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Two optical emission components with different variability in V404 Cygni

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Abstract. V404 Cygni went into an outburst again on June 15, 2015 after 26 years of quietness. Soon after the notifications, we started intense optical observation campaign of this source. The spectral index between R_C and I_C-band was stable over the outburst, whereas that between g' and R_C-band varied violently. With the time domain analysis of the multi-color optical light curves, we successfully decomposed optical variations into three components: highly-variable component (HVC), little-variable component (LVC). The loci of the LVC in the color-color diagram is consistent with that of a single temperature blackbody radiation or a multi-color blackbody radiation from a standard accretion disk, while those of the HVC trace that of power-law spectra.

Keywords. X-rays: binaries – Stars: individual (V404 Cygni) – Techniques: photometric

1. Introduction

V404 Cygni, also known as GS 2023+338, is a black hole binary (BHB), originally discovered during the 1989 outburst by the *GINGA* satellite (Kitamoto *et al.* 1989, and Makino *et al.* 1989). In contrast to typical blackhole transients having a fast rise and exponential decay profile, V404 Cygni showed multiple flaring activity during one outburst (Tanaka and Shibazaki. 1996, Ferrigno *et al.* 2015). The nature of the variation is still under discussion (*e.g.*, Tanaka *et al.* 2016, Martí *et al.* 2016, Gandhi *et al.* 2016, and Kimura *et al.* 2016). Our aim is to derive information about the nature of the complex optical variation.

2. Analysis & Result

Light Curve and Flux-flux Plots

Fig.1 shows the optical (g', R_C, and I_C-band) light curves during MJD 57192–57194 (left side), and the flux-flux plot constructed by the g' and I_C-band photometric data (right side).

The amplitudes of optical flux variations reached ∼3 mag on a timescale shorter than an hour, and the variations in the optical bands were perfectly correlated. The data in the flux-flux plot is well expressed by a broken- linear model (left side). Linear branches below and above a break, colored by red and blue respectively, 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.

SED Modeling

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

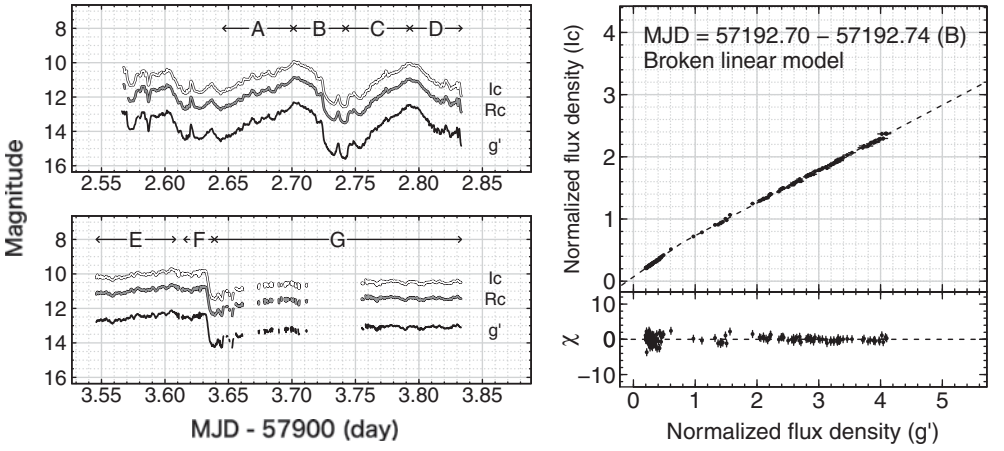

Figure 1. Left figure: g′, R_C, I_C and K_s light curves. **Right figure**: Flux-flux plots and fits for fluxes in g′ and I_C-band at "B" portion.

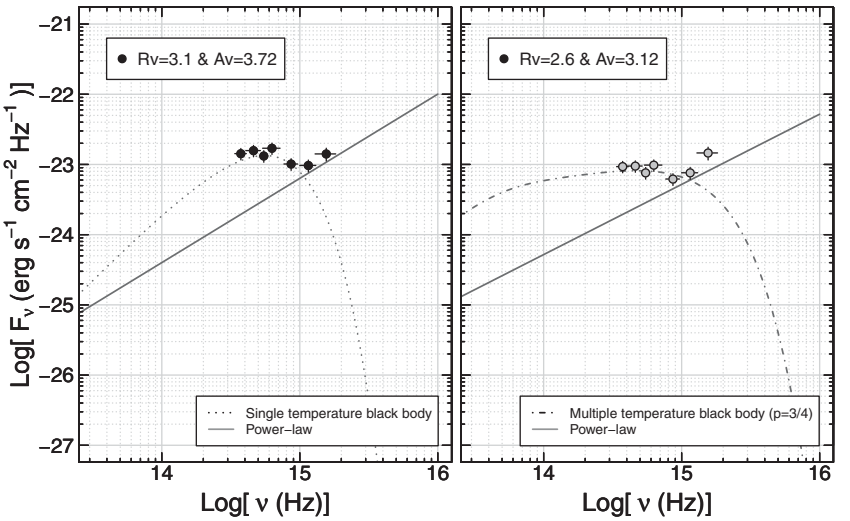

Figure 2. SED from optical to UV with two variable components at MJD = 57194.

Fig. 2 shows the SED from optical to UV. In the left panel, the dotted line and the solid line denote the black body spectrum and power-law spectrum respectively, and the dash-dotted line denote the standard disk spectrum in the right panel. The SED is well reproduced with our model.

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