Bursting Activity in a High-Mass-Star-Forming Region Observed with the 6.7GHz Methanol Maser

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Abstract

We report on our observational results of single dish monitoring observations of the 6.7 GHz methanol maser emission in a high mass star-forming region G33.641-0.228. Previous observations using the Yamaguchi 32-m radio telescope have revealed that the maser shows the bursting activity (the rapidly rise of flux). Since the timescale of bursts is quite short less than a day, the details of the variation of the burst has been unclear. This study aims to reveal the variations by high frequent monitoring observations. As a result of these observations, we have detected three bursts. One of the spectral components of this maser in this source changed its flux density ten times that of the previous day, and its decaying phase, the variation was not smooth, but showed very rapid rise and fall repeatedly in 6.5 days.

Introduction

The 6.7 GHz methanol maser is observed in High-Mass-Star-Forming regions. It is thought to trace the circumstellar gas disk or outflow [1][2][3] . The maser shows characteristic variability including periodicity. Fujisawa et al. (2012) discovered a bursting activity of the maser in high mass star forming region G33.641-0.228. The burst is a rapid rise of flux in a short timescale. The burst can be explained as a solar-flare like event in which the energy is accumulated in the magnetic field of the circumstellar disk, and is released for a short time. However, the heating process of the dust has not been yet identified as mechanism of the energy release. Fujisawa et al (2014) reported that five bursts were detected in G33.641-0.228 in the observation period of 294 days from 2009 to 2012. All of detected bursts have changed one of the components (component II , Fig.1). The flux variation of component II from 2009 to 2012 are collectively shown in Figure 2.

In previous observations, the variation profile of each burst is not known in detail. To know the details of the variability would help to understand the burst mechanism. In 2014, we are doing a daily and sub-daily observations in G33.641-0.228 in order to know in detail the variation profile. We report the results.

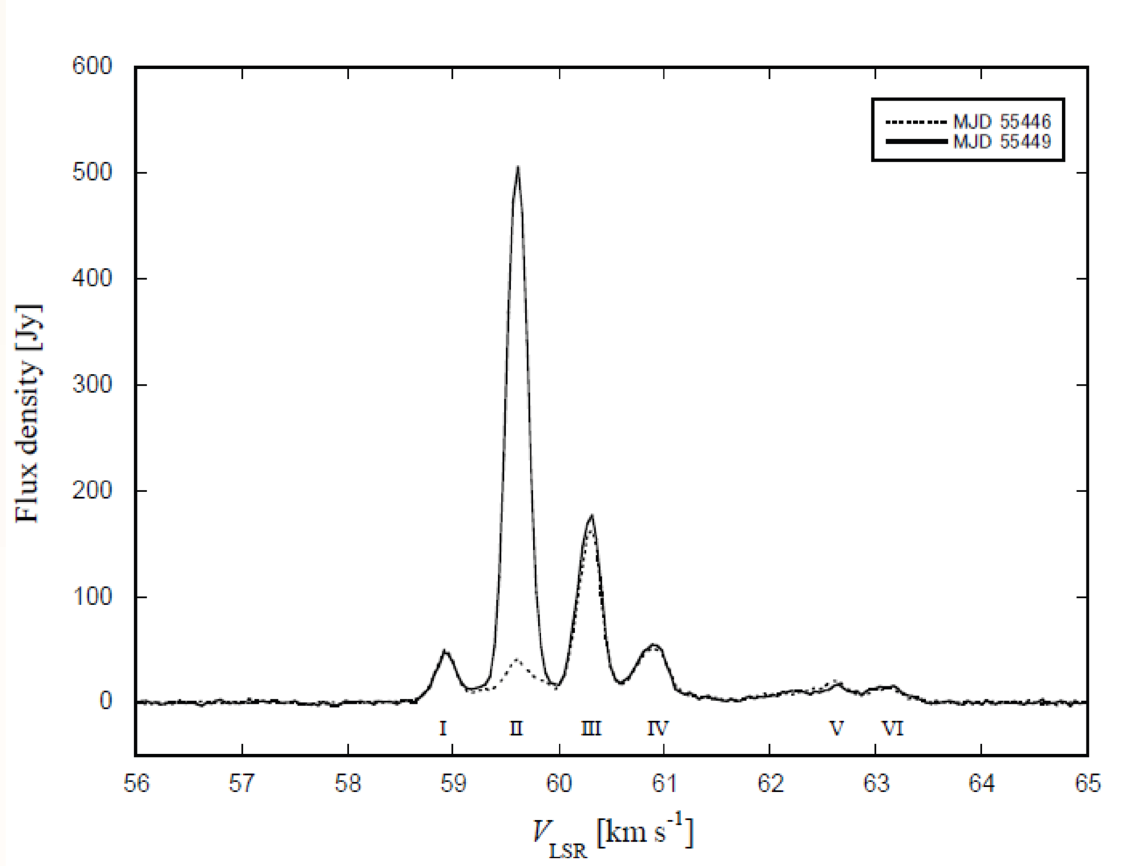

Fig.1 Spectra of G33.641 -0.228

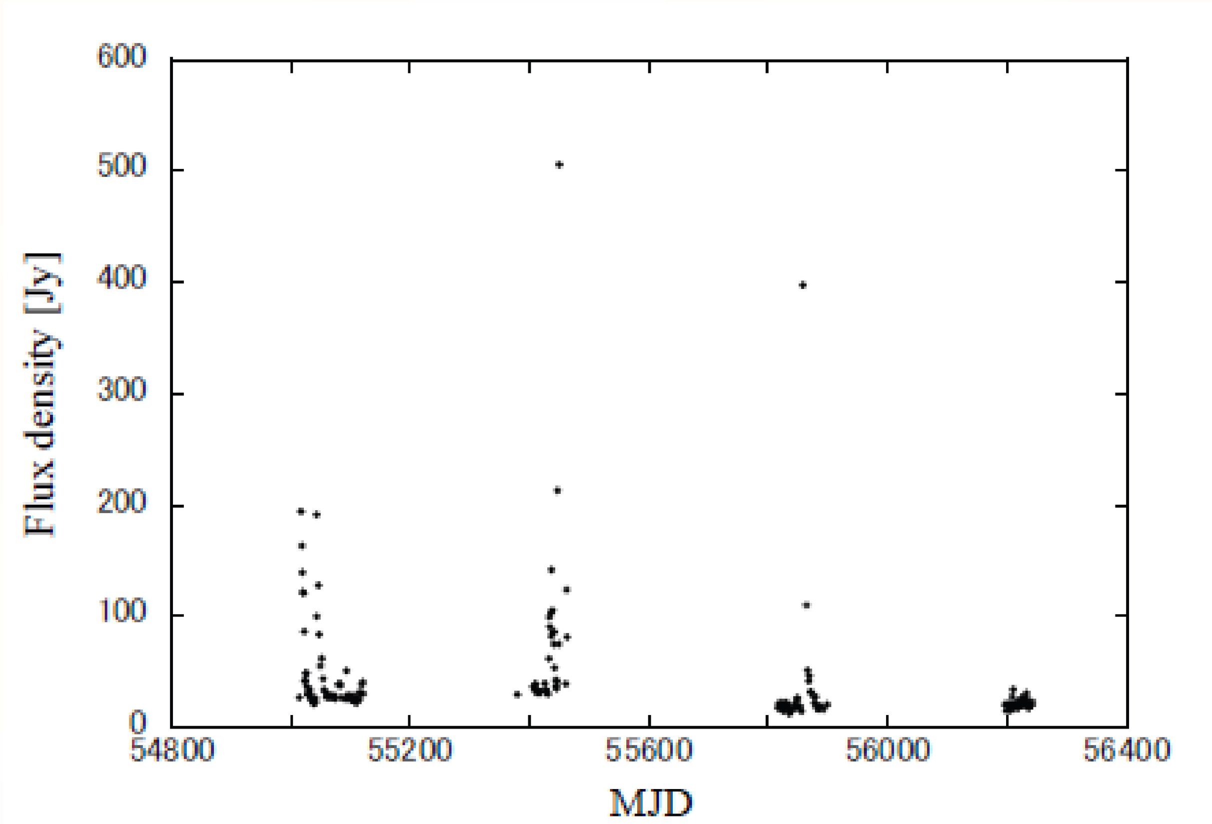

Fig.2 Variations of the spectral components II observed 2009 to 2012.

Observation

The monitoring observations is being made with the Yamaguchi 32-m radio telescope from 2014 July 19 (day-of-year; DOY 170). The observations have been usually made everyday, and made twice a day. The observing band width, number of frequency channels, and velocity resolution were 8 MHz, 8192, and 0.044 km s^{-1}, respectively.

A session of sub-daily monitoring observation was made during the period of 2014 August 30 (DOY 242) to September 18 (DOY 261) when a burst was detected. During the session, 13 scans were made in a day.

Table 1 Observation parameter

Radio telescope	Yamaguchi 32 m
Beam size [arcmin]	~5
Bandwidth [MHz]	8
Velocity resolution [km/s]	0.044
Integration time [s]	180

Result

The rapid rises in the flux density (burst) were detected in G33.641-0.228 at DOY 241 and 283 only in component II (V_{LSR} = 59.6 km s^{-1}), as shown in figure 4.

At the first burst, the flux density rose to 22 times the day before the flux density in a day, and fell exponentially with an e-folding time of 6.5 day. As shown in figure 5, the flux density showed repeatedly rising and falling. Amplitude of such a fluctuation was more than 100 Jy. The maximum flux density was 365 Jy on day 4(DOY 244) of the burst. Then also showed rise and fall (amplitude of fluctuation was 30 ~ 70 Jy). The peak flux density on day 17 (DOY 250) dropped below 100 Jy. The burst was calm and fully down until 20 Jy on day 17 (DOY 258). The flux density while the burst fluctuated wildly.

At the second burst, the flux density rose to 78 Jy. This time we did not carry out the high frequent monitoring observations.

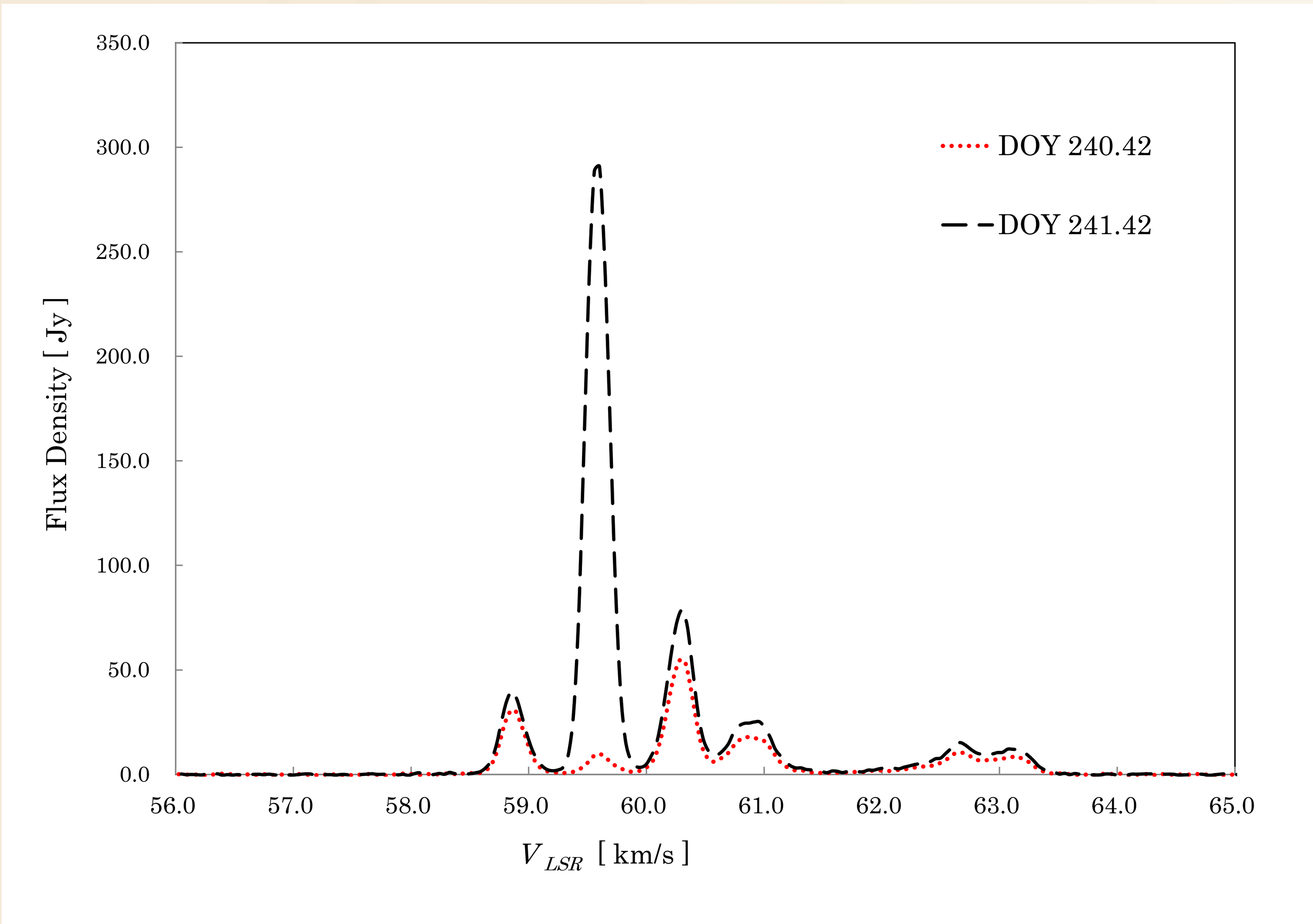

Fig.3 Spectra of G33.641-0.228.The spectra of G33.641-0.228 observed with Yamaguchi-32m radio telescope are shown. The dotted and dashed lines show the spectra of DOY240 and 241, respectively, just before and after the first burst.

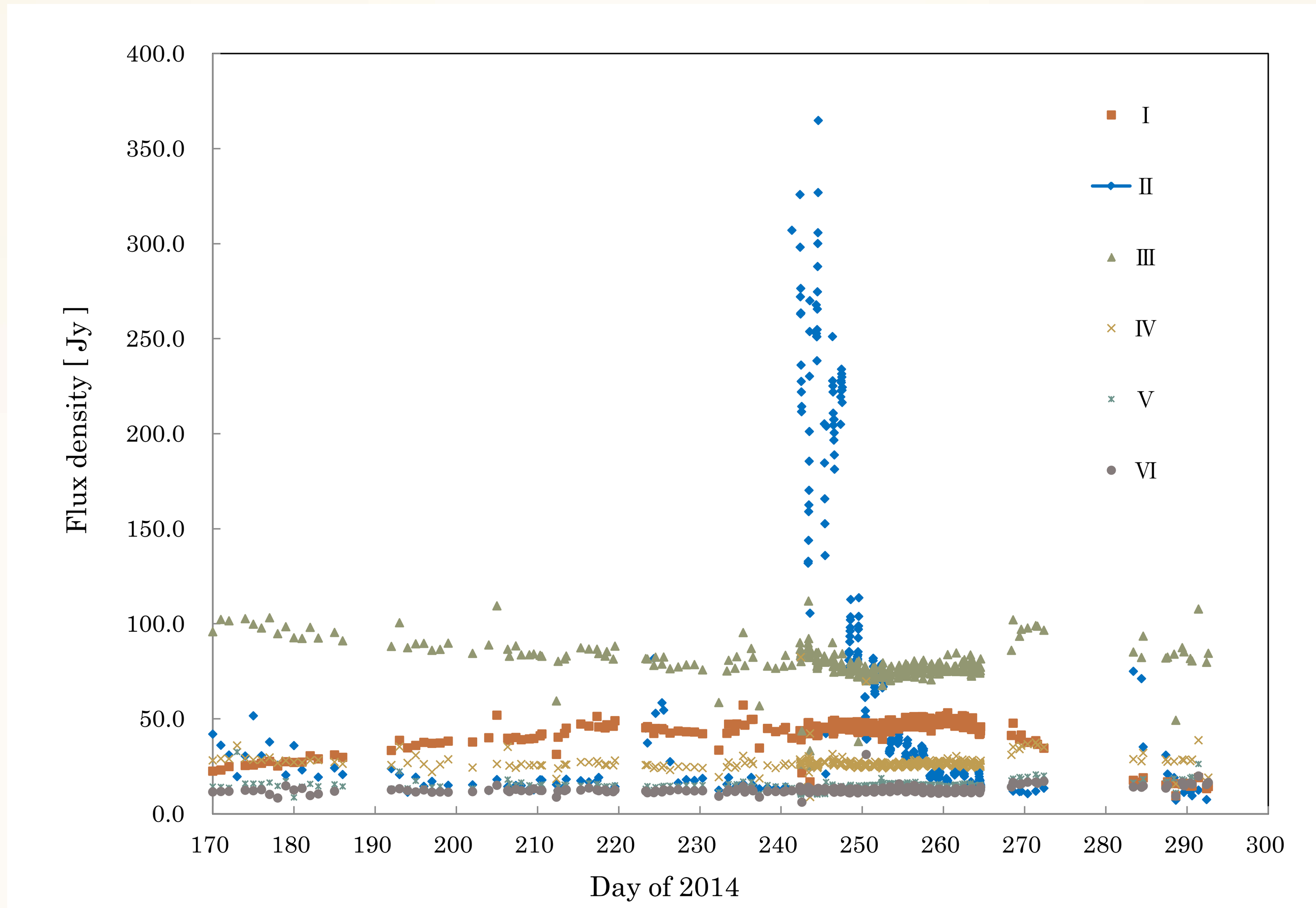

Fig.4 Light curve of the spectral components. The changes in the peak flux density for each six spectral components(I -VI) are shown. Only component II (filled diamond shapes and the solid line) shows the burst, while the other components are completely unrelated to the burst.

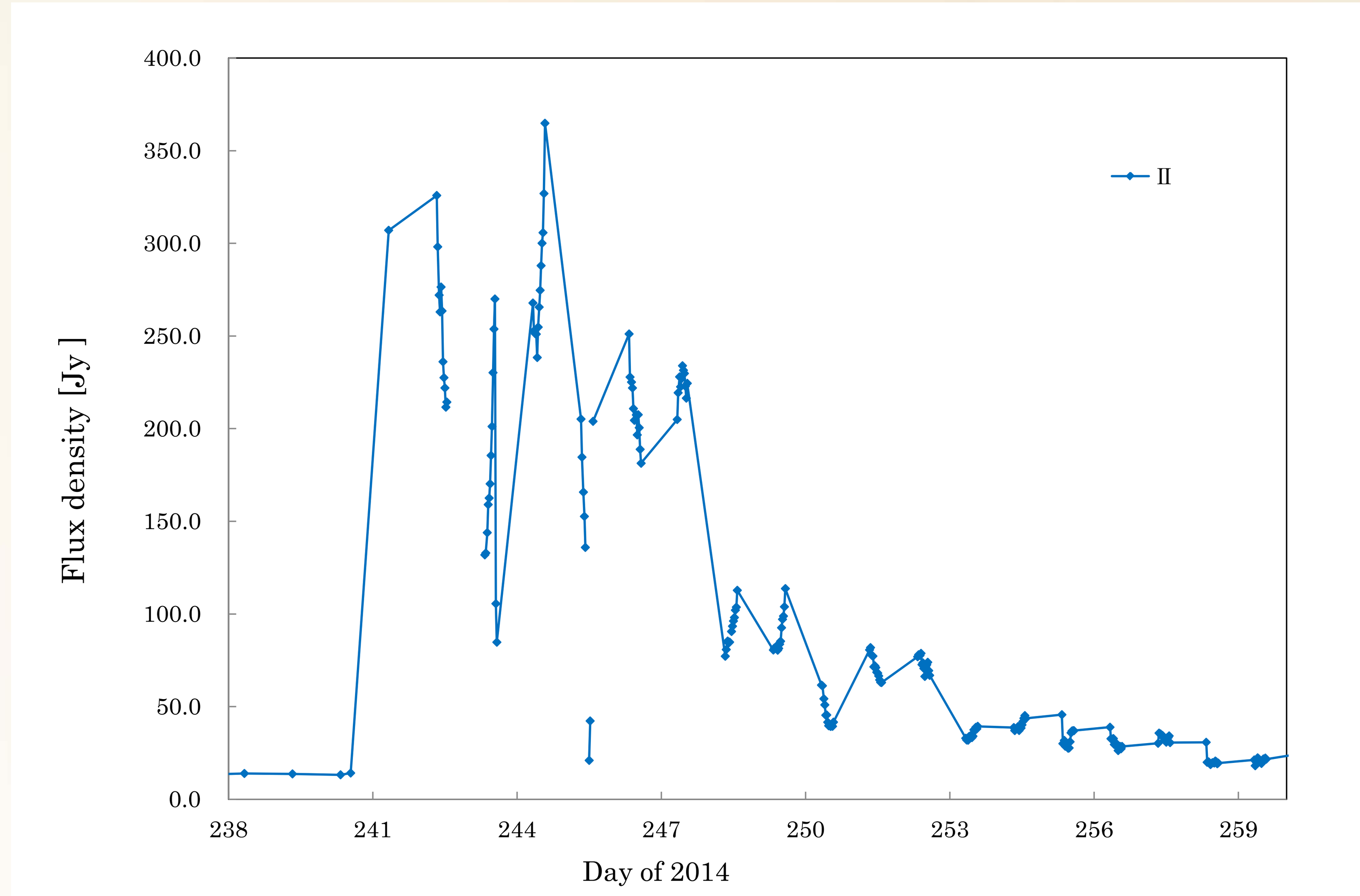

Fig.5 Light curve of component II. The change in the peak flux density for spectral component II showed repeatedly rising and falling with timescale of less than 1 day. (Note that this flux densities were strongly affected from the pointing offset and not well calibrated. The very fast fluctuations are probably due to the pointing offset.)

Future work

We will discuss the trend and the frequency of bursts in short timescale.

Therefore…

- We subject model fitting and elucidate the variability of flux density while the burst happen, and discuss the bursting mechanism.
- In order to reveal the rising process of the flux density in the bursts, we continue the monitoring observations and carry out the high frequent monitoring observations.

Reference

[1] Minier, V., et al. 2003, A&A, 403, 1095
[2] De Buizer, J. M. et al. 2003, MNRAS, 341, 277
[3] Sugiyama, K., Fujisawa, K., et al. 2014 A&A, 562, A82
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