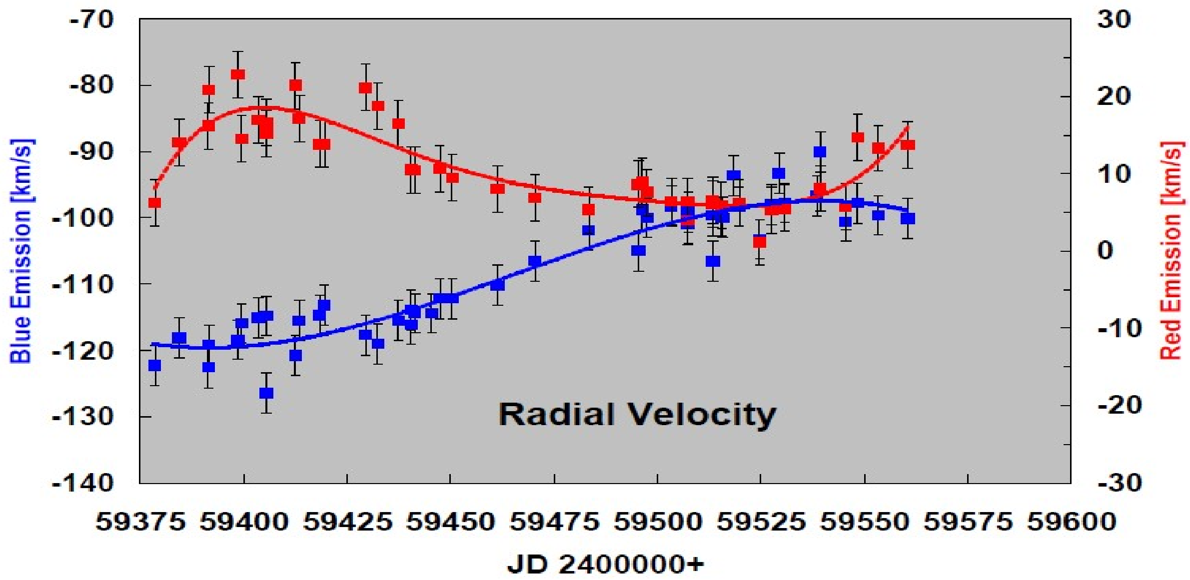

Fig. 2: RV Monitoring of the blue & red emission component from 06/2021 to 12/2021

In the emission flux behavior (Fig. 1), an average spectrum from 1 spectra from June-July 2021 was generated in order to be able to assess the further development over time from a starting basis or comparison basis (dark blue curve). In comparison, it is easy to see from the spectrum from October 7th, 2021 (K. Alich, red curve) that within the observation period up to now, the strongest ejection event could be recorded at this point in time.

In addition, both emissions show a significant reduction in their radial velocity behavior (RV) in the observed period (Fig. 2):

- blue emission of approx. -120 km/s > approx. -100 km/s (Δ = 20 km/s)
- red emission of approx. 20 km/s > approx. 5 km/s (Δ = 15 km/s)

In the rotational velocity law $V(R) = Vrot * R^{-0.5}$ (Hutchings 1970), in which R represents the radial coordinate with its origin in the star's center, and in which Vrot represents the actual rotational velocity at the star's surface, V is inversely proportional to the distance (from the center of the star) of the expanding ejection volume above the photosphere. The validity of this law in the area of the ejection (shell) volume is clearly shown in the RV difference of the maximum line flux of the blue emission component from approx. -60 km/s to approx. -40 km/s in Fig. 3.

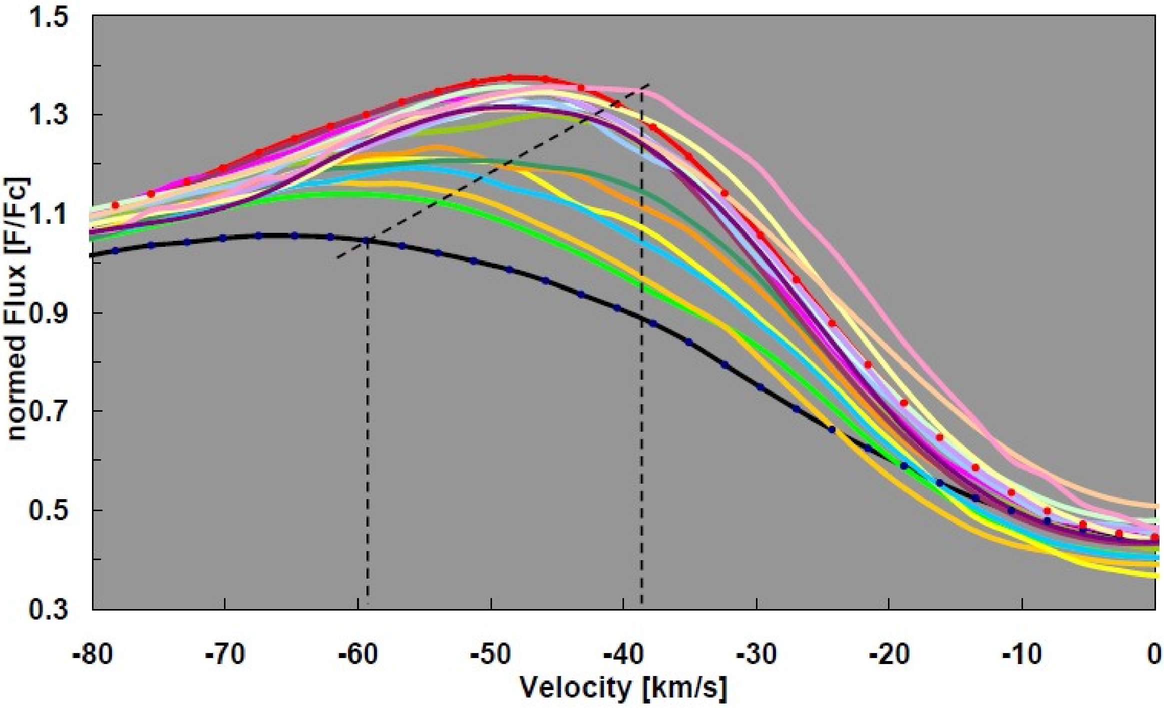

Fig. 3: RV decrease to positive values with increase of the max. line flux of the blue emission component

The measurement of radial velocities is not a simple endeavor, the emission lines can be of different strengths and have variable profiles due to build-up or dissipation processes. The accuracy of the RV measurements in a single spectrum of a given observation night (normal case) can therefore only be given here as the reproducibility of the spectrum evaluation. In the available spectra, this is in the order of magnitude of ± 5 km/s.

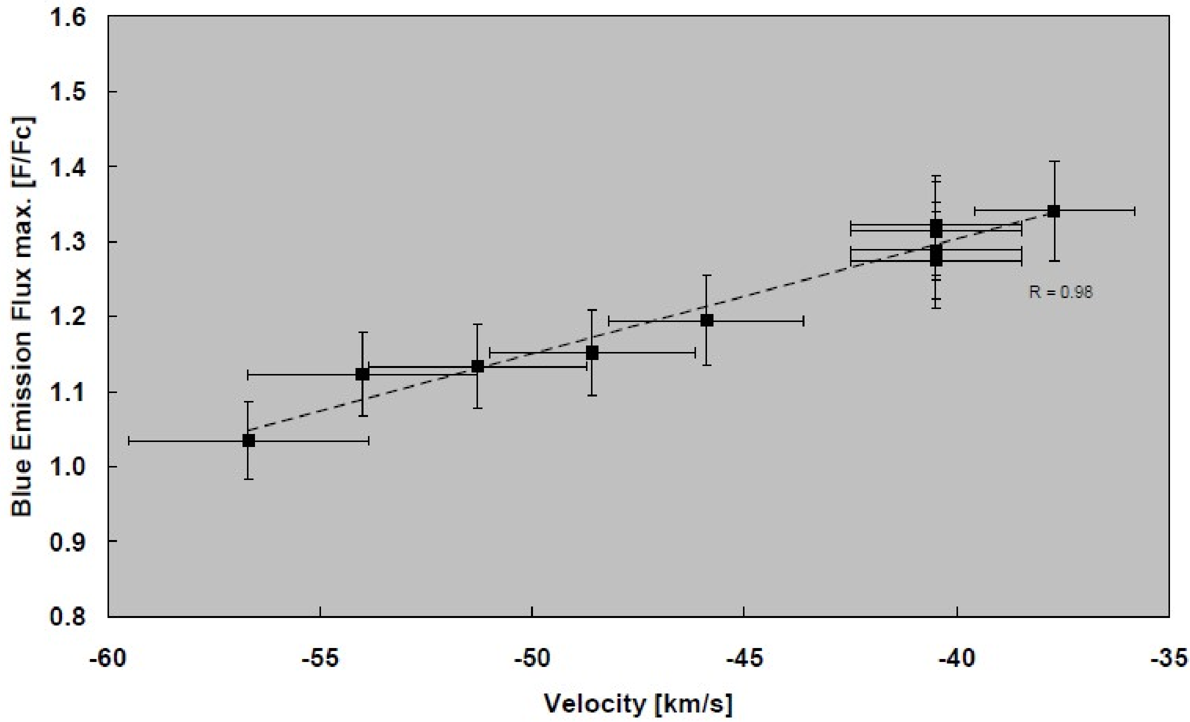

Fig. 4: Clarification of the flux versus RV relationship from Fig. 3; max.line flux and corresponding RV of 10 selected spectra

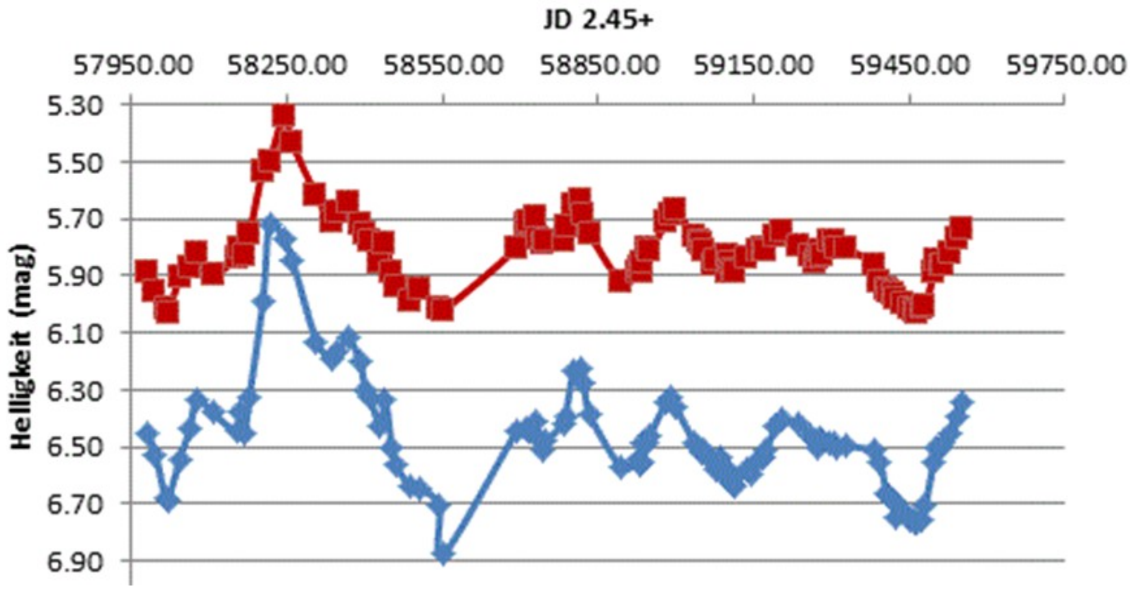

Fig. 5: Brightness monitoring in B (above) and U (below) by M. Sblewski

The middle of the last descending branch of the light curves in Fig. 5 coincides with the RV rise to the maximum at approx. 20 km/s in Fig. 2. This area (59375-59475) is characterized by the clear decrease in brightness $\Delta B = 0.15$ mag and $\Delta U = 0.3$ mag.

Assuming the validity of $V(R) = V_{rot} R^{-0.5}$, and assuming a circumstellar matter ejection, would with an increase of the RV (max) and simultaneous decrease in brightness ΔB and ΔU correspond to a decrease of the radius (volume). The subsequent decrease in RV to approx. 5 km/s (Fig. 2) would then, conversely, correspond to a radius (volume?) increase with a corresponding simultaneous (observed) increase in brightness in B and U.

The fact that radial velocity and maximum fluxes [based on $V(R) = Vrot\ R^{-0.5}$] are correlated according to the result in Fig. 4 could mean that the ejected volume of matter is distributed circumstellar (shell).

In addition, it seems to be expressed in Fig. 2 that both emission components with a nearly time-synchronous course of their radial velocities might follow a cyclic / periodic process (non-radial pulsation mode?)

In view of the unpredictability of the ejection behavior of this star, the intention is to continue the monitoring outlined here over the next few years in order to present a larger database to professional astronomy at a later date.

E. Pollmann, 2021-12-14