OPTICAL POLARIMETRY OF THE BLAZAR CGRaBS J0211+1051 FROM MOUNT ABU INFRARED OBSERVATORY

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ABSTRACT

We report the detection of high polarization in the first detailed optical linear polarization measurements on the BL Lac object CGRaBS J0211+1051, which flared in γ-rays on 2011 January 23 as reported by Fermi. The observations were made during 2011 January 30–February 3 using a photo-polarimeter mounted at the 1.2 m telescope of Mount Abu Infrared Observatory. CGRaBS J0211+1051 was detected to have a ~21.05% ± 0.41% degree of polarization (DP) with a steady position angle (P.A.) at 43° on 2011 January 30. During January 31 and February 1, while polarization shows some variation, the P.A. remained steady through the night. Several polarization flashes occurred during February 2 and 3 resulting in changes in the DP by more than 4% at short timescales (~17–45 minutes). The intra-night variability shown by the source appears to be related to the turbulence in the relativistic jet. A mild wavelength dependence of polarization is not ruled out during the nights of February 2 and 3. The source exhibited significant inter-night variations in the DP (changing by about 2%–9%) and P.A. (changing by 2°–22°) during the five nights of observations. A sudden change in the P.A. accompanied by a rise in the DP could be indicative of the fresh injection of plasma in the jet. The detection of a high and variable DP suggests that the source is a low-energy peaked blazar.

Key words: BL Lacertae objects: individual (CGRaBS J0211+1051) – galaxies: active – galaxies: nuclei – methods: observational – techniques: polarimetric

1. INTRODUCTION

CGRaBS J0211+1051, also known as MG1 J021114+1051, 1FGL J0211.2+1049, 87GB 020832.6+103726, etc. (R.A. 02:11:13.2, decl. 10:51:35, J2000), was found to have a featureless optical spectrum and R-band magnitude of 15.42 in optical characterization of bright blazars in the uniform all-sky survey, CGRaBS (Healey et al. 2008). It was identified as a radio source and/or BL Lac object in a 8.4 GHz survey of bright, flat-spectrum radio sources (Healey et al. 2007) and in several other surveys, including the 4775 MHz survey of bright, flat-spectrum radio sources (Healey et al. 2007) and the Large Area Telescopes (Lawrence et al. 1986). Snellen et al. (2002) performed optical identification of the radio sources from the Jodrell Bank Very Large Area astrometric survey with S_{6cm} > 200 mJy and reported CGRaBS J0211+1051 to have an R-band magnitude of 15.41 along with 384 mJy and 318 mJy flux values at 5 GHz and 1.4 GHz, respectively. The source was detected in γ-rays (E > 100 MeV) by the Large Area Telescope (LAT) on board Fermi and is listed in the first Fermi catalog (Abdo et al. 2010). Recently, the redshift of CGRaBS J0211+1051 was estimated to be z = 0.20 ± 0.05 from its host galaxy observations (Meisner & Romani 2010).

On 2011 January 23, flaring activity in γ-rays (E > 100 MeV) was detected in CGRaBS J0211+1051 by LAT on board Fermi (D’Ammando et al. 2011a). The measured flux at the level of 1.0(±0.3) × 10^{-6} photon cm^{-2} s^{-1} was 25 times the flux averaged over the previous 11 months (Abdo et al. 2010). Swift/UVOT Target of Opportunity observations (D’Ammando et al. 2011b) on 2011 January 25 found that CGRaBS J0211+1051 was about 1.3 and 1.4 mag brighter in the U band (13.77 ± 0.03 mag) and W2 band (14.44 ± 0.04 mag), respectively, compared with their values on 2010 March 5. Swift also observed CGRaBS J0211+1051 in V band with 14.00 ± 0.08 mag. On 2011 January 27, Neschi (2011) reported an R_{c} band magnitude of 13.37 for the source showing it to be 1.74 mag brighter than the POSS-I red plate value and the Digitized First Byurakan Survey value of R = 15.1 as obtained in 1950 and 1971, respectively. Based on their past observations made with MASTER-net (Lipunov et al. 2004), Kudelina et al. (2011) found the source to have continuously increased in brightness from 14.45 mag in white light on 2010 February 3 to 13.35 mag on 2011 January 24. Djorgovski et al. (2011) reported a steady rise in the source brightness from ~15.6 mag in 2008 to about 13.5 mag in V band on 2011 January 24.

All of these reports suggest that CGRaBS J0211+1051 has been in a brightening phase for the last several years, having short (months) variability timescales with 0.5–1 mag amplitude of variation. Such variations indicate strong activity in the optical while the source flared at high-energy γ-rays. It would be interesting to see the behavior of this source on intra-night timescales with continuous monitoring. Following the flaring of the source in γ-rays, Gorbovskoy et al. (2011) made optical polarimetric measurements in the V band using MASTER-net observational sites at Tunka-Baykal and Amur-Blagoveschesk and found the source to have a 12% polarization on 2011 January 28. The corresponding V-band brightness magnitude of the source was about 13.65 mag. Chandra et al. (2011b) detected an even higher degree of polarization (DP; > 20.7%) in white light during their observations from Mount Abu Infrared Observatory (MIRO) on 2011 January 30.

Extreme variations in the flux and polarization at various timescales across the whole electromagnetic spectrum are the characteristics of blazars, a subclass of active galactic nuclei (AGNs) seen at a small angle (⩽10°) to the jet emanating from very close to the black hole (Ury & Padovani 1995; Blandford & Konigl 1979; Chandra et al. 2011a). Such variations could be caused by the perturbations in the accretion disk or the relativistic jet as described by several models (e.g., Mangalam & Wiita 1993; Marscher & Gear 1985; Qian et al. 1991; Marscher et al. 1992; Gopal-Krishna & Wiita 1992).
Since radio to X-ray emission in blazars is normally associated with the synchrotron radiation from the relativistic electrons moving in the magnetic field, systematic polarization measurements provide an important tool to understand the nature of such variations and help constrain the models of emission. However, very limited observations have been reported that deal with intra-night and night-to-night variations in blazars (e.g., Andrucow et al. 2003; Villforth et al. 2009; Heidt & Nilsson 2011, and references therein). The DP and its variation have been used by many workers as a tool for detecting or confirming BL Lac candidates (e.g., Smith et al. 2007; Jannuzi et al. 1993, and references therein). A detailed review of polarization properties of the blazars is given by Angel & Stockman (1980). The study of the variations in polarization is also useful in probing the structure of the jet and the nature of the physical processes in AGNs (Marscher 2008; Andrucow et al. 2005). Motivated by this, we made detailed optical polarization measurements from MIRO during 2011 January 30 to February 3. The main objective was to investigate the night-to-night variability in polarization and position angle (P.A.) and any possible intra-night activity in the source. These are, we believe, the first detailed and systematic polarization data reported so far on the blazar CGRaBS J0211+1051.

2. OBSERVATIONS AND DATA ANALYSIS

The observations were made using the two-channel Physical Research Laboratory Photo-polarimeter (PRLPOL) mounted on the Cassegrain focus of the 1.2 m telescope of MIRO, operated by the Physical Research Laboratory, Ahmedabad, India, during five consecutive nights, 2011 January 30 to February 3. The PRLPOL, described in detail by Deshpande et al. (1985), was recently fully refurbished and automated (Ganesh et al. 2009). It works on the principle of rapid modulation with a fast-rotating, super-achromatic half-wave plate, completing one physical rotation in 96 steps (3.75 per step). The four modulation cycles are thus completed in one full rotation of the half-wave plate with 24 steps per modulation cycle. A Wollaston prism divides the incident light beam into two orthogonally polarized components, each one directed to a separate photomultiplier tube (PMT). The rapid modulation of the incident light and simultaneous measurement of the two polarized components take care of the atmospheric scintillation effects. The instrument has a UBVRI-system filter slide and a second slide with diaphragms of differently sized apertures. The observations were carried out mostly in the white light to maximize the signal. For white light, the effective wavelength is determined by the sensitivity of the detector, here PMT (EMI 9863B), which peaks at $\lambda_{\text{peak}} \approx 400$ nm. Some measurements were made with $B$, $V$, and $R$ filters to investigate any wavelength dependence of polarization (WDP). We adopted a sky–source–sky observation strategy for the observations where, alternately, sky and source were kept at the center of the aperture. The source was centered whenever a drift was noticed during the observation. The sky measurements were taken about 30' away from the source. The exposure time for both the sky and the source was kept at 40 s during all five nights for unfiltered white light observations and 120 s for observations in the $B$, $V$, and $R$ bands. The appropriate size of the aperture is chosen by keeping in mind the optimum value of the signal-to-noise ratio and the prescription of Andrucow et al. (2008) for avoiding spurious variations caused by any possible change in the seeing and the contamination by the thermal emission from the host galaxy, which tends to decrease the value of intrinsic polarization. Too small ($< 0.02\%$) an aperture might introduce spurious variations if the seeing changes under unstable sky conditions, while a large one would result in the suppression of any intrinsic variation and extent of the polarization of the source.

In the present case, the host galaxy was more than 3 mag fainter than the source (Meisner & Romani 2010) as the source was in a relatively brighter phase (Nesci 2011; Kudelina et al. 2011). Based on these criteria, we use a 10 arcsec aperture for the target and other observed stars used for the calibration. Weather conditions were photometric with a moonless sky, which was more than 2 mag fainter than the source.

For the duration of integration on the sky or the source, counts are accumulated in 24 array locations corresponding to the half-wave plate positions with a 2 ms sampling time. The DP and the P.A. for the source are then calculated by the control program after each integration, subtracting the previously observed sky counts. The computation is performed using a least-squares fit to the counts from the two PMTs. The mean error in the DP is estimated from the deviation of the actual counts from the fitted curve. Standard stars were observed every night to determine the zero point for the P.A. and the instrumental polarization, which was found to be negligibly small ($< 0.02\%$).

3. RESULTS AND DISCUSSION

The P.A. of polarization for the source was corrected using measurements on the 9-Gem and error in P.A. was calculated using the expression by Serkowski (1974). A possible source of error in the measurement of polarization parameters lies in dealing with the sky background. It could be particularly serious when the sky is close to the source in brightness and has large and variable polarization due to, for example, the presence of Moon. Such large, variable polarization affects both the source and the sky, and, therefore, this systematic error should be removed when the data are reduced if the sky measurements are made close (both in time and position) to the source observations. In the present case, we have taken the above precaution in the sky measurement. In addition, the observations were made in moonless sky conditions and the source was more than 2 mag brighter than the sky. Also, the sky was fairly stable with DP remaining low (maximum 6%) during 2011 January 30 to February 3. Any change in the DP of the sky on any particular night remained well within the measurement errors. We, therefore, do not expect any significant spurious effect on the source polarization due to the sky.

The nightly averaged values of the DP and the P.A. were calculated and their standard deviations were obtained. In Table 1, we report polarization data during the given observing run date, MJD, duration of observation in hours, nightly averaged values of the DP, P.A., and their respective standard deviations.

| Date       | MJD   | $\Delta T$ (hr) | DP (%) | $\sigma_{\text{DP}}$ (%) | P.A. (°) | $\sigma_{\text{P.A.}}$ (°) |
|------------|-------|----------------|--------|--------------------------|----------|-----------------------------|
| 2011 Jan 30| 55591.3796 | 0.336 | 21.052 | 0.295 | 42.771 | 0.634 |
| 2011 Jan 31| 55592.4665 | 0.864 | 12.871 | 0.489 | 28.963 | 0.758 |
| 2011 Feb 1  | 55593.4552 | 2.498 | 10.643 | 0.493 | 30.679 | 1.373 |
| 2011 Feb 2  | 55594.4362 | 2.112 | 12.629 | 0.981 | 52.982 | 1.412 |
| 2011 Feb 3  | 55595.4308 | 1.920 | 15.481 | 1.412 | 43.578 | 1.762 |

Table 1: Nightly Averaged Polarization Data for CGRaBS J0211+1051

Note. Entries are the dates of observation, MJD, duration of observation, DP, $\sigma_{\text{DP}}$, P.A., and $\sigma_{\text{P.A.}}$. 

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deviations. The polarization data reported here are obtained through a 10 arcsec aperture as mentioned in the previous section. A larger aperture might result in a significant reduction in the DP due to thermal emission from the host galaxy contaminating the nonthermal emission from the nucleus, particularly when the host galaxy is bright. CGRaBS J0211+1051 and its host galaxy had I'-band magnitudes of 15.32 and 16.91, respectively, as reported by Meisner & Romani (2010) during their 2008 October 31 to November 2 observations. Since galaxy light peaks in the near-infrared band and has a reduced brightness at a shorter wavelength, the effect of galaxy light contaminating the nuclear emission will be reduced in the optical B, V, and R bands. Also, the source was in a fairly bright phase, brighter than 13.5 in R (Nesci 2011; Kudelina et al. 2011), during our polarimetric observations, making it more than 3 mag brighter than the host galaxy. Therefore, there should not be any significant contamination of the nuclear light by the host. Nevertheless, the polarization values reported here should be marginally lower than their intrinsic values.

3.1. Intra-night and Inter-night Variation in Polarization

The blazars are known to show rapid, large-amplitude variations in flux and polarization at various timescales. The nature of such variations can be used to infer the physical processes at work in these sources. To investigate the intra-night polarization behavior of CGRaBS J0211+1051, DP and P.A. are plotted as a function of time (MJD) in Figures 1(a)–(c) and 2(a) and (b) for the observations made during 2011 January 30 to February 1 (in white light) and February 2 and 3 (in B, V, R bands and white light), respectively. The error bars indicate the uncertainties (including the uncertainty in the background determination) in the individual measurement of DP and P.A. In the following, we present polarization results from our nightly observations.

On 2011 January 30, the source was highly polarized at more than a 21% level during our 20 minute observations (Figure 1(a)). The P.A. was $\sim$43°. We do not note any significant variation in DP or P.A. during this night. However, this value of DP is much higher than the value reported by Gorbovskoy et al. (2011) on 2011 January 28 (DP = 12%), just two days prior to our measurements. We have 14 data points on 2011 January 31 obtained within 0.7 hr of observation. At the onset of observations, DP is about 13%, increasing to 13.81(±0.35)% before falling by 2.7% (>5$\sigma$) to 11.10(±0.41)% within about 20 minutes (decay rate, $\sim$8% hr$^{-1}$). The DP starts increasing again and reaches about a 13.2% level in 18 minutes (rising rate, 7% hr$^{-1}$) with a 2.1% (>4$\sigma$) amplitude of variation. The visual inspection, therefore, shows rapid variation in DP with significant (4$\sigma$–5$\sigma$) amplitude of variation on 2011 January 31. The P.A., however, remains well behaved without any appreciable variation. 2011 February 1 has a large number of observational points (87) obtained during 2.4 hr of monitoring. Several microvariability events appear to be superimposed over a nonvarying component (Figure 1(c)). However, except for the two events beginning at MJD 55593.424 and MJD 55593.446 with more than 3$\sigma$ amplitude of variation in DP, other variations are within 2$\sigma$. The P.A. stays within 31° ± 3° without any structures.

The temporal behavior of the polarization of the blazar CGRaBS J0211+1051 on 2011 February 2 and 3 is shown in Figures 2(a) and (b). During these two nights, in addition to the white light, we also made observations in the B, V, and R filter bands to observe any wavelength dependence in the DP and P.A. Let us first look at the behavior of the source in the white light only. On 2011 February 2, beginning and ending segments (from time 4.388 to 4.418 and 4.456 to 4.476) of the
The visual inspection of the plot clearly shows an increase in DP by 2.2% (close to 3σ) during ≈32 minutes (rate of increase in DP, 4% hr⁻¹). The measurements in the white light toward the end also give an indication of a change (at 2σ level) in DP. On 2011 February 3, DP decreases from 16.8% at time 3.432 to 13.8% at time 3.442 (cf. Figure 2(b)), with an amplitude of variation of about 3% (> 3σ). This drop is then followed by an increase in DP by about 2.6% within a span of 35 minutes at the rate of 4.5% hr⁻¹ toward the end of the observations. The source, therefore, undergoes rapid intra-night variations in the DP on 2011 January 31, and February 2 and 3, as reflected in the white light polarization curves.

Considering the observations made through the B, V, and R filters in addition to the white light ones, we now discuss Figure 2 again. On 2011 February 2, DP rises from 11.5% (at time 4.392) to 13.5% (at time 4.416, cf. Figure 2(a)) in white light. The rise continues in the B-band observations reaching more than 15% at MJD = 55594.43. Beyond that, DP decreases in V and R bands partly due perhaps to the increase in wavelength and partly due to the intrinsic variation in the polarization of the source. The rates of decay in DP from the B to V bands and the V to R bands are approximately 22% hr⁻¹ and 11% hr⁻¹, respectively. Toward the end, observations in the white light show an increasing trend with DP peaking in the B band (∼14.3%) before dropping to ∼12.2% in the V band (DP decay rate from the B to V bands was 14% hr⁻¹). The P.A. largely remains within the ±3° range. Figure 2(b) shows polarization behavior of CGRABS J0211+1051 during 2011 February 3. Interestingly, the composite curve shows three quasiperiodic polarization flashes with a significant amplitude of variation (up to 4%). These events have fast rise and fall timescales, ranging from 17 to 35 minutes. It is important to note that DP changes at a rate of about 31%, 35%, and 40% hr⁻¹ from B to V, V to R, and R to B bands, respectively, as estimated from the polarization curve for 2011 February 3. The P.A. varies between 41° and 46° during the course of observations and can be considered as mildly variable.

The blazars are known to show WDP. Any WDP in the jet-dominated blazars is known to be due to the source geometry and/or due to the contamination of the nuclear nonthermal radiation by the thermal unpolarized emission from the host galaxy (Brindle et al. 1986; Angel & Stockman 1980). In many cases, DP is noticed to increase with frequency (e.g., Sitko et al. 1985; Holmes et al. 1984; Angel & Stockman 1980, and references therein) in the optical region. However, decrease in DP with frequency is also detected in several cases. For example, Tommasi et al. (2001) observed several blazars simultaneously in UBVRI optical bands. While they found DP to increase with frequency in many sources, OJ287 and the BL Lac object were noticed to show a decrease in DP with frequency.

In the present case, 2011 February 2 and 3 measurements with B, V, and R filters appear to support the trend that the DP increases with frequency in BL Lac objects. The DP in the B band shows an increase over R- and V-band values (Figure 2), which cannot only be due to the intrinsic variation because variation timescales are expected to be longer than the temporal resolution (about 5 minutes) used here. A careful examination of the variation pattern in DP shows that while the rate of change in DP obtained in white light is, on average, about 4%–8% hr⁻¹ (except for a segment in the polarization curve on 2011 February 3 when it is about 11% per Hr), it is as high as 12%–40% per Hr in the values obtained using different bands. The significant increase in the rate of change in DP with time when observed through the B, V, and R bands, is, perhaps, partly due to WDP. However, from the present data, it is not possible to clearly establish the extent to which WDP contributes to the observed polarization variability. For this, simultaneous observations in different optical bands are needed.

Now, let us look at the inter-night variations during 2011 January 30 to February 3. Table 1 and Figure 3 show averaged DP and P.A. for these nights. The error bars in the figure reflect the spread (1σ) due to intra-night variations in addition to the measurement errors. It is evident from the observed data that the source was highly polarized on 2011 January 30 with DP at about 21%, which decreased by 9% and 11% on 2011 January 31 and February 1, respectively. The DP increased again reaching 15.5% on 2011 February 3. The P.A. also changed significantly from night to night, initially following the trend in the DP but dropping to 45° on the last night while DP increased to a 15% level. We note changes in the P.A. by 2°–22° while remaining within the 28°–53° range during our observations.

Apart from visual inspection of the polarization curves to look for variations, we also carried out a statistical analysis to

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**Figure 2.** Same as Figure 1 but for 2011 February 2 and 3 in the B, V, and R bands and white light.
detect and quantify the variation parameters using the criterion of Kesteven et al. (1976) applied by several authors to the variability studies (e.g., Romero et al. 1994; Andrichow et al. 2005). Here, the variability in DP and P.A. is described by the fluctuation index $\mu$ and the fractional variability index $FV$ of the source obtained from each individual night’s data. The corresponding expressions are

\begin{align}
\mu &= 100\frac{\sigma_S}{\langle S \rangle} \% , \\
FV &= \frac{S_{\text{max}} - S_{\text{min}}}{S_{\text{max}} + S_{\text{min}}},
\end{align}

where $\sigma_S$ is the standard deviation, $\langle S \rangle$ is the mean value of the DP or the P.A. obtained during a particular night, $S_{\text{max}}$ and $S_{\text{min}}$ are, respectively, the maximum and minimum values for the DP or P.A. The source is classified as variable (V) if the probability of exceeding the observed value of

$$
\chi^2 = \sum_{i=1}^{n} \epsilon_i^2 \left( S_i - \langle S \rangle \right)$$

by chance is <0.1%, nonvariable (NV) if > 0.5%, and possibly variable (PV) for in-between values. In the above expression, $\epsilon_i$ are the uncertainties in the individual measurements. If the errors are random, $\chi^2$ is distributed as $\chi^2$ with $n-1$ degrees of freedom, where $n$ is the number of points in the distribution.

Since variability in the polarization parameters (DP and P.A.) due to the WDP and intrinsic variation cannot be separated, a statistical analysis is performed using only the white light data. Table 2 shows the values of the variability parameters for the DP and P.A. Columns 1 and 2 give the date and the number of observation points, Columns 3–6 present the values of $\mu$, $FV$, and $\chi^2$ for DP, and the status of the source (V, NV, and PV). The remaining four columns give these values for the P.A. These results quantitatively substantiate significant intra-night variability during 2011 February 2 and 3 in the polarization behavior of the source as noticed in the visual inspection of the respective figures. It is, however, to be noted that when the number of measurements during a night is not large enough, the above test may not be very suitable. Perhaps that is why the test gives a PV status for DP on 2011 January 31 when we only had 14 data points, while visual inspection shows noticeable variability.

Let us briefly discuss these results. The observed optical emission in the blazars originates in a part of the accretion disk and the inner (parsec-scale) regions of the jet. The polarization caused by the electron or dust scattering in the accretion disk is usually low (a few percent). Since CGRABS J0211+1051 shows a high DP (10%–21%) during the present observations, the emission must be dominated by the relativistic jet, aligned at a small angle to the line of sight. This emission is mostly synchrotron radiation from the relativistically moving electrons in the jet and is highly polarized (>70%) if the magnetic field is uniformly aligned. A reduced observed DP indicates a chaotic magnetic field, which can be described in terms of $N$ cells with a uniform but randomly oriented magnetic field (Marscher 2008). The DP could also be reduced by geometrical depolarization due to variation in the magnetic field orientation along the line of sight and the contamination by the thermal emission from the host galaxy. The P.A. is orthogonal to the projected direction of the magnetic field. However, relativistic motion aberrates the angle resulting in a P.A. that is more aligned with the jet direction.

In BL Lac objects, the parsec-scale magnetic field in the jet is tangled and shocks moving down the jet compress the magnetic fields, aligning it perpendicular to the flow direction (Marscher & Gear 1985). The interaction of relativistic shocks with features in the parsec-scale jet results in rapid variations in the flux and polarization (Marscher et al. 1992; Qian et al. 1991). The features are varied in nature depending on the model and they are generally subparsec in size. Macroscopic Kelvin–Helmholtz instabilities are capable of producing such features in the inner beam. Quasiperiodic variations could be caused by the regularly spaced obstacles in the path of the jet.

These models can explain variations with timescales of weeks to days. Faster variations down to the subhour timescales cannot be explained by these models due to the limited thickness of the shocks. The rapid, intra-night flickerings in the DP as observed during 2011 January 31 to February 3 could be the effect of turbulence in the postshock region of the jet. The P.A. of polarization suffered drastic changes between the nights of 2011 January 30 and 31, February 2 and 3 by more than 8° and 10°, respectively, while the DP underwent an 8% and 3% change during these periods. The DP changed by more than 9% during 2011 January 28 (DP 12% as reported by Gorbovskoy et al. 2011) and January 30 (21%, our value). These sudden changes in the P.A. and DP, as noticed in other BL Lac objects, for example, 3C279 (Andrichow et al. 2003), are perhaps caused by the fresh injection of the plasma blobs in the jet on 2011

\begin{table}[h]
\centering
\caption{Variability Test Results for CGRABS J0211+1051 Using White Light Data Only}
\begin{tabular}{|c|c|c|c|c|c|c|c|}
\hline
Date & n & DP & $\mu(\%)$ & Status & P.A. & $\mu(\%)$ & Status \\
\hline
2011 Jan 30 & 8 & 1.403 & 0.021 & 2.942 & NV & 1.482 & 0.023 & 8.215 & PV \\
2011 Jan 31 & 14 & 3.799 & 0.075 & 13.341 & PV & 2.618 & 0.044 & 7.573 & NV \\
2011 Feb 1 & 87 & 4.639 & 0.093 & 84.610 & NV & 4.475 & 0.127 & 89.691 & PV \\
2011 Feb 2 & 39 & 6.153 & 0.103 & 128.810 & V & 2.473 & 0.056 & 61.825 & V \\
2011 Feb 3 & 30 & 6.121 & 0.107 & 121.733 & V & 2.944 & 0.054 & 60.086 & V \\
\hline
\end{tabular}
\end{table}
January 28 and February 2. Shocks thus formed compress and enhance the magnetic field parallel to the shock front, giving rise to sudden changes in the P.A. and DP.

3.2. CGRaBS J0211+1051: A Probable Low-energy Peaked Blazar

Depending on the position of the synchrotron peak in the spectral energy distribution of the blazars, they are subclassified into blazar sequence, flat spectrum radio quasars (FSRQ), radio-selected BL Lac objects (RBL), and X-ray-selected BL Lac objects (XBL) (Urry & Padovani 1995; Fan et al. 1997; Heidt & Nilsson 2011, and references therein). These subclasses are known to have some very distinct properties. For example, their bolometric luminosity decreases from FSRQ to XBL with XBLs. Multifrequency observations, along with very low baseline interferometry imaging, are needed to study the structure and spectral energy distribution of the source to constrain the models of variability.

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