

Gaia20dsk: A new MNor discovered by the GLORIOUS collaboration

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ABSTRACT

Among known young stellar objects (YSOs), those exhibiting the most dramatic increases in brightness due to sudden increase in mass accretion rate are eruptive young stars. Gaia20dsk is one of the Gaia-Alerted young star candidates that has displayed a double, nonperiodic brightening, and spectral properties resembling that of other young eruptive stars.

Classically, two major groups are known of YSOs: **EXors** (short, months-long bursts; $\dot{M} \sim 10^{-8} - 10^{-7} M_{\odot} \text{ yr}^{-1}$) and **FUors** (decades-long bursts; $\dot{M} \sim 10^{-5} - 10^{-4} M_{\odot} \text{ yr}^{-1}$). However, a growing number of objects fall in between. The **MNor class** (Contreras Peña et al. 2017) was introduced to describe them: *bursts >1.5 yr, embedded flat-spectrum SEDs, H₂ emission at 2.12 μm , and intermediate accretion rates.*

Gaia20dsk lies in the NGC 6334 star-forming region. Its Gaia-based photogeometric distance is 2542^{+707}_{-606} pc (Bailer-Jones et al. 2021), while the cluster distance is 1650^{+14}_{-7} pc. We used both distances to derive the stellar and accretion parameters.

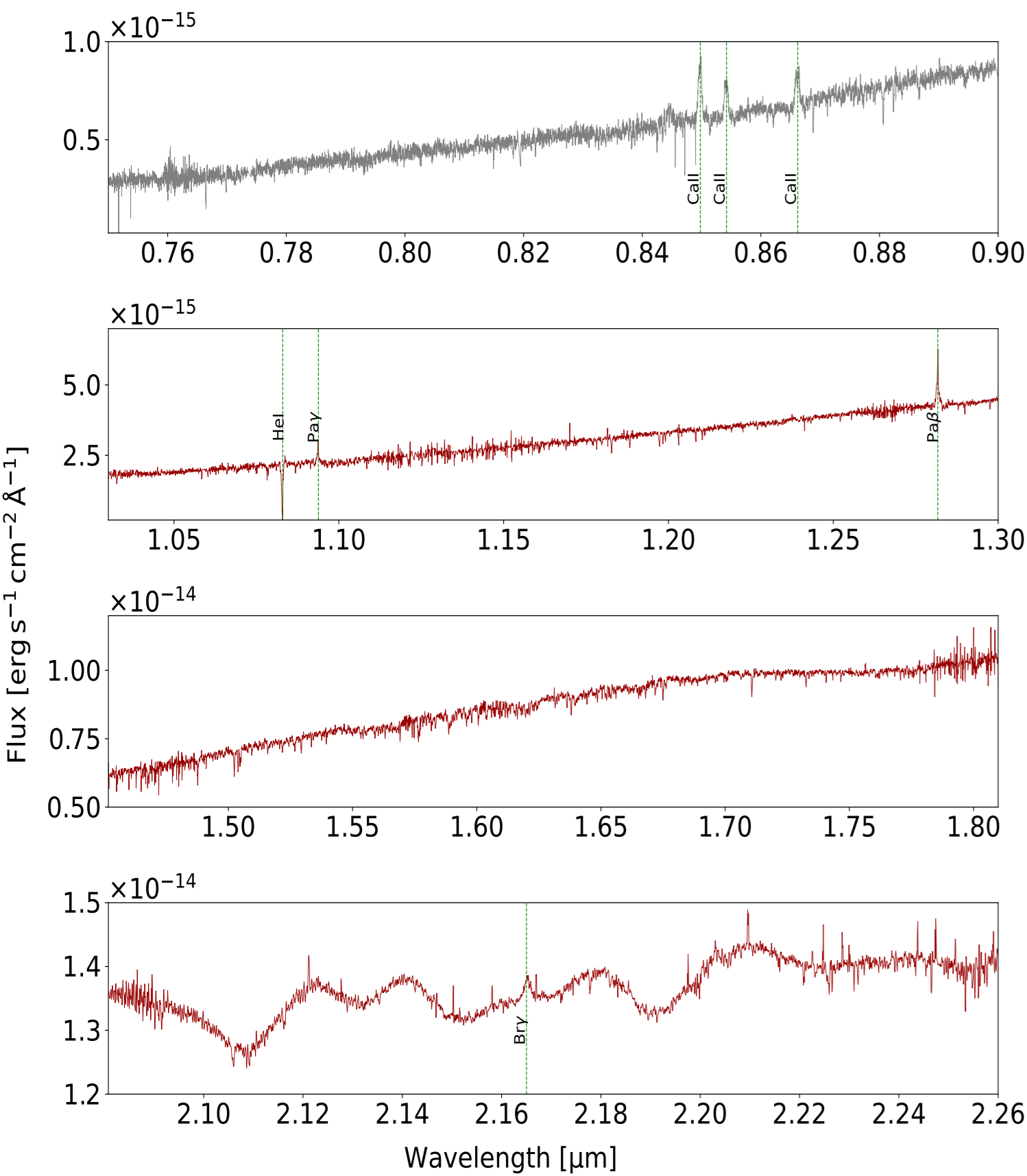
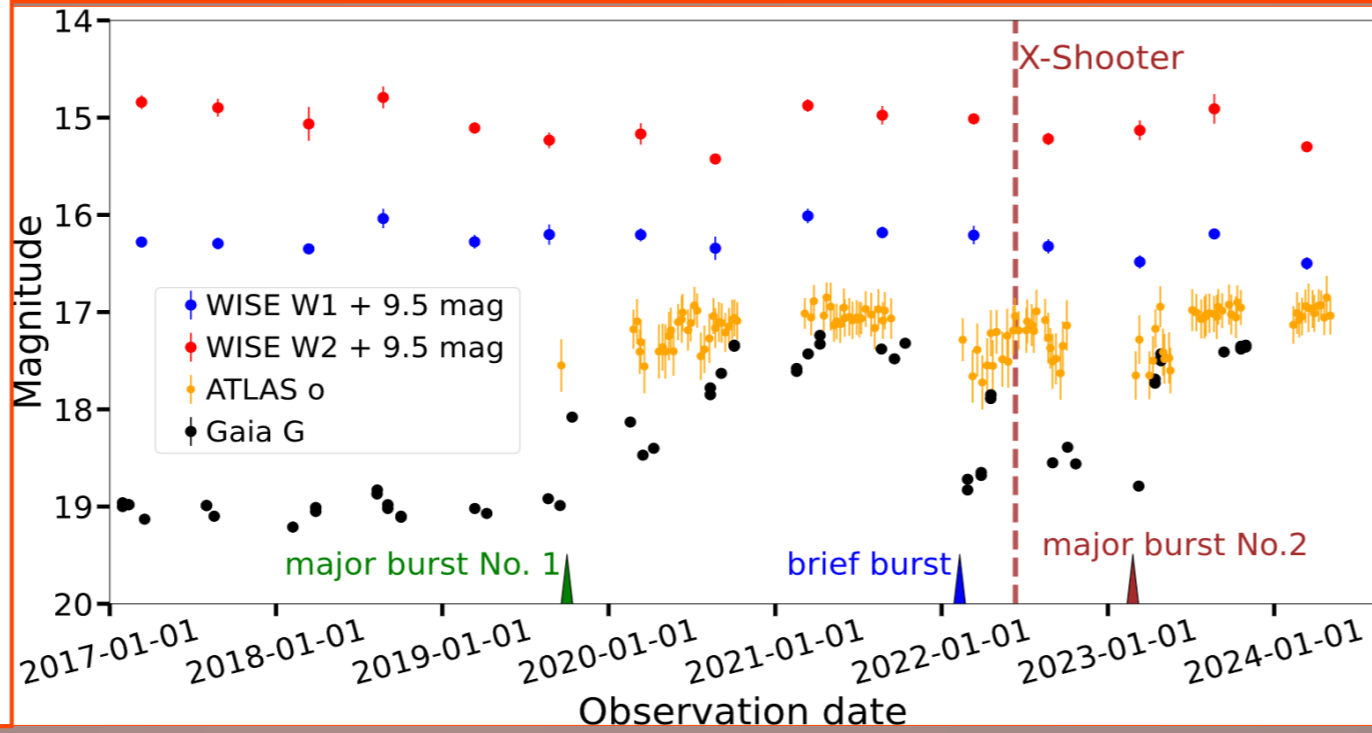
1) Observational & spectral properties

We combined public optical/infrared photometry (Gaia, ATLAS, NEOWISE, 2MASS, VIRAC, Spitzer) with a VLT/X-SHOOTER spectrum taken on 12 June 2022.

Multi-band light curve of Gaia20dsk show **brightening by $\Delta G = 1.8$ mag** between 2019 and 2021; the **outburst lasted for ~ 2 yr**. A second burst began in 2023. The changes were also observable in ATLAS o band, which is in agreement with Gaia data.

The spectrum shows strong emission lines — notably the **Ca II IR triplet, Paschen β , and Bry**. These lines are considered as magnetospheric accretion tracer lines. All the lines show broad and narrow component. The former component originates in the infalling gas, while the later component comes from the chromosphere (Herbig 2008). Their fluxes can be used to measure the mass accretion rate via empirical relations (Alcala et al. 2017, Fairlamb et al. 2017).

Additionally, the spectrum shows the **H₂ 1–0 S(1) line at 2.12 μm** , which is a characteristic signature of MNor-type eruptive stars.



4) Color evolution

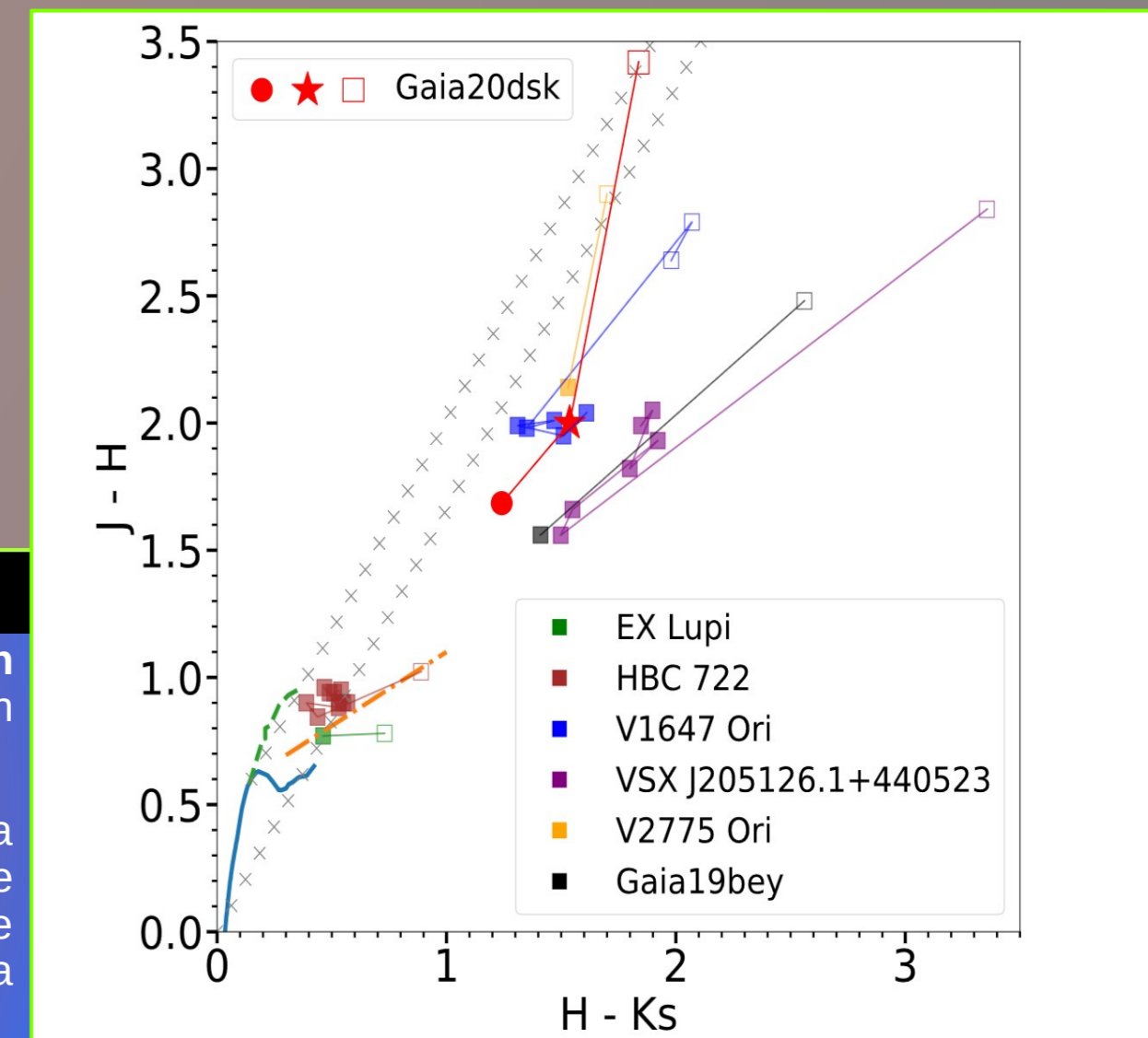
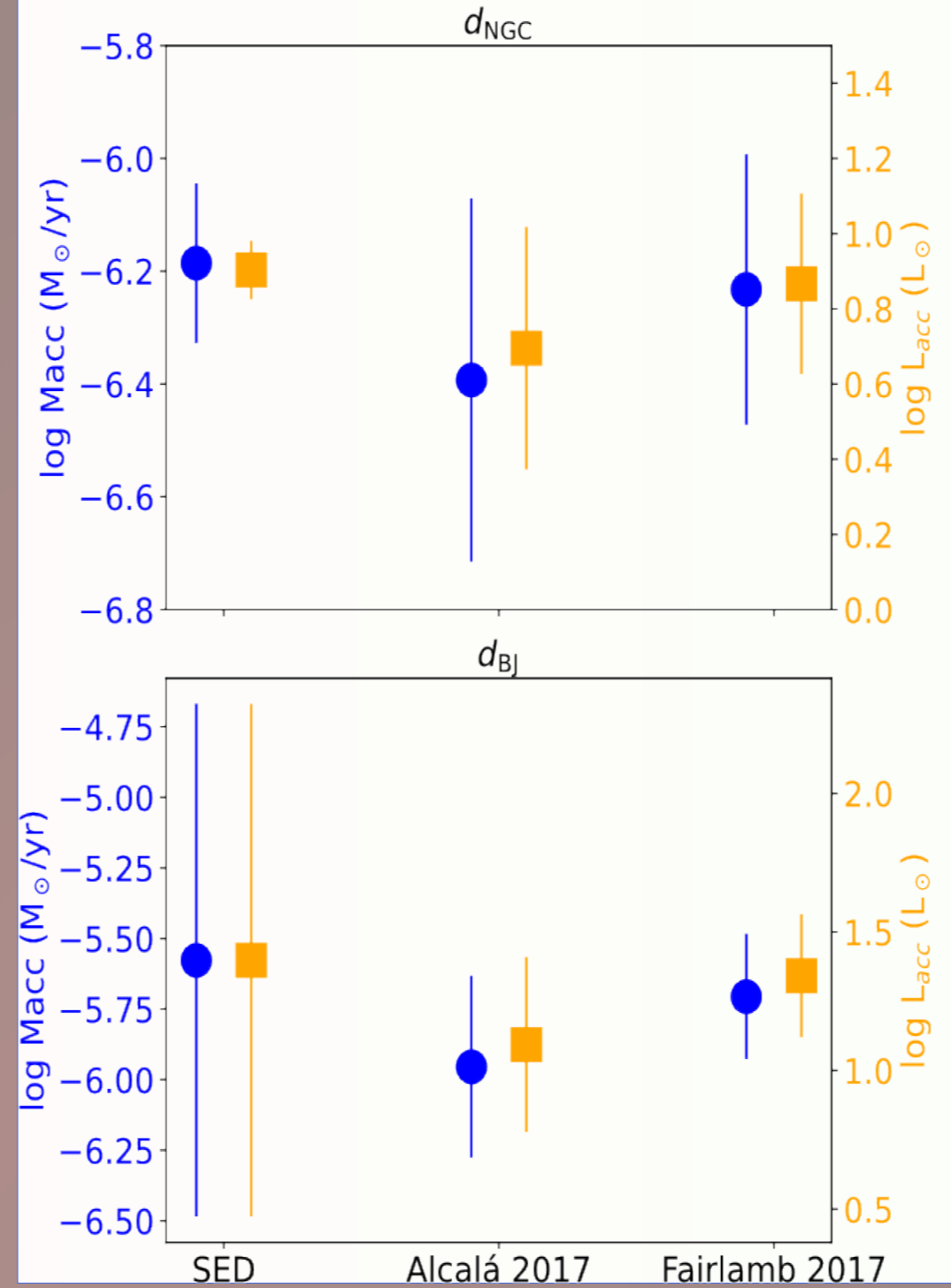
The near-infrared colors show the star becoming **bluer when brighter**. This movement is inconsistent with a change in foreground extinction supporting an accretion origin.

The spectral index $\alpha = 0.04 \pm 0.07$ places Gaia20dsk as a **flat-spectrum source**. Using 2MASS and WISE colors the source is also consistent with a Class I/flat-spectrum object. The Spitzer colour-colour criteria of Gutermuth et al. (2008) give a similar classification, placing it at the Class I.

3) Mass accretion rate

After correcting for $A_V = 8.6$ mag (derived by requiring consistent accretion luminosity from all lines), we measured the fluxes of Pa δ , Pa γ , Pa β , and Bry. Accretion luminosities from two empirical calibrations (Alcalá et al. 2017, Fairlamb et al. 2017) give $\dot{M}_{\text{acc}} = (0.5 - 1.8) \times 10^{-6} M_{\odot} \text{ yr}^{-1}$. An independent estimate from the outburst and quiescent spectral energy distributions yields $\dot{M}_{\text{acc}} = (0.6 - 2.5) \times 10^{-6} M_{\odot} \text{ yr}^{-1}$ consistent with the line-derived values.

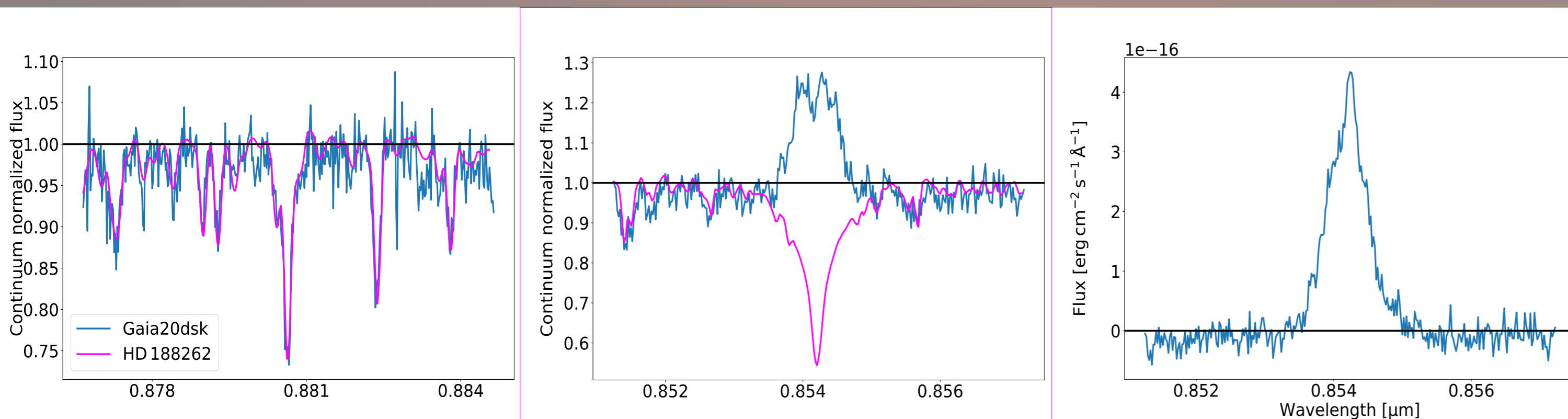
The accretion luminosity is 8–26 L_{\odot} which is about one tenth of the bolometric luminosity – another MNor characteristic.



2) Photosphere subtraction

The emission lines we use to calculate the accretion rate are superimposed on the stellar photosphere. The photospheric absorption, and veiling modify the true line fluxes; therefore we must subtract it. We compared the target spectrum to 125 templates from the X-SHOOTER Spectral Library, applying a grid of veiling and rotational broadening.

A χ^2 minimisation in the 8770–8840 Å region identified HD 188262 as the best-matching photosphere. Its effective temperature is 5919 ± 93 K and we adopted a veiling of 0.1 and $v \sin i = 31 \text{ km s}^{-1}$. The photosphere was then subtracted, leaving clean accretion-tracing lines.



Conclusion

Gaia20dsk meets all four MNor properties (Contreras Peña et al. 2017):

- ① flat-spectrum SED
- ② outburst duration >1.5 yr (here ~ 2 yr)
- ③ accretion-tracing emission lines
- ④ H₂ 2.12 μm emission detection

Conclusion: Gaia20dsk is a new MNor. Its properties are between EXors and FUors, adding to the small number of transitional eruptive young stars.

Acknowledgement: We acknowledge the Hungarian National Research, Development and Innovation Office grant OTKA FK 146023.