

# Gaia21bja: pre-main sequence star with quasi-periodic bursts

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## Abstract

Gaia21bja is a Gaia alerted YSO that exhibits at least seven quasi-periodic brightenings over a 20 year-long light curve with durations of 1.5-2 years and amplitudes up to  $\sim 1.7$  mag in the Gaia  $G$ -band. We analyze its optical and near-infrared photometry and spectra taken using the IRTF and VLT in its faint and bright states in order to characterize its physical properties. We found that the accretion luminosity and mass accretion rate increased by a factor of 5.5 – 6 during the burst. Based on this, and the quasi-periodic bursts, we suggest that Gaia21bja is an eruptive YSO, and is most consistent with the ‘Periodic’ category of the Outbursting YSOs Catalogue.

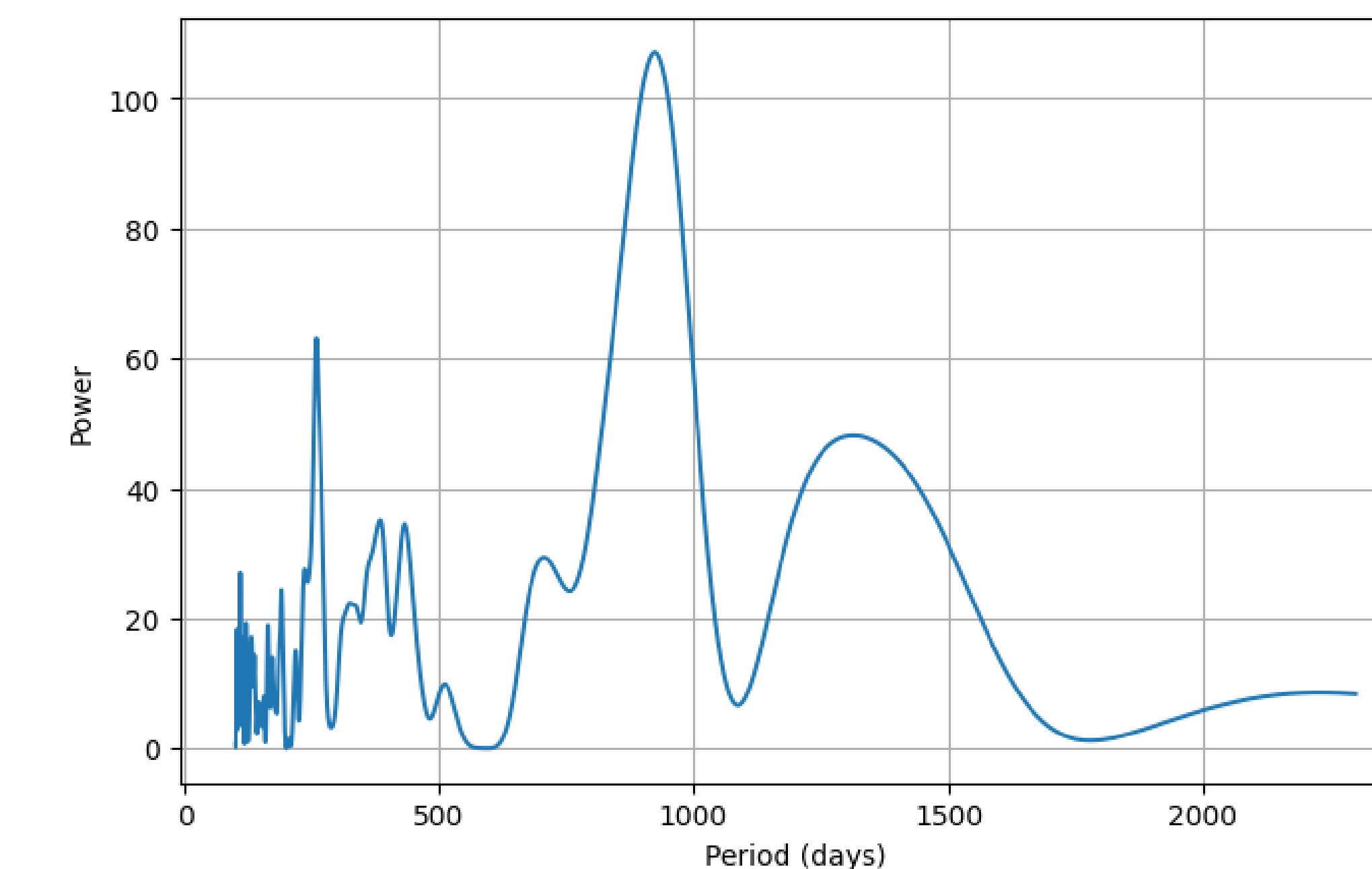
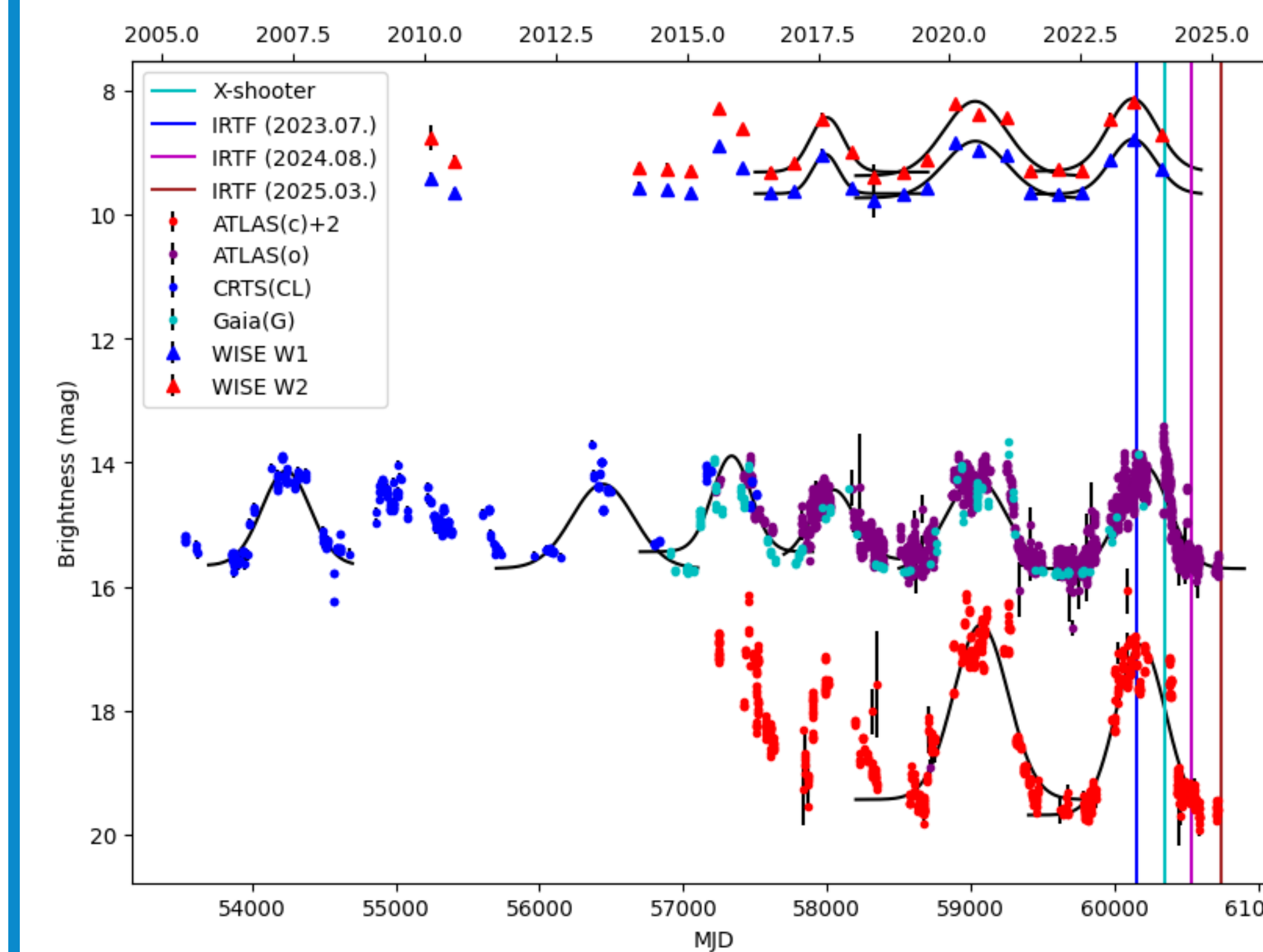
## Gaia21bja

Gaia21bja had a Gaia alert on 2021 February 11 due to a brightening by about 1.5 mag. It is located at  $\alpha_{J2000} = 16^h04^m14.17^s$ ,  $\delta_{J2000} = -21^\circ29'15.28''$  at a distance of  $d = 146.5 \pm 1.3$  pc (Bailer-Jones et al. 2021). Esplin et al. (2018) confirmed that Gaia21bja is a YSO. Luhman et al. (2018) determined its spectral type as M4, corresponding to an effective temperature of  $3190 \pm 75$  K (Thanathibodee et al. 2022). Luhman & Esplin (2020) estimated that its  $K$  band extinction is  $A_K = 0.051$  mag, based on the  $J - H$  color excess, and have also confirmed it to be a member of the Upper Scorpius star-forming region (Upper Sco). Ratzenböck et al. (2023) also confirmed Gaia21bja to belong to Upper Sco.

## Quasi-periodic light curves

The light curve that covers about 20 years, shows at least seven brightenings with amplitudes up to  $\sim 1.7$  mag in the optical and durations of 1.5-2 years.

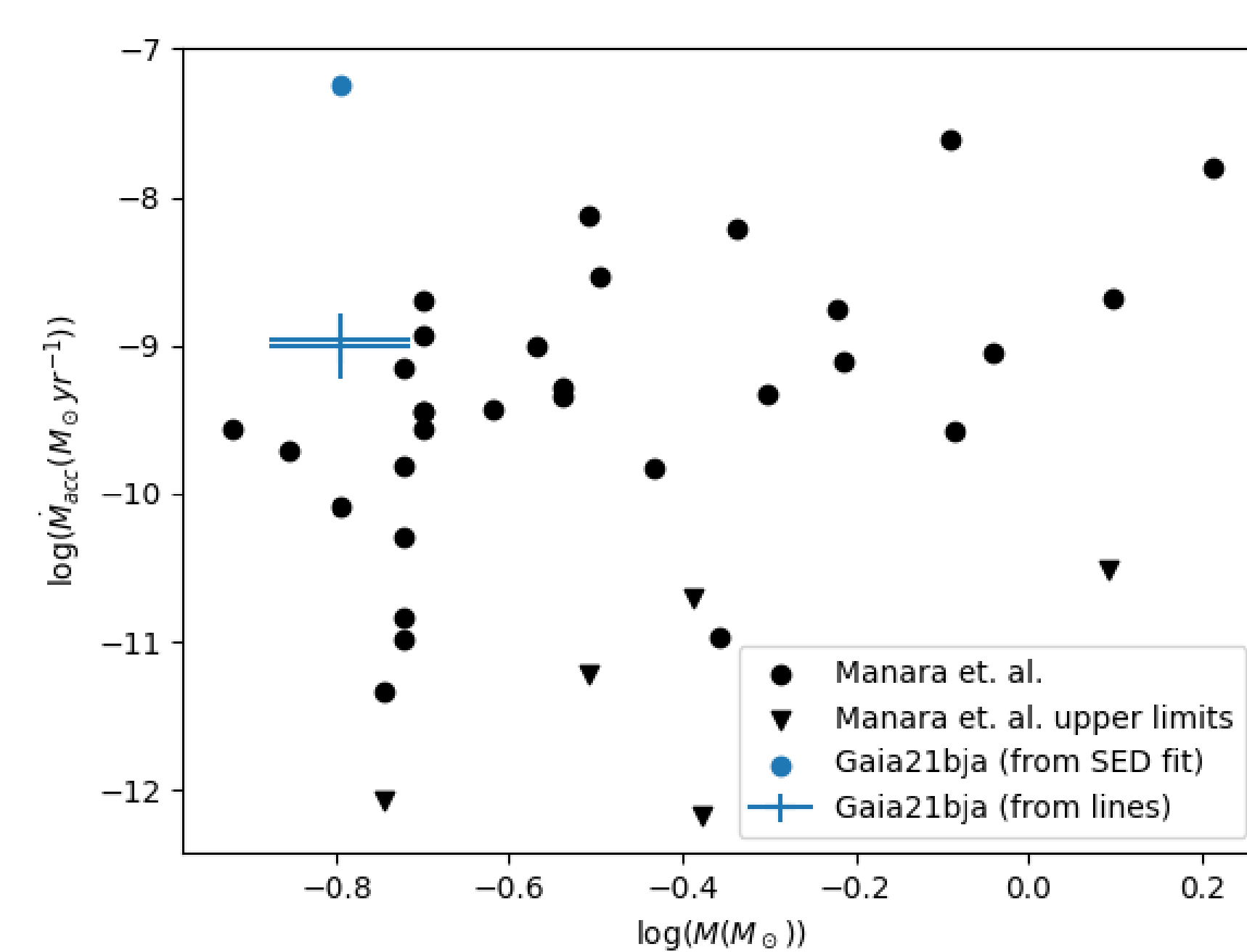
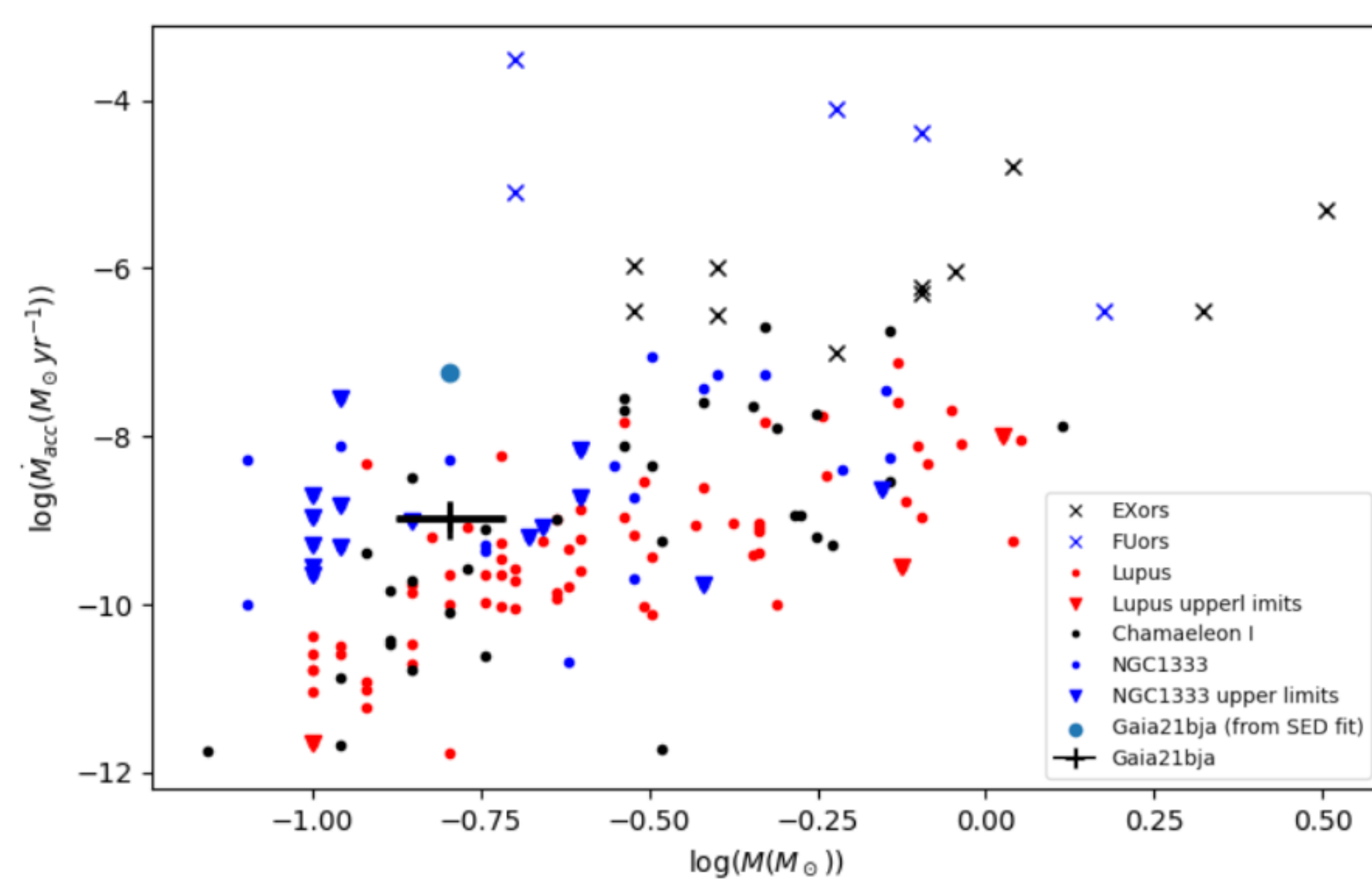
We performed a Lomb-Scargle periodogram analysis based on the CRTS and Gaia  $G$  photometry obtained after 2011, using the public tools at the NASA Exoplanet Archive Periodogram Service<sup>a</sup>. The most significant period was found to be  $T = 916 \pm 77$  days.



<sup>a</sup><https://exoplanetarchive.ipac.caltech.edu/cgi-bin/Pgram/nph-pgram>

## Accretion parameters

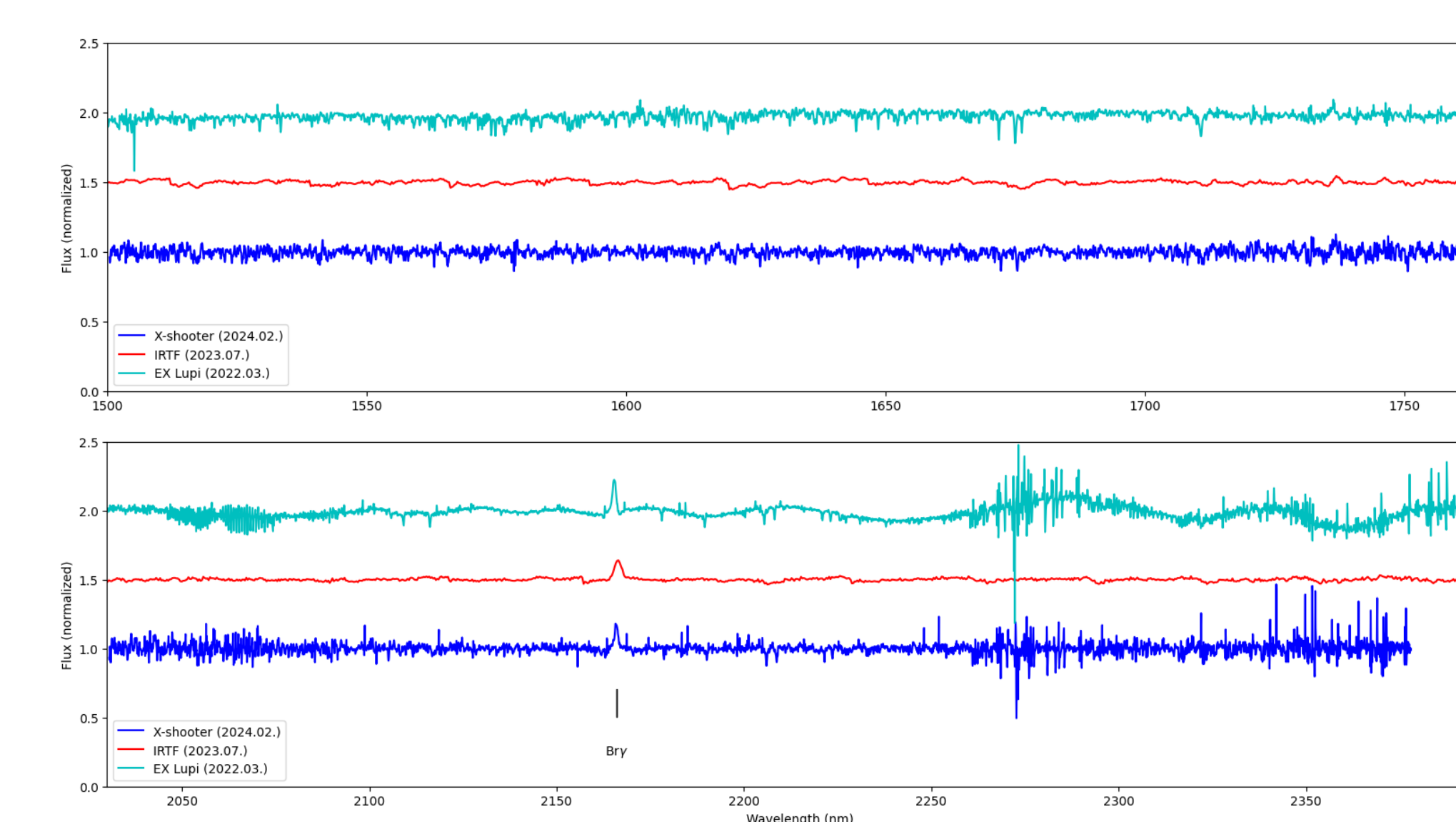
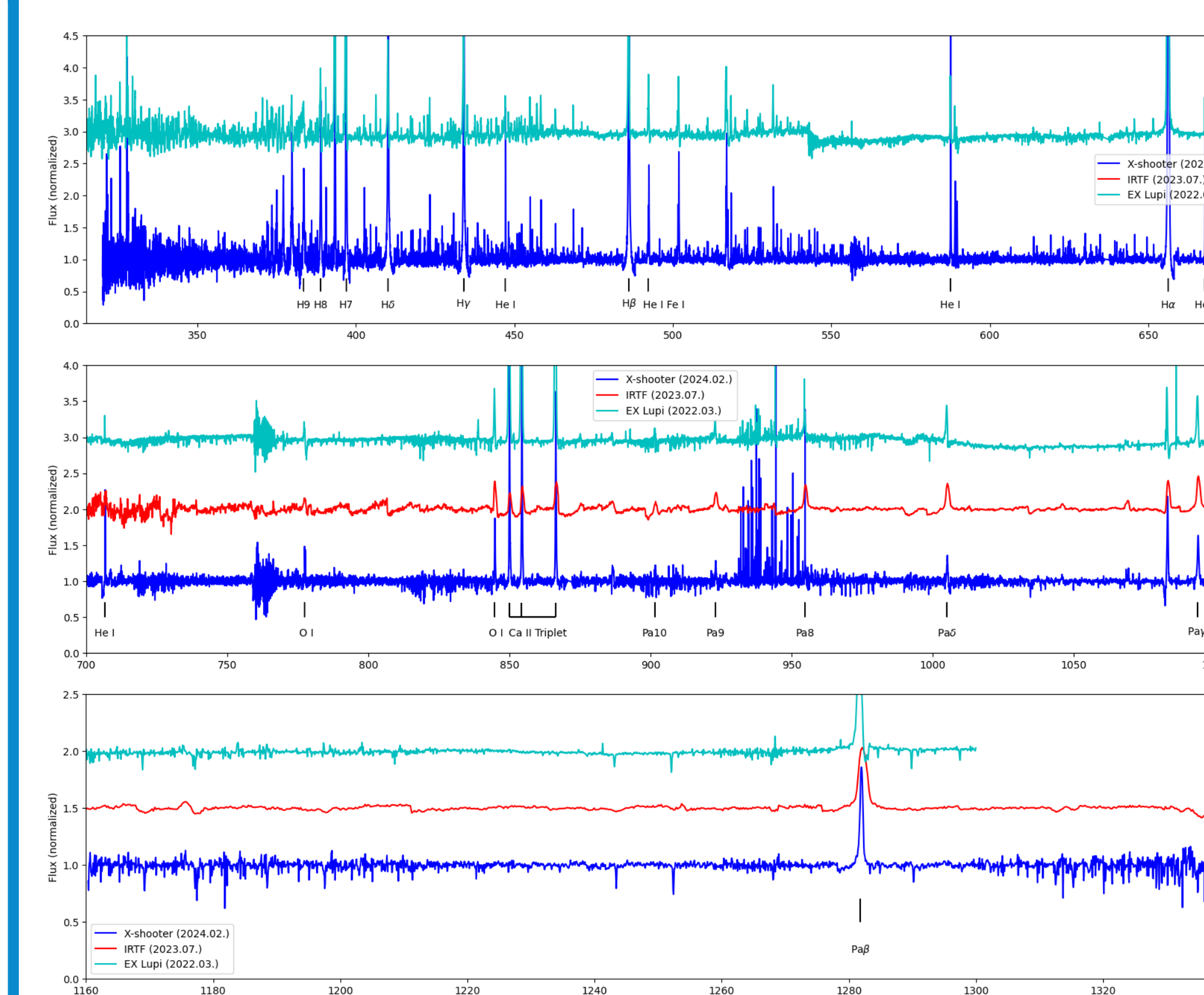
We derived accretion parameters using the empirical relations of Alcalá et al. (2017) as well as based on the bolometric luminosity, and found that the accretion parameters increased by a factor of 5.5 – 6 during the burst.



The accretion parameters derived from the bolometric luminosity are clearly above the CTTS with similar luminosities and masses. Even the accretion parameters estimated using the empirical relations are among the highest values for similar stellar parameters.

Based on its quasi-periodic light curve, Gaia21bja seems to be most consistent with the ‘Periodic’ group of the The outbursting YSOs catalogue (Contreras-Pena et al. 2025).

## Outburst spectra



The IRTF and VLT spectra taken during the burst are similar to those of EXors and CTTS. The CO-bandhead is seen in absorption in quiescence and during the burst. There are various accretion rate tracer lines detected at both epochs during the burst, including the Balmer, Brackett and Paschen series of H I, Ca II, O I, He I, and Na I.

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