Two optical emission components with different variability in V404 Cygni

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0. Abstract

V404 Cygni (GS 2023+338) is a black hole binary (BHB), discovered during the 1989 outburst by the GINGA satellite (e.g. Kitamoto et al.). It is known that V404 Cygni showed **multiple X-ray and optical flaring activity** within one outburst in contrast to typical blackhole transients having a fast rise and exponential decay profile (e.g. Tanaka and Shibazaki 1996), though the nature of the variation is still under discussion.

On 2015 June 15, V404 Cygni had an outburst after 26 years of quiescence. Soon after notifications, we started intense observations using the MITSuME telescope in Akeno, Japan, and the MURIKABUSHI Telescope at Ishigakijima Astronomical Observatory. MITSuME camera attached to these telescopes enabled us to **simultaneously obtain images in three color** (g', R_C, and I_C).

Here we present results of observations and time domain analysis, and then mention the nature of the optical variation during the flare.

1. Light Curve and Flux-flux Plots

Fig.1 shows the optical (g′, R_C, and I_C-band) and NIR (Ks-band) light curves during MJD 57192–57194. The amplitudes of flux variations reached ~ 3 mag on a timescale shorter than an hour, and the variations in the optical bands were well correlated.

Fig.2 shows the flux-flux plot constructed by the g' and I_C-band photometric data. The data in the flux-flux plot is well expressed by a **broken-linear model** (lower panels). Linear branches below and above a break imply that **the existence of two variable components** with distinct spectral indices. We named these components as little-variable component (**LVC**) and highly-variable component (**HVC**), respectively.

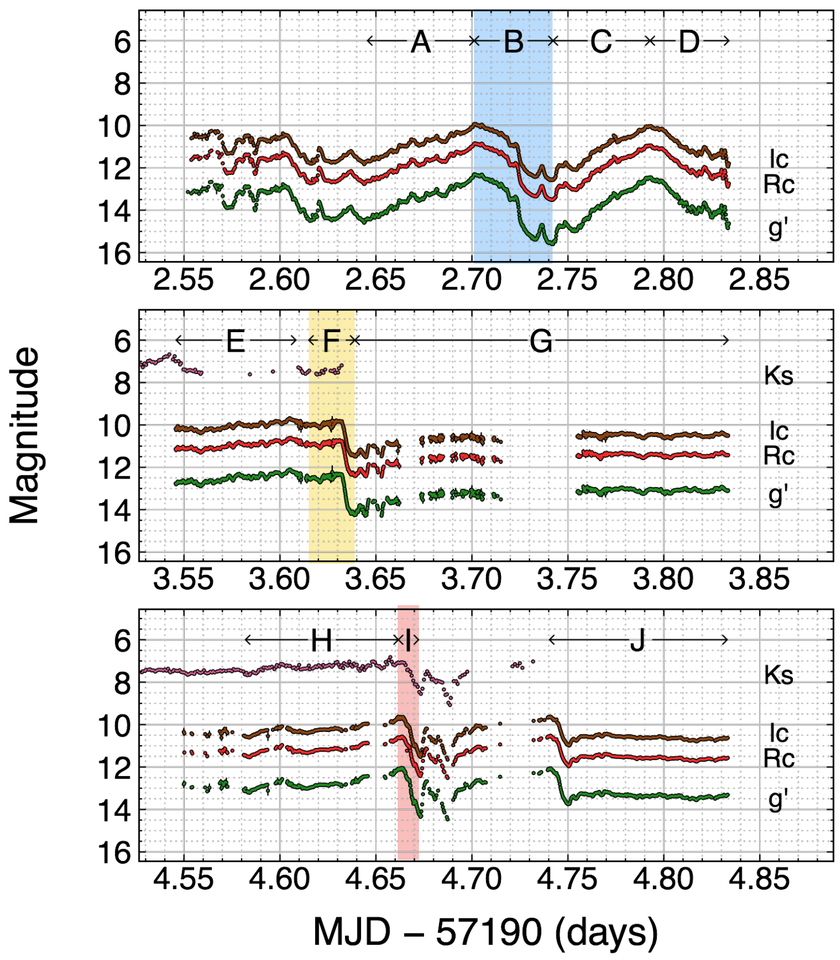

Fig.1.— g', R_C, I_C, and Ks light curves.

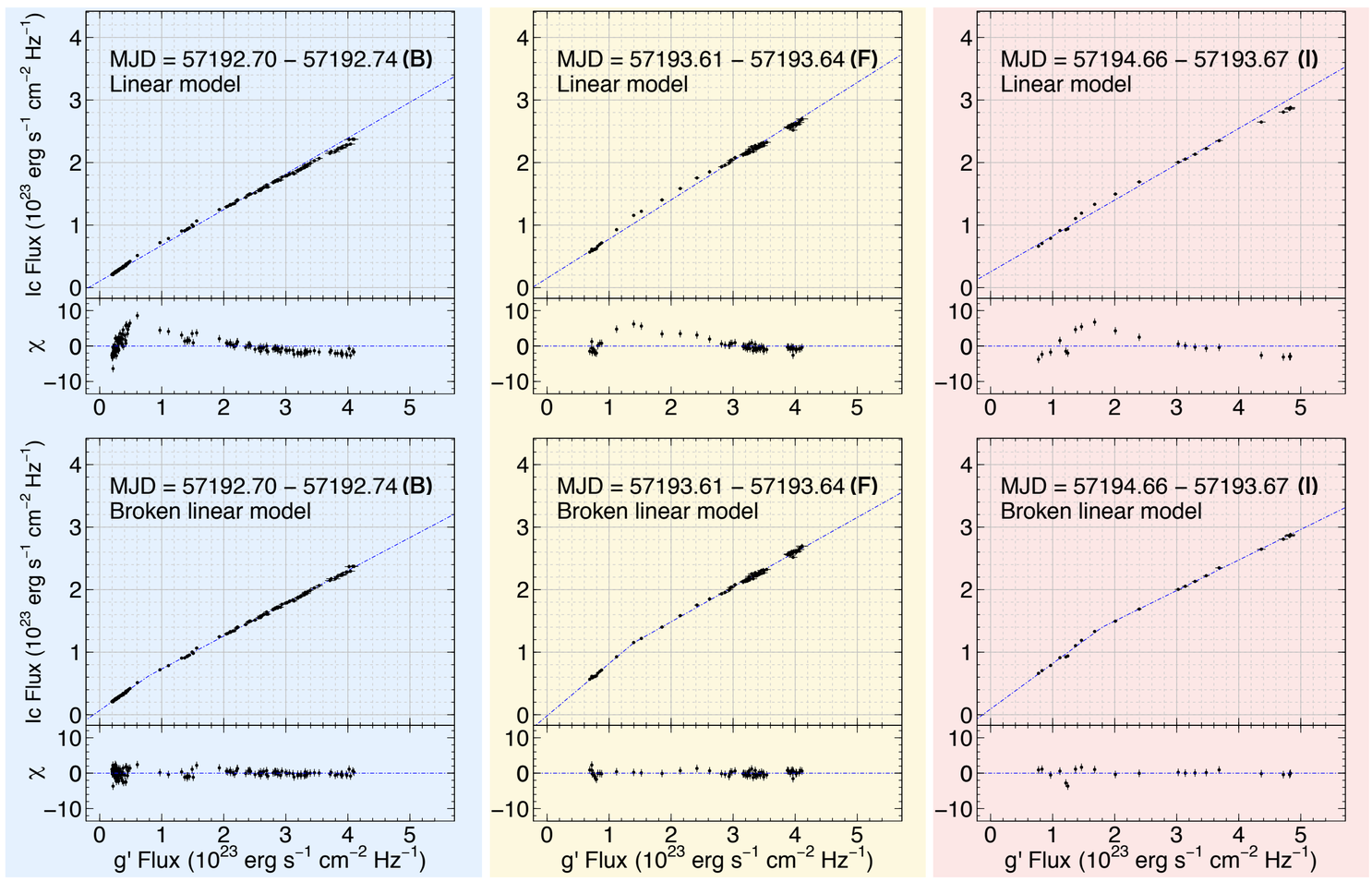

Fig.2.— Flux-flux plots and fits for fluxes in g' and I_C-band at three portions (B, F and I).

2. Color-color Diagram

The spectral indices of a variable components can be directly derived from slopes of straight lines in flux-flux plot. Fig.7 shows the color-color diagram for the decomposing components. Spectral indices of LVC are consisted with that of **standard disk radiation**, while those of the HVC trace out a **power-law spectrum**.

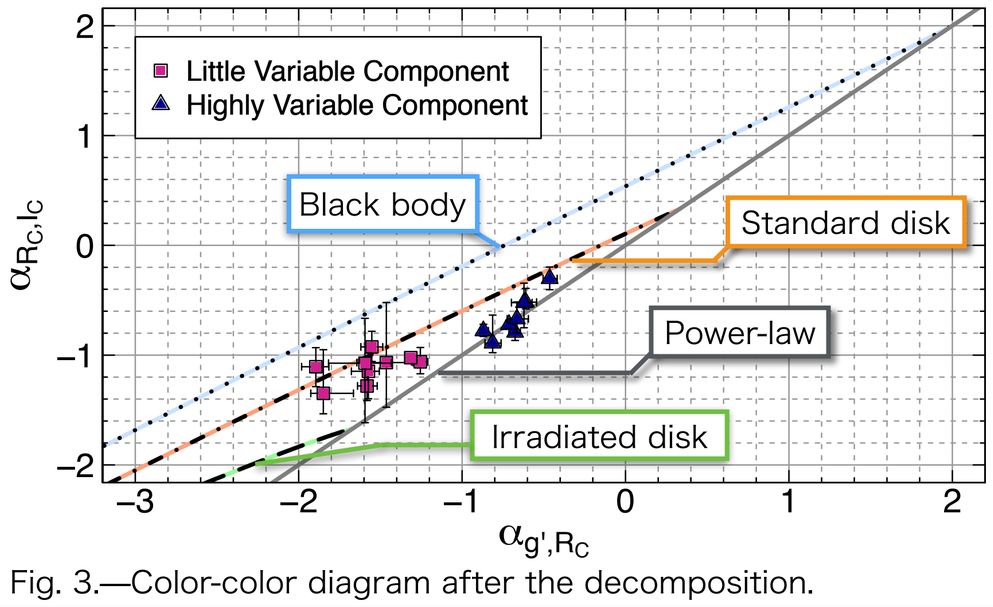

Fig. 3.—Color-color diagram after the decomposition.

3. SED Modeling

Fig. 4 shows the SED from IR to UV. Black points show simultaneous observation data, red and blue points are decomposed LVC and HVC from black data points, and grey points are quasi-simultaneous data obtained within 15 mins. The SED is well reproduced with our model.

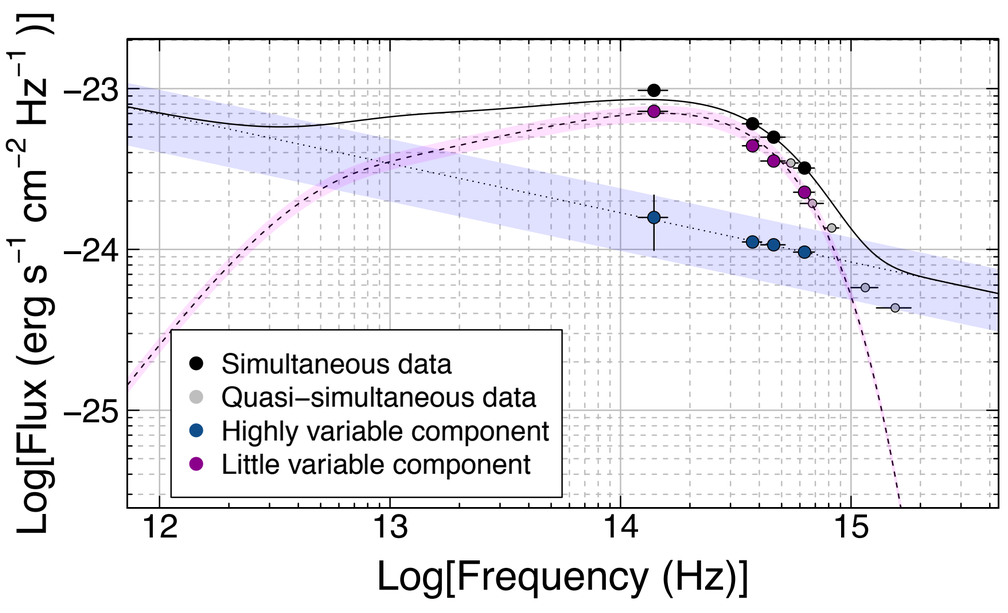

Fig.4: SED with LVC and HVC at MJD = 57194.

4. Summary

The optical variation in V404 Cygni can be decomposed to two components: little-variable component (LVC), highly-variable component (HVC). The loci of LVC and HVC on the color-color diagram trace out that of standard disk model, and a power-law spectrum, respectively. We confirmed the results in spectral energy distribution from near-infrared to ultraviolet.