Preliminary rough analysis of the Nova Herculis 2021

Richard Walker, 3. July 2021

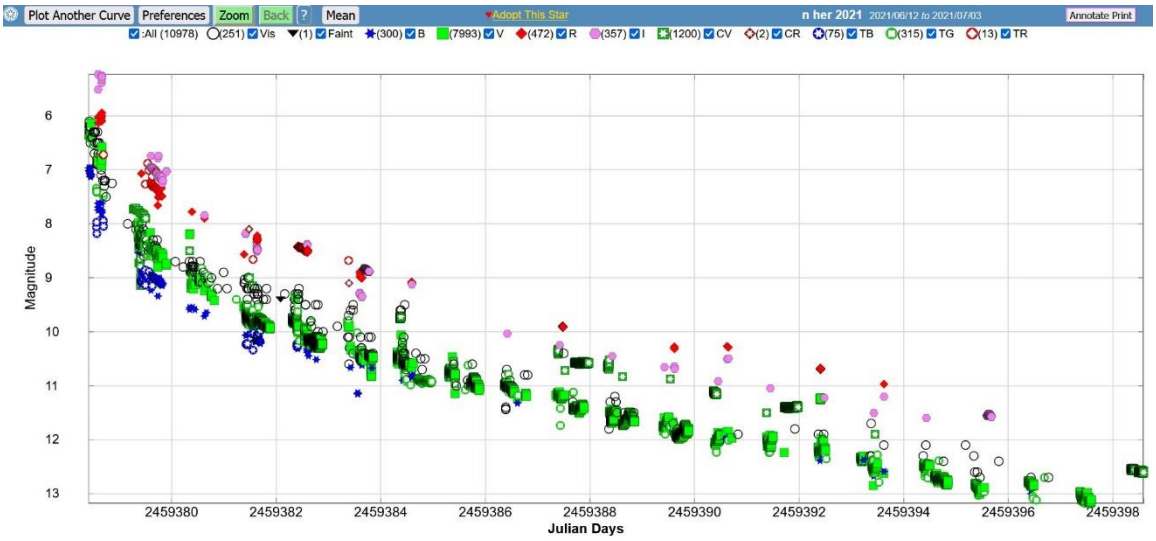
https://forum.sag-sas.ch/viewtopic.php?f=8&t=312&sid=30810b292c8db416f96c94de59775325

Unfortunately, in Central Europe the long-time blocked thunderstorm situation of the last weeks did not allow to record any spectra. Furthermore until 3. July 2021 the brightness of the Nova has already dropped below magnitude 13 and thus remains, at least for my equipment, spectroscopically unreachable. For a rough analysis, however, the valuable profiles of the ARAS group can be used, which currently cover a period from June 12 - 30.

https://www.spectro-aras.com/forum/viewtopic.php?p=15738

The nova was discovered on June 12, 2021 by the Japanese Seiji Ueda. Since scientific publications are still missing, neither the actual explosion date is known, nor a progenitor star has been identified. The following light curve of the AAVSO starts at the discovery date with brighter than Mag 6 and obviously shows only the "descending branch" of this event.

https://app.aavso.org/webobs/results/?star=000-BNZ-786&num_results=200

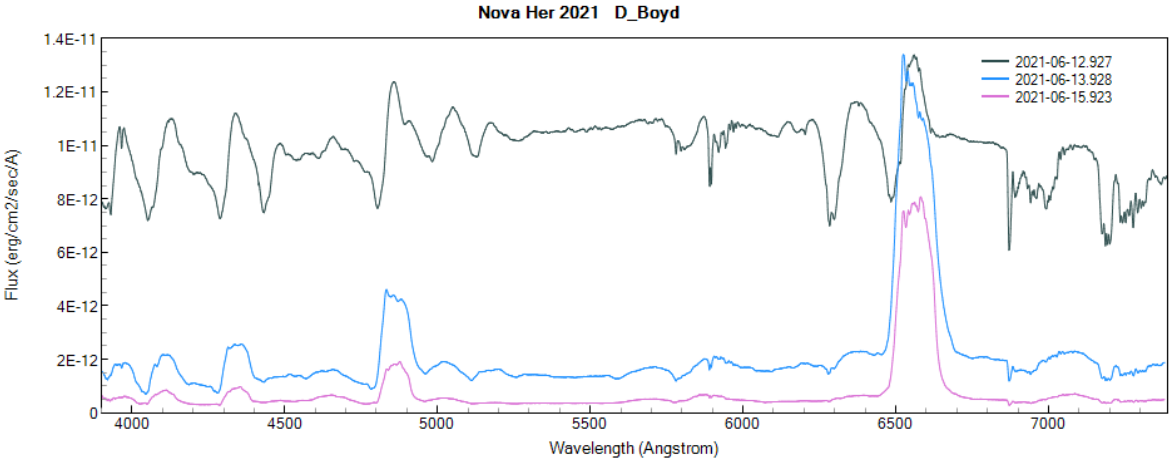


This is not at all problematic for the classification, because only here the relevant, spectral signatures appear and the transition from the "fireball" to the "nebular" phase takes place, where the conditions have calmed down enough to allow the thin lines of the so-called "forbidden transitions" to be generated (e.g., O III).

The first stage of the Fireball phase was fortunately recorded by several ARAS members on the day of discovery! Representatively, the top profile (black) of D. Boyd shows here the typical features of this stage, i.e., all emissions of allowed transitions - besides Fe II and others, mainly of the H-Balmer series. Equally characteristically, the Hα-, Hβ-, and Hγ-line show up here as textbook like P-Cygni profiles with blue-shifted absorption part. This is a clear indication for the expansion of the here optically still dense envelope! As usual these emissions mutate here later to almost rectangular "boxes" (blue and red profile). This is also the reason, why for the estimation of the "terminal velocity" (v∞) of novae not the FWHM value (Full width at Half Intensity) but the much broader HWZI (Half width at Zero Intensity) is used in the Doppler formula.

$$v\infty = \frac{\mathrm{HWZI} \cdot c}{\lambda_0}$$

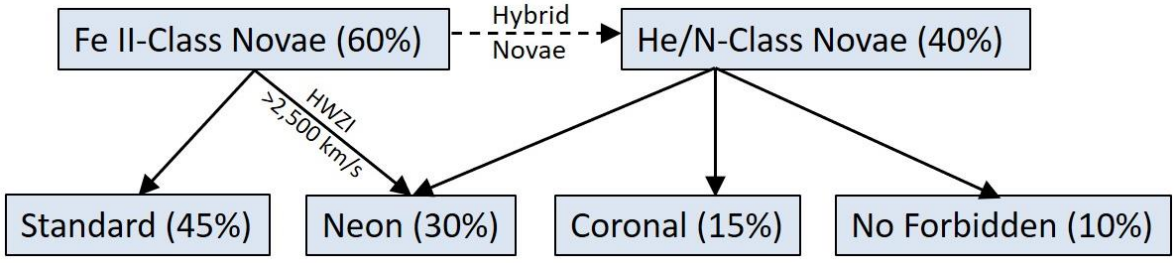
Based on the profile widths, v∞ values of up to 5000 km/s can be estimated here, i.e., about 1.7% of the speed of light!



Classification of Nova Her 2021

According to current knowledge, this is a so-called "Classical Nova", because no precursor explosion has taken place here and therefore the object cannot be a "Recurrent Nova".

In the *"Spectral Atlas for Amateur Astronomers..."* the *Tololo classification* system for Novae is introduced in chap. 24 by the example of the nova V339 Del of August 2013. The following scheme from the atlas shows at the top the two Nova main groups "FeII" and "He/N" followed by the possible evolutionary options of their emission lines in the "nebular phase", i.e. from permitted to forbidden transitions.



Nova V339 Del was classified in 2013 as *Fe II Nova*, with relatively slender emissions. After 47 days, the evolution into the "nebular phase" (subgroup "Standard") could still be observed here, where many "forbidden lines" appeared. Their metastable initial states are extremely shock-sensitive and show that until here the conditions must have calmed down significantly.

Nova Her 2021, on the other hand, can clearly be classified in the other category *He/N*. Typical for this are also the impressive, box-shaped, massively broadened emissions, but also the surprisingly fast decline of the light curve, why here with amateur means the monitoring from the "Permitted" (P-) into the Nebular (N-) phase was made impossible! In addition, the terminal velocities are extremely high here, with v∞ > 3000 km/s, which is also characteristic for the He/N Type. It is furthermore not a rare hybrid nova, which starts as FeII Class and later mutates to He/N. The reasons for these subdivisions and evolutionary steps are still largely unclear scientifically. For more details see Spectral Atlas...

Many thanks to D. Boyd, providing the profiles on the ARAS forum!