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Variability Analysis of EGRET Gamma-Ray Sources *

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Abstract The variability of γ-ray sources listed in the third EGRET catalog is studied using three variability indices. These indices are found to be statistically equivalent if the observed data are sufficiently accurate. Using the three indices, 30 EGRET point sources which are positionally coincident with pulsars and 40 persistent unidentified sources at low latitudes are analyzed for their variability status. It is found that 14 of the 30 point sources may have genuine or plausible associations with pulsars, and 16 of the 40 persistent unidentified sources are possible pulsar candidates.

Key words: gamma-rays: observations — galaxies: statistics — stars: variables

1 INTRODUCTION

EGRET is the high-energy gamma-ray telescope on the Compton Gamma Ray Observatory (CGRO), it covers the energy range from 30 MeV to over 20 GeV. Up to now, it has detected 271 high-energy ($E > 100$ MeV) γ-ray sources, including the single 1991 solar flare, the Large Magellanic Cloud, five pulsars, one possible radio galaxy detection (Cen A), 66 high-confidence AGNs, 27 low-confidence AGNs, and 170 unidentified sources (Hartman et al. 1999). At present, three methods are used to study the variability of these sources, using, respectively, the V-index (Mclaughlin et al. 1996), the I-index (Zhang et al. 2000; Torres et al. 2001) and the τ-index (Tompkins 1999; also see Nolan et al. 2003). The questions are, (i) are the three indices statistically consistent assuming the observed data are sufficiently accurate? and (ii) how do we effectively determine the variability of γ-ray sources using current observed γ-ray data?

In this paper, we study the γ-ray variability of EGRET sources, especially the unidentified EGRET sources. These unidentified EGRET sources have been widely examined, including their space distribution, spectral features, variability and possible counterparts. It is generally believed that most of the unidentified sources in the Galactic plane ($|b| < 5°$) correlate with

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Galactic objects such as OB associations, supernova remnants (SNRs), young pulsars and HII regions (e.g., Montmerle 1979; Kaaret & Cottam 1996; Yadigaroglu & Romani 1997; Zhang & Cheng 1998; Romero, Benaglia & Torres 1999; Zhang, Zhang & Cheng 2000). Recently, 30 EGRET point sources were found to be positionally coincident with pulsars within their 95% error boxes, and most of them are within the Galactic plane (Kramer et al. 2003). There are 50 unidentified sources at low latitude, 40 of them are persistent sources, and some display a rather hard spectrum, indicating a pulsar population (Grenier 2000; Grenier & Perrot 2001). In order to answer the above questions, we will study the variability methods in detail, and apply them to analyze the variability of the unidentified EGRET sources. Section 2 briefly introduce the three variability methods. Results obtained with the methods are compared in Sect. 3. Application of the methods to the unidentified EGRET sources is made in Sect. 4. Finally, a brief discussion and conclusions are given in Sect. 5.

2 VARIABILITY INDICES

2.1 The V-Index for Gamma-Ray Variability

Mclaughlin et al. (1996) made the first systematic study on the variability of EGRET sources using individual viewing periods from the Second EGRET catalog (Thompson et al. 1995). In order to quantify the flux variability, they introduced a variability index, Wallace et al. (2000) used this method for a short timescale study. The basic idea of this method is to find the χ^2 of the observed fluxes and to calculate $V = -\log Q$, where Q is the probability of obtaining such a χ^2 if the source is constant (see Mclaughlin et al. 1996 in detail).

It should be pointed out that there is a shortcoming in this method, i.e., a large V-value of a source can be due to large intensity fluctuation, or due to small error bars on the intensity measurements. Similarly, a source with a small V might truly be non-variable, or it might just have very poor measurement of its flux (Nolan et al. 2003). Then pulsars might have very high values of V (for example, the Vela pulsar), and AGNs might have very low values. However, the V method is very reliable for quantifying the variability of sources if the observations are accurate enough.

In our analysis, we take the data directly from the 3EG catalog (Hartman et al. 1999) and consider only single viewing periods. A systematic uncertainty of 10% was added in quadrature with the statistical uncertainty for each flux value. We take $V < 0.5$ to indicate non-variability, $V \geq 1$ to indicate variability, and $0.5 \leq V < 1$ as uncertain.

2.2 The I-Index for Gamma-Ray Variability

Zhang et al. (2000) and Torres et al. (2001) applied the following method to analyze the γ-ray variability of the 3EG sources. They introduced a variability index, I, to qualify the variability. The basic idea is to compare the γ-ray flux variability of any given source with that of pulsars. In this method, a weighted mean value of γ-ray flux for an EGRET source is calculated first

$$\langle F \rangle = \left[\Sigma_{i=1}^{N_{\rm vp}} \frac{F_i}{\sigma_i^2} \right] \cdot \left[\Sigma_{i=1}^{N_{\rm vp}} \frac{1}{\sigma_i^2} \right]^{-1} , \quad (1)$$

where, $N_{\rm vp}$ is the number of single viewing periods of the source, F_i and σ_i are the observed flux and the corresponding error in the $i^{\rm th}$-period. Because some flux observations are only upper bounds, it is necessary to make an assumption for F_i and σ_i. We assumed that both F_i and σ_i are one-half of the given upper bound, if the significance ($\sqrt{TS}$ in the EGRET catalog) is not greater than 2σ. For those observations in which the significance is greater than 2σ, we use the error listed in 3EG catalog and take the 10% systematic error into account (as pointed out by

Table 1 I and V Variability Indices of Gamma-Ray Pulsars in the Third EGRET Catalog

3EG J	Pulsar Name	l (deg)	b (deg)	$N_{\rm vp}$	$\bar{F} \times 10^{-8}$ (ph cm^{-2}s^{-1})	$\sigma_{\rm sd}$	μ	I	V
0534+2200	Crab	184.53	–5.84	16	208.90	29.21	13.98	0.51	0.32
0633+1751	Geminga	195.06	4.31	14	353.55	50.18	14.19	0.51	0.41
0834−4511	Vela	263.52	–2.86	8	759.50	183.65	24.18	0.88	4.81
1058−5234	PSR B1055–52	286.14	6.58	15	35.41	14.60	41.22	1.49	0.26
1710−4439	PSR B1706–44	343.00	–2.86	20	107.98	44.53	41.24	1.49	0.04

Hartman et al. 1999); this differs slightly from that given by Torres et al. (2001) who took the error as $F_i/\sqrt{TS}$. Then, a fluctuation index μ is defined as:

$$\mu = 100\frac{\sigma_{\rm sd}}{\langle F \rangle}, \tag{2}$$

where, $\sigma_{\rm sd}$ is the standard deviation of the flux measurements, which is taken into account in the previous considerations.

We have calculated μ-values of the confirmed γ-ray pulsars in the 3EG catalog and listed the μ-values for five pulsars in Table 1. The average value of these pulsars $\langle\mu\rangle_{\rm pulsar} = 27.6$ with an error $\delta\langle\mu\rangle_{\rm pulsar} = 13.7$. It is believed that γ-ray pulsars are non-variable γ-ray sources, the averaged statistical index of variability, I, is introduced, which is the ratio of μ-value of the γ-ray source to the averaged value of γ-ray pulsars:

$$I = \frac{\mu_{\rm source}}{\langle\mu\rangle_{\rm pulsar}}, \tag{3}$$

and the error of I is

$$\delta I = \frac{\delta\langle\mu\rangle_{\rm pulsar}}{\langle\mu\rangle_{\rm pulsar}} I \sim 0.5\, I. \tag{4}$$

The classification criterion is as follows: non-variable sources are defined as those for which $I < 1 + 1\sigma$; sources with $I > 1$ at a 3σ level are classified as variable ($1\sigma = 0.5$); sources with $I > 1$ at less than 3σ are dubious cases and their variability cannot be concluded within the present observational accuracy. Based on above definition, a source is variable when $I > 2.5$, non-variable when $I < 1.5$ and dubious for the value of $1.5 \leq I \leq 2.5$.

2.3 The τ-Index for Gamma-Ray Variability

Tompkins (1999) (also see Nolan et al. 2003) introduced a new variability criterion, which considers both published EGRET data listed in the 3EG catalog and unpublished information. In order to determine the variability index for a given source, Tompkins used also the 145 marginal sources that were detected but not included in the final official list. The maximum likelihood set of source fluxes was then re-calculated. From these fluxes, a new statistics measuring the variability was defined as $\tau = \sigma/\mu$, where σ is the standard deviation of the fluxes and μ their average value. This method includes some possible fluctuations from the background and from neighboring sources, careful sensitivity corrections throughout EGRET lifetime, and others systematic errors related either with the equipment itself or with the processing of the information, in a similar way to that used in the construction of the 3EG sources (Hartman et al. 1999; Tompkins 1999). The final result of Tompkins' analysis is a table which lists the name of the EGRET source and three values for τ: a mean, a lower, and an upper limit (68% error bars) (Nolan et al. 2003). Torres et al. (2001) analyzed the plausible criteria for τ in detail and found that there is a threshold of 0.5–0.6 for the τ-value. A source is non-variable when the upper limit is less than 0.6 and variable if the lower limit on τ is greater than 0.6. Sources not satisfying either condition should be considered as dubious.

3 RESULTS AND ANALYSIS

We calculate the I-values and V-values for the EGRET sources. The results for five identified pulsars are given in Table 1. A source is classified as variable if $I > 2.5$ or $V \geq 1.0$, non-variable if $I < 1.5$ or $V < 0.5$ and dubious in between. According to these criteria, we find that all the identified pulsars are non-variable according to the I classification. According to the V classification, four pulsars (excluding Vela pulsar) are non-variable. The high V-value of Vela may result from the small errors and large intensity fluctuations in its observations.

We classify AGNs using the I and V variability indices. The results for 67 AGNs are given in Table 2, and those for 27 possible AGNs in Table 3. We can see that more sources are classified as non-variable sources using the V-index than using the I-index. The possible reason may be that sources that have upper limits included in the analysis will have a lower V value than that implied by the data (Tompkins 1999). About 61% of the AGNs, and 52% of the possible AGNs, have the same classifications according to the two indices. Therefore, we can conclude that these two indices are statistically equivalent.

We compare our results with the τ-values given by Tompkins et al. (1999). We classify the AGNs using the three variability indices, and the results are given in Table 4. We can see that about 33% of them have the same classification. Most AGNs are classified as dubious sources according to the τ index.

Table 2 Variability Classification of 67 Confirmed AGNs in the Third EGRET Catalog According to the I and V Indices

Scheme	nonvariable	dubious	variable
I	7	21	39
V	13	16	38
Same class	4	8	29

Table 3 Variability Classification of 27 Possible AGNs in the Third EGRET Catalog According to the I and V Indices

Scheme	nonvariable	dubious	variable
I	8	8	11
V	16	5	6
Same class	7	2	5

Table 4 Classification of 67 Confirmed AGNs in the Third EGRET Catalog According to the Three Variability Indices

Scheme	nonvariable	dubious	variable
I	7	21	39
V	13	16	38
τ	11	40	16
Same class	2	6	14

Table 5 Classification of the 26 EGRET Sources which Have no Upper Limits or only Have One or Two Upper Limits in the Multi Observations According to the Three Variability Indices

Scheme	nonvariable	dubious	variable
I	16	5	5
V	13	2	11
τ	18	6	2
Same class	10	1	2

Obviously, there are some differences using these three indices. What is the main reason for the differences? We guess that accuracy of the observed data is the main reason. In order to account for it, we first single out 26 sources which have no upper limits in its observations or only have one or two upper limits in its multi observations from 3EG catalog, and then classify the 26 sources using the three variability indices. The results are shown in Table 5, we can see that 50% of them get the same classification and 69% of them get essentially consistent classification. Then we only choose the 11 sources which have no upper limits in its observations, we can see that 8 of the 11 (73%) get the same classification. Therefore, we can conclude that the three variability indices are also statistically equivalent if the observations are sufficiently accurate.

4 APPLICATIONS TO UNIDENTIFIED EGRET SOURCES

We now combine the three methods to analyze the γ-ray variability of 30 EGRET sources possibly associated with pulsars and 40 persistent unidentified EGRET sources at low latitude. This joint use of variability indices can provide a better idea of the variability status of any given source (Torres et al. 2001).

4.1 Variability of 30 EGRET Point Sources which are Positionally Coincident with Pulsars

We have calculated the I-values and V-values for the 30 EGRET point sources which are positionally coincident with pulsars within the 95% error boxes given by Kramer et al. (2003), and we take their mean τ-values, lower and upper limits (68% error bars) from the table given by Tompkins et al. (1999). In Table 6 we list the EGRET source name, longitude, latitude, weighted mean flux, I-values, V-values, τ-values, the upper limits and lower limits of τ-values and its identification as listed in the Third EGRET catalogue (Hartman et al. 1999).

Considering the three variability indices (or only I and V if the τ-value of the source is not given in the table), we finally derive a 'quality indicator', Q, for a proposed association. If a source is non-variable on all three indices, we assign a '+' sign in the Q column, to indicate a genuine or very likely association with pulsars. If a source is non-variable or dubious according to the three indices, we write a '+?' in the Q column, to indicate a plausible association with pulsars. If a source is variable according to any one of the three indices, we write a '−' in the Q column, to indicate that the apparent association is almost surely due to a chance alignment.

From Table 6 we find that 14 of the 30 EGRET point sources have genuine or plausible association with pulsars. In Fig. 1, we plot the variability index I and V against the latitude. From Fig. 1 we can see that all possible pulsars are at low latitudes, most of them are within $|b| \leq 5°$. Comparing our results with those of Kramer, we found that 11 of the 14 possible pulsars are consistent with Kramer's results. We list our results and Kramer's results of the 11 sources in Table 7, where '?' indicates that an association cannot be ruled out.

4.2 Variability of 40 Persistent Unidentified Sources at Low Latitude

Grenier (2000) defined a class of 88 persistent unidentified sources. These are detected with a significance $\sqrt{TS} > 4$ at $|b| > 2.5°$ in the cumulative data up to 1995 October. If sources with a significance $\sqrt{TS} > 5$ at $|b| \leq 2.5°$ are assumed to be persistent sources, then there are 40 persistent unidentified EGRET sources at $|b| \leq 5°$, almost all of them have mean fluxes greater than 30×10^{-8}ph cm^{-2} s^{-1}, and some display rather hard spectra, indicating a pulsar population. Zhang et al.(2000) also proposed that most of the Galactic plane unidentified sources spatially coincident with SNRs and OB association could be pulsars. Using the same analysis method as for the 30 point sources which are positionally coincident with pulsars, we checked the variability of 40 persistent unidentified sources. The results are given in Table 8. We find that 16 of the 40 sources are possible pulsar candidates.

Table 6 Associations between 30 EGRET Point Sources which are Positionally Coincident with Pulsars within their 95% Error Boxes and the Pulsars

3EG J	l (deg)	b (deg)	$\bar{F} \times 10^{-8}$ (ph cm^{-2} s^{-1})	$\sigma_{\rm sd}$	μ	I	V	τ	min	max	Q	ID
0222+4253	140.22	–16.89	19.59	4.50	22.98	0.83	0.25	0.00	0.00	0.23	+	A
0500−0159	201.35	–25.47	13.76	17.23	125.19	4.54	1.20	2.20	0.92	19.3	−	A
0533−6916	279.73	–32.09	16.24	14.01	86.25	3.12	1.36				−	G
0534+2200	184.53	–5.84	208.90	29.21	13.98	0.51	0.32	0.07	0.06	0.10	+	P
0834−4511	263.52	–2.86	759.50	183.65	24.18	0.88	4.81	0.17	0.12	0.24	+	P
1013−5915	283.93	–2.34	42.42	19.27	45.43	1.65	0.63	0.22	0.00	0.46	+?	
1014−5705	282.80	–0.51	46.54	18.95	40.72	1.48	0.67				+?	
1048−5840	287.53	0.47	64.80	17.05	26.32	0.95	0.09	0.00	0.00	0.18	+	
1058−5234	286.14	6.58	35.41	14.60	41.22	1.49	0.26	0.00	0.00	0.25	+	P
1102−6103	290.12	–0.92	38.52	19.72	51.18	1.85	0.28	0.00	0.00	0.90	+?	
1308−6112	305.01	1.59	31.39	15.63	49.79	1.80	0.53	0.72	0.38	1.53	+?	
1410−6147	312.18	–0.35	83.14	28.23	33.95	1.23	0.46	0.33	0.16	0.55	+	
1420−6038	313.63	0.37	56.05	34.57	61.68	2.23	1.50	1.22	0.51	7.43	−	
1638−5155	334.05	–3.34	43.13	29.97	69.48	2.52	0.51				−	
1639−4702	337.75	–0.15	75.96	41.35	54.44	1.97	0.56				+?	
1704−4732	340.10	–3.79	27.89	27.45	98.41	3.57	0.48				−	
1710−4439	343.00	–2.86	107.98	44.53	41.24	1.49	0.04	0.16	0.06	0.27	+	P
1714−3857	348.04	–0.09	60.89	34.19	56.14	2.03	0.68	0.15	0.00	0.38	+?	
1736−2908	358.79	1.56	45.36	32.42	71.47	2.59	1.65				−	
1741−2050	6.44	5.00	31.36	19.96	63.66	2.31	0.79				+?	
1746−1001	16.34	9.64	29.12	26.05	89.47	3.24	0.19				−	
1824−1514	16.37	–1.16	50.75	41.35	81.49	2.95	0.64	0.00	0.00	0.51	−	
1826−1302	18.47	–0.44	63.68	49.49	77.72	2.82	2.37	0.75	0.49	1.28	−	
1837−0423	27.44	1.06	30.52	75.42	247.09	8.95	0.90	12.01	2.17	9999	−	
1837−0606	25.86	0.40	53.92	37.42	69.41	2.51	1.45				−	
1850−2652	8.58	–11.75	14.27	17.81	124.79	4.52	0.11				−	
1856+0114	34.60	–0.54	72.96	59.95	82.18	2.98	2.44	0.80	0.50	1.51	−	
1903+0550	39.52	–0.05	72.64	45.40	62.50	2.26	1.01	0.35	0.18	0.60	−	
2021+3716	75.58	0.33	58.01	38.34	66.09	2.39	1.39	0.29	0.11	0.53	−	
2227+6122	106.53	3.18	43.20	42.36	98.07	3.55	0.66	0.10	0.00	0.41	−	

Table 7 The EGRET Point Sources which are Consistent with Kramer's Results

3EG J	l (deg)	b (deg)	$\bar{F} \times 10^{-8}$ (ph cm^{-2} s^{-1})	I	V	τ	min	max	Q	Q (Kramer)	ID
0222+4253	140.22	–16.89	19.59	0.83	0.25	0.00	0.00	0.23	+	+	A
0534+2200	184.53	–5.84	208.90	0.51	0.32	0.07	0.06	0.10	+	+	P
0834−4511	263.52	–2.86	759.50	0.88	4.81	0.17	0.12	0.24	+	+	P
1013−5915	283.93	–2.34	42.42	1.65	0.63	0.22	0.00	0.46	+?	+?	
1014−5705	282.80	–0.51	46.54	1.48	0.67				+?	+?	
1048−5840	287.53	0.47	64.80	0.95	0.09	0.00	0.00	0.18	+	+	
1058−5234	286.14	6.58	35.41	1.49	0.26	0.0	0.0	0.25	+	+	P
1102−6103	290.12	–0.92	38.52	1.85	0.28	0.00	0.00	0.90	+?	+	
1410−6147	312.18	–0.35	83.14	1.23	0.46	0.33	0.16	0.55	+	?	
1639−4702	337.75	–0.15	75.96	1.97	0.56				+?	?	
1710−4439	343.00	–2.86	107.98	1.49	0.04	0.16	0.06	0.27	+	+	P

Table 8 Variability Analysis of 40 Persistent Unidentified Sources at Low Latitude

3EG J	l (deg)	b (deg)	$\bar{F}\times 10^{-8}$ (ph cm^{-2}s^{-1})	$\sigma_{\rm sd}$	μ	I	V	τ	min	max	Q
0229+6151	134.20	1.15	41.31	14.69	35.55	1.29	0.45	0.39	0.16	0.74	+?
0241+6103	135.87	0.99	64.04	24.62	38.45	1.39	1.81				–
0617+2238	189.00	3.05	53.66	25.72	47.93	1.74	2.10	0.26	0.15	0.38	–
0628+1847	193.66	3.64	29.84	12.02	40.28	1.46	1.09				–
1013–5915	283.93	–2.34	42.42	19.27	45.43	1.65	0.63	0.22	0.00	0.46	+?
1014–5705	282.80	–0.51	46.54	18.95	40.72	1.48	0.67				+?
1027–5817	284.94	–0.52	68.30	28.11	41.15	1.49	0.62	0.26	0.09	0.45	+?
1048–5840	287.53	0.47	64.80	17.05	26.32	0.95	0.09	0.00	0.00	0.18	+
1102–6103	290.12	–0.92	38.52	19.72	51.18	1.85	0.28	0.00	0.00	0.90	+?
1410–6147	312.18	–0.35	83.14	28.23	33.95	1.23	0.46	0.33	0.16	0.55	+
1420–6038	313.63	0.37	56.05	34.57	61.68	2.23	1.50	1.22	0.51	7.43	–
1638–5155	334.05	–3.34	43.13	29.97	69.48	2.52	0.51				–
1639–4702	337.75	–0.15	75.96	41.35	54.44	1.97	0.56				+?
1655–4554	340.48	–1.61	60.35	20.15	33.40	1.21	0.45	0.91	0.46	2.27	+?
1714–3857	348.04	–0.09	60.89	34.19	56.14	2.03	0.68	0.15	0.00	0.38	+?
1734–3232	355.64	0.15	49.17	35.37	71.93	2.61	0.23	0.00	0.00	0.24	–
1736–2908	358.79	1.56	45.36	32.42	71.47	2.59	1.65				–
1741–2050	6.44	5.00	31.36	19.96	63.66	2.31	0.79				+?
1741–2312	4.42	3.76	32.55	19.84	60.95	2.21	0.31				+?
1744–3011	358.85	–0.52	78.78	42.28	53.66	1.94	2.24	0.38	0.20	0.62	–
1746–2851	0.11	–0.04	117.11	65.85	56.23	2.04	3.60	0.50	0.36	0.69	–
1800–2338	6.25	–0.18	71.50	31.75	44.41	1.61	0.55	0.03	0.00	0.32	+?
1809–2328	7.47	–1.99	53.69	38.06	70.89	2.57	2.82	0.69	0.49	1.02	–
1810–1032	18.81	4.23	31.03	22.27	71.78	2.60	0.14				–
1812–1316	16.70	2.39	40.87	31.14	76.19	2.76	1.74				–
1823–1314	17.94	0.14	57.40	48.90	85.18	3.09	1.84	0.72	0.40	1.37	–
1824–1514	16.37	–1.16	50.75	41.35	81.49	2.95	0.64	0.00	0.00	0.51	–
1826–1302	18.47	–0.44	63.68	49.49	77.72	2.82	2.37	0.75	0.49	1.28	–
1837–0606	25.86	0.40	53.92	37.42	69.41	2.51	1.45				–
1856+0114	34.60	–0.54	72.96	59.95	82.18	2.98	2.44	0.80	0.50	1.51	–
1903+0550	39.52	–0.05	72.64	45.40	62.50	2.26	1.01	0.35	0.18	0.60	–
1958+2909	66.23	–0.16	33.46	16.21	48.46	1.76	1.53				–
2016+3657	74.76	0.98	40.01	23.65	59.11	2.14	1.27	0.37	0.08	0.75	–
2020+4017	78.05	2.08	115.67	36.32	31.40	1.14	0.46	0.07	0.00	0.18	+
2021+3716	75.58	0.33	58.01	38.34	66.09	2.39	1.39	0.29	0.11	0.53	–
2022+4317	80.63	3.62	28.78	16.31	56.67	2.05	0.22	0.13	0.00	0.50	+?
2027+3429	74.08	–2.36	24.39	23.80	97.57	3.54	1.27	0.00	0.00	0.28	–
2033+4118	80.27	0.73	74.19	28.04	37.79	1.37	0.71	0.20	0.00	0.37	+?
2035+4441	83.17	2.50	39.18	34.38	87.75	3.18	0.92				–
2227+6122	106.53	3.18	43.20	42.36	98.07	3.55	0.66	0.10	0.00	0.41	–

5 DISCUSSION AND CONCLUSIONS

We have applied two variability indices, I and V, to determine the variability status of EGRET gamma-ray sources. We have calculated the I-values and V-values for five confirmed γ-ray pulsars, 66 confirmed AGNs and 27 possible AGNs. We find that these two indices, despite the different ways they were calculated, are statistically equivalent. Further, we compare these

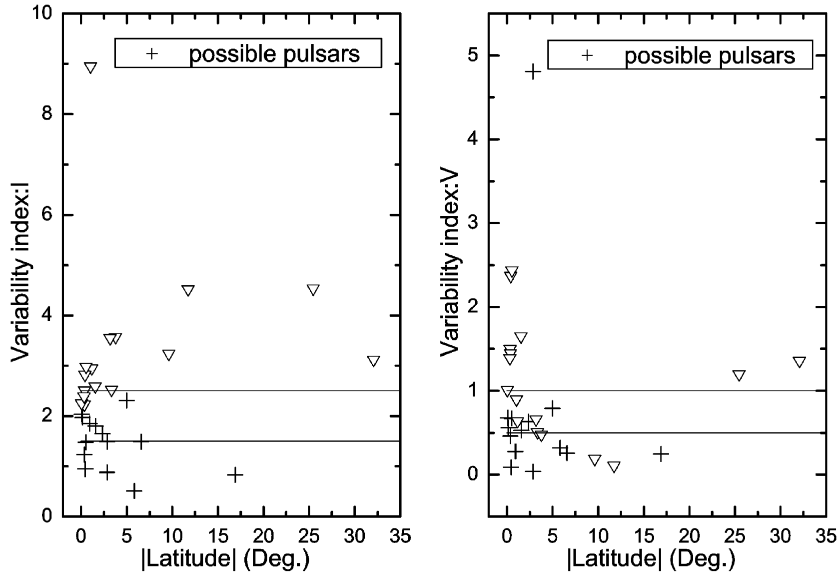

Fig. 1 Variability index vs. latitude for 30 3EG point sources that are positionally coincident with pulsars within their 95% error boxes.

results with those by using the τ index and find all three indices are statistically equivalent if the observations are sufficiently accurate.

At present, a better way is the joint use of variability indices, because the status of a particular source can change from one scheme to the other. Combining the three indices, we studied the variability of 30 EGRET point sources which are positionally coincident with pulsars within their 95% error boxes. We found that 14 of the 30 point sources have genuine or plausible association with pulsars, and most of them are within $|b| \leq 5°$. We have also studied the variability status of 40 persistent unidentified sources at low latitudes, and found that 16 of the 40 persistent unidentified sources are possible pulsar candidates, most of them have mean fluxes greater than 30×10^{-8} ph cm^{-2} s^{-1}.

It should be pointed out that we only considered space distribution, variability indices and weighted mean flux of the EGRET point sources in this paper. We believe that the combination of the variability analysis with the further study of their $\log N$-$\log S$ distribution, spectral features and possible counterparts will present a better clue for the identification of the unidentified EGRET sources.

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