A revised catalogue of EGRET $\gamma$-ray sources

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ABSTRACT

Aims. We present a catalog of point $\gamma$-ray sources detected by the EGRET detector aboard the Compton Gamma Ray Observatory. We have used the whole $\gamma$-ray dataset of reprocessed photons at energies above 100 MeV together with new Galactic interstellar emission models based on recent CO, HI, dark gas, and interstellar radiation field data. Two different assumptions have been used for the cosmic-ray distribution in the Galaxy to explore the resulting systematic uncertainties in source detection and characterization.

Methods. We have used the same 2-dimensional maximum-likelihood detection method as for the 3rd EGRET catalogue.

Results. The revised catalogue lists 188 sources, 14 of which are marked as confused, compared to the 271 entries of the 3rd EGRET (3EG) catalogue. 107 former sources have not been confirmed because of the additional structure in the interstellar background. The vast majority of them were unidentified and marked as possibly extended or confused in the 3EG catalogue. In particular, we do not confirm most of the 3EG sources associated with the local clouds of the Gould Belt. Alternatively, we find 30 new sources with no 3EG counterpart. The new error circles for the confirmed 3EG sources largely overlap the previous ones, but several counterparts of particular interest that had been discussed in the literature, such as Sgr A*, radiogalaxies and several microquasars are now found outside the error circles. We have cross-correlated the source positions with a large number of radio pulsars, pulsar wind nebulae, supernova remnants, OB associations, blazars and flat radio sources and we find a surprising large number of sources (87) at all latitudes with no counterpart among the potential $\gamma$-ray emitters.

Key words. Egret, gamma-ray source, catalog

1. Introduction

The Energetic Gamma-Ray Experiment Telescope (EGRET), which operated on board the Compton-Gamma Ray Observatory from April 1991 to May 2000, detected photons in the 20 MeV to 30 GeV range. The observation program made use of the large instrumental field of view (25° in radius) to cover the whole sky and for in-depth studies of specific regions. The resulting exposure and flux sensitivity to point sources are therefore not uniform across the sky. The sensitivity threshold also varies because of the intense background emission that arises from cosmic-ray interactions with the interstellar gas and photon fields in the Milky Way. The minimum flux that EGRET could detect steeply rises with decreasing Galactic latitude. In order to detect point sources and assess their significance in these varying conditions, a 2-dimensional maximum-likelihood method using binned maps had been developed for the COS-B data (Pollock et al., 1981) and implemented for the EGRET one (Mattox et al., 1996). A first catalog using this method was published after 1.5 years of data (Fichtel et al., 1994), followed by the second one (Thompson et al., 1995) and its supplement (Thompson et al., 1996) after 3 years of data. Lamb & Macomb (1997) presented a catalog of sources detected above 1 GeV. The last EGRET catalog (hereafter 3EG, Hartman et al., 1999) comprised reprocessed data from April 1991 to October 1995 with the interstellar emission model from Hunter (1997) and extragalactic background from Sreekumar et al. (1998). This version contained 271 point sources including a solar flare, the Large Magellanic Cloud, five pulsars, one radiogalaxy detection (Cen A), 66 high-confidence identifications of blazars (BL Lac objects and flat-spectrum radio quasars), and 27 lower-confidence blazar identifications. Because of the wide tails of the instrument point-spread function, seven potential artifacts were noted around the brightest sources and many sources were marked as confused or possibly extended.

The 3EG catalogue also contained 170 sources with no attractive counterpart at lower energy. About 130 of them remain unidentified as of today (see Grenier (2004) and references therein). Candidate counterparts that have been searched for include pulsars and their wind nebulae, supernova remnants, massive stars, X-ray binaries and microquasars, blazars and nearby radiogalaxies, luminous infrared and starburst galaxies, and galaxy clusters. It was also noticed (Grenier, 1995, Grenier, 2000, Gehrels et al., 2000) that the most stable unidentified sources are significantly correlated with the nearby Gould Belt, a system of massive stars and interstellar clouds that surrounds the Sun at a distance of hundreds of parsecs. The offset position of the Sun with respect to the Belt centre and the Belt inclination of 17° to the Galactic plane indeed provides a useful spatial signature across the sky (Perrot & Grenier, 2003).

EGRET went on observing for another 4.5 years after the 4 cycles used for the 3EG work. Its sensitivity was reduced because of the ageing gas in the spark chamber, but it gathered nearly ten percent more photons and saw several new variable sources. Several authors (Nolan et al., 2003, Sowards-Emmerd et al., 2005), however, noticed discrepancies between their studies and at least five 3EG sources. They failed to confirm sources and found others. The whole $\gamma$-ray dataset and final instrument response functions have

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also been significantly reprocessed by the EGRET team in 2001. Furthermore, the spatial coverage of the CO surveys has reached higher latitudes since 1999, finding new small CO clouds (Dame et al., 2001). In parallel, new HI surveys (Kalberla et al., 2005) have been completed to correct for the significant contamination of stray radiation in the older ones. Finally, an additional ‘dark’ gas component has been found in the Gould Belt clouds that significantly increases their mass and spatial extent (Grenier et al., 2005). The additional mass is structured into large envelopes around the dense CO cores. They do not follow the HI and CO maps commonly used to trace atomic and molecular column-densities. So, the dark gas provides both γ-ray intensity and structure that were not accounted for in the 3EG background model.

For all these reasons and in preparation of the new GLAST mission, it was necessary to revise the interstellar background model and to apply the EGRET detection method to the full nine years of data to build a new catalogue of sources above 100 MeV. In order to study the systematic uncertainties induced on source locations and fluxes by our limited knowledge of the intense interstellar background, we have applied the analysis to two different background models exploiting the same new interstellar data, but using different approaches to constrain the cosmic-ray gradient across the Galaxy.

2. The Galactic interstellar emission models

The high-energy Galactic emission is produced by the interaction of energetic cosmic-ray electrons and protons with interstellar nucleons and photons. The decay of neutral pions produced in hadron collisions accounts for most of the emission above 300 MeV. Inverse Compton (IC) scattering of the interstellar radiation field by electrons and their Bremsstrahlung emission in the interstellar gas are the other main contributors to the Galactic emission. The observed intensity therefore scales with the integral along the line of sight of the cosmic-ray density times the gas or soft-photon one.

The diffuse model used for the 3EG catalogue (Hunter et al., 1997) was based on a 3D-distribution of matter, cosmic-ray and soft-photon densities in the Galaxy, where the cosmic-ray density was assumed to be coupled to the gas one over a given length scale. This length as well as the CO-to-H2 conversion factor (X ratio) were adjusted to the data. The 3D gas map was obtained from the HI and CO line surveys and from kinematical distances derived for circular rotation. Distance ambiguities in the inner Galaxy were solved by splitting the gas into the far and near sides according to its expected scale height. Gas with velocities in excess of the tangent values was attributed to the tangent point and gas emission within 10° of the Galactic center and anticenter was interpolated from the regions just outside these boundaries and normalized to match the total emission seen along the line of sight. The resulting map is, however, still strongly biased to our side of the Galaxy, particularly for the atomic gas. This bias is reflected in the cosmic-ray density via the coupling length.

For the present analyses, we have assumed an axisymmetric Galaxy for the cosmic-ray density and we have used gas column-density distributions in Galacticcentric rings that are less subject to biases due to the strategy adopted to solve the cloud distance in the inner Galaxy. The radial velocity information in the HI and CO line surveys, together with the rotation curve of Clemens (1985) and the solar motion (v = 220 km/s at R = 8.5 kpc), have been used to partition the gas into 6 rings bounded by 3.5, 7.5, 9.5, 11.5, and 13.5 kpc in Galactocentric distance (Digel et al., in preparation). Gas within 10° of the Galactic center and anticenter was interpolated as before. The all-sky Leiden-Argentina-Bonn (LAB) composite survey (Kalberla et al., 2005) was used for the HI data. Column densities, N(HI), were derived under the assumption of a constant spin temperature of 125 K. The velocity-integrated CO brightness temperature, W(CO), comes from the Center for Astrophysics compilation of observations at |b| ≤ 3° (Dame et al., 2001). The regions outside the survey boundaries should be free of bright CO emission.

We have used two different approaches to account for the cosmic-ray density gradient. One is based on the Galprop model for cosmic-ray propagation developed by Strong et al. (2007, 2004a, 2004b), using run number 49-6002029RB to derive the γ-ray maps from pion decay, Lπ, bremsstrahlung radiation, Ibrems, and inverse Compton radiation, IIC. This version includes secondary electrons and positrons, an optimized cosmic-ray spectrum to fit the GeV excess in the EGRET data, a cosmic-ray source distribution matching the radial profile of pulsars and supernova remnants, a radial gradient in the X factor, and the new HI and CO gas rings.

The second model, hereby referred to as the Ring model, is based on the simpler, but realistic hypothesis that, if energetic cosmic rays uniformly penetrate all gas phases, the γ-ray intensity in each direction can be modelled as a linear combination of gas column-densities in the different rings, plus the IC intensity map (as predicted by Galprop), and an isotropic intensity (Iiso) that accounts for very local IC emission and extragalactic emission. This assumption has been used to derive gas emissivities in several rings from the COS-B and EGRET data (Strong et al., 1988) [Strong & Mattox, 1996]. We have reproduced these analyses to derive gas emissivities for the new HI and CO rings using 9 years of EGRET data in three energy bands (> 100 MeV, 0.3 – 1 GeV, > 1 GeV). Both the Ring and Galprop models used the revised distribution of the interstellar radiation field (Porter et al., 2005) [Moskalenko et al., 2006] to calculate the IC intensity map. The Galprop IC map is common to both diffuse models.

As indicated in the introduction, we have also included in the local ring the large column-densities of "dark" gas associated with cold and anomalous dust at the transition between the atomic and molecular phases (Grenier et al., 2005). This transitional phase is not traced in the radio. When removing from total dust column-density maps the part that linearly correlates with N(HI) and W(CO), one is left with large envelopes of excess dust around all the nearby CO clouds. The fact that the excess dust spatially correlates with significant diffuse gamma radiation indicates that cosmic rays pervade gas not accounted for in HI or CO. The gas-to-dust ratio in this phase, as inferred from the excess dust and correlated γ-ray data, is normal. This phase appears to form an extended layer at the transition between the dense CO cores and the densest parts of the outer HI envelope of a cloud complex. It is best seen in total dust maps such as the reddening E(B-V) map (Schlegel et al., 1998), or low-frequency thermal emission at 93 GHz for WMAP (Finkbeiner et al., 1999), or anomalous emission near 20 GHz (Lagache, 2003). We constructed a "dark" gas column-density template, NH,dark, by removing from the E(B-V) map the part linearly correlated with N(HI) and W(CO). This template was turned into gas column-densities by fitting it together with the N(HI) and W(CO) rings, as well as IC and isotropic components, to the all-sky γ-ray maps. Because of its column-densities, clumpiness, and large spread across the sky (see Figure 4 in Grenier et al. (2005)), the "dark" gas component
Jean-Marc Casandjian and Isabelle A. Grenier: A revised catalogue of EGRET γ-ray sources

Fig. 1. The top figure is the longitude profile of all photon counts observed by EGRET above 100 MeV at all latitudes (black error bars), compared with the diffuse counts predicted by the 3EG model (blue curve) and the Ring model (red curve). The bottom figure is the residual expressed in number of standard deviation, colors are the same as above, we added the Galprop residuals in purple. Counts from bright sources have been added to the diffuse component. For more visibility the plot are presented with a binning of 4°.

may strongly affect source detectability. This template was also added to the Galprop 49-6002029RB background model.

To summarize, two diffuse backgrounds were constructed by fitting different components to the EGRET photon maps, in 0.5° × 0.5° bins, in the three energy bands that will be used for source detection (> 100 MeV, 0.3 – 1 GeV, > 1 GeV).

1. With the Ring model, the predicted count rates are calculated as:

\[ N_{\text{pred}}(l, b) = \left[ \sum_{i=\text{rings}} q_{HI}l_{HI}(r_i, l, b) + \sum_{i=\text{CO}} q_{CO}l_{CO}(r_i, l, b) + q_{\text{dark}NH_{\text{dark}}}(l, b) + q_{\text{IC}l_{\text{IC}}}(l, b) + l_{\text{iso}} \right] \times \epsilon(l, b) + \sum_{j=\text{sources}} \epsilon(l_j, b_j) f_j PSF(l_j, b_j) \]

2. and the Galprop model as:

\[ N_{\text{pred}}(l, b) = \left[ q_{\nu}l_{\nu}(l, b) + q_{\text{brem}l_{\text{brem}}}(l, b) + q_{\text{dark}NH_{\text{dark}}}(l, b) + q_{\text{IC}l_{\text{IC}}}(l, b) + l_{\text{iso}} \right] \times \epsilon(l, b) + \sum_{j=\text{sources}} \epsilon(l_j, b_j) f_j PSF(l_j, b_j) \]

In both models, \( \epsilon(l, b) \) and \( f_j \) note the EGRET exposure map and source fluxes. The diffuse maps times the exposure were convolved with the EGRET PSF for an input \( E^{-2.7} \) spectrum before adding the source maps. The EGRET count and exposure maps, the 3EG diffuse model, as well as the latest instrument response functions, were downloaded from the CGRO Science Support Center. They differ from those used for 3EG since they were reprocessed in 2001. The \( q \) parameters (gas emissivities or relative contributions of different radiation components) were fitted to the data by means of a maximum likelihood with Poisson statistics. To avoid biasing the interstellar parameters, the model included the brightest sources detected during a first source detection iteration with a significance > 5σ, with fixed fluxes. Changing these fluxes within their statistical uncertainties do not significantly change the diffuse results.

The resulting emissivities corresponding to the local gas are fully consistent with Grenier et al. (2005) Table 1. The emissivity gradient in the Galactic plane will be described in a separate paper. The quality of the fit can be seen in Figure 1. The top figure displays the longitude profile of all the EGRET photon counts above 100 MeV. The error bars are only statistical. The plot compares the best fit that can be obtained using the former 3EG diffuse model with the longitude profile resulting from the present Ring model. The bottom plot shows the longitude profile of the residuals and the improvement of the ring model over the 3EG one. It also shows the residuals for the best fit Galprop model. All modelled profiles include the brightest sources. Systematic differences can be seen in various places where the 3EG model significantly over-predicts and under-predicts the data while the new models behave better. Because of its larger flexibility (the gas emissivity gradient due to cosmic-ray variations is measured, not inferred from propagation properties or gas coupling), the Ring model was found to best fit the data. It is worth noting than even if the agreement is excellent, there still exists small devia-
tions that can significantly impact source detection and characterization.

The residual count map obtained above 100 MeV with the Ring model is presented in Figure 2. It displays the statistical difference \((N_{\text{obs}} - N_{\text{pred}})/\sqrt{N_{\text{pred}}}\) between the observed counts and those predicted from the diffuse background and bright sources using equation (1). The model globally fits very well the data. The extended blue fan-like structures with negative residuals are correlated with the edge of several observing periods. They probably result from a wrong exposure estimate at large angle from the instrument axis. They are visible independently of the choice of diffuse model (Ring, Galprop, or 3EG). Their spatial extent is large enough compared to the PSF size not to severely affect source detection, yet source fluxes in these directions are underestimated. Uncertain knowledge of the off-axis instrument exposure is also reflected in the small model deficit (orange edge) bordering the fan-like excesses. We have checked for suspicious strings of faint sources that would correlate with these instrumental features.

The use of two different background models allowed us to study their impact on source detection and characterization. Given its higher likelihood value and locally flatter residuals, the Ring model was used to derive the default source flux and location. The values obtained with the Galprop background are used to illustrate the amplitude of the systematic uncertainty due to the background modelling. When searching for sources we used the diffuse emission parameters calculated from this global fit. We adjusted a source flux together with a free normalization of the total diffuse flux within 15° around each pixel, and a free isotropic flux. This procedure is the same as used for 3EG (Gmult and Gbias). These two parameters correct for small local mismatches between the diffuse model and the data. Gmult fluctuates around 1.

3. Source detection

As for the derivation of the 3EG catalogue, we have used the LIKEx code (Mattox, 1996, version 5.61) to compute the 2-dimensional binned Poisson likelihood of detecting a source at a particular location on top of the diffuse background. LIKEx calculates the Test Statistic \((TS)\) value that compares the likelihood of detecting a PSF-like excess above the background to the null hypothesis - a random background fluctuation - for a given position. The likelihood \((L)\) is calculated as the product, for all pixels within 15° of a specific position, of the Poisson probabilities of observing photons in a pixel where the number of counts is predicted by the model (background + source). The likelihood ratio test statistic is defined as \(TS = -2(LnL_0 - LnL)\), where the likelihood values \(L_1\) and \(L_0\) are respectively optimized with and without a source in the model. Asymptotically, the \(TS\) distribution follows a \(\chi^2\) one. The detection significance of a source at the given position is \(\sqrt{TS}\sigma\) (Mattox 1996).

Sources have been searched for in the summed maps corresponding to cycle 1, 2, 3, 4, 1+2, 3+4, 1+2+3+4, 5+6, 7+8+9, 1+2+3+4+5+6+7+8+9. In addition, we have analyzed the 46 individual periods listed in Table I for which flaring 3EG sources had been detected. As for the summed maps, the individual period maps retained only photons with inclinations within 30° from the instrument axis, or 19° for cycle 6, 7, 8, and 9. Photons and exposure maps were binned to 0.5° × 0.5°.

To build the 3EG catalogue, sources were detected only in the integrated \(E > 100\) MeV band. \(TS\) maps were then constructed in three energy bands (\(> 100\) MeV, 0.3–1 GeV, and > 1 GeV) from the observation (single or summed) with highest \(TS\) and a source final position was obtained from the smallest error contours. Given the modern computer performance, we have directly searched for sources independently in the three energy bands.

At 100 MeV, the EGRET PSF is wide and there exists discrepancies between its real shape, as observed in bright sources, and the modelled one. In practice, differences may also come from a more complex source spectrum than the single power-law assumed to integrate the PSF. A choice of 300 MeV instead of 100 MeV for the lower analysis threshold might have been a better trade-off between count rates for detection and systematic uncertainties in the PSF. We have, however, kept a lower limit of 100 MeV as in 3EG in order to account for soft sources and to allow comparison with the 3EG results. We have assumed a spectral index of 2.0 for all sources but for 11 bright ones which had a 3EG spectral index far from 2.0. For the latter, we have used their 3EG index to integrate the PSF.

Each of the 10 all-sky summed maps was divided, both in Galactic and equatorial coordinates, in 45 zones with a large overlap. The use of both coordinates systems is required since source images are deformed in rectangular projection at high latitude or declination. For each zone, each individual period, and each of the 3 energy bands (\(> 100\) MeV, 0.3–1 GeV, and > 1 GeV), we calculated a \(TS\) map for excesses above the background. Sources were iteratively detected from high \(TS\) to low \(TS\) in successive \(TS\) maps. Between each steps, the detected sources were included in the background model until no excess with \(\sqrt{TS} > 3\) was left in the final \(TS\) map. An example of the iteration around Geminga is given in Figure 3. Peaks in the \(TS\) map were automatically detected with SExtractor (Bertin & Arnouts, 1996) and converted into source position by taking the \(TS\)-weighted centroid in the region enclosed by the 95% confidence contour around this position. Source positions were recalculated at each iteration to take into account the influence of the neighbouring sources. More than 1100 \(TS\)-maps were thus calculated at the CCIN2P3 Computing Center.
Table 1. List of individual or short periods used in the analysis in addition to the summed cycles.

| Name  | Sum of viewing periods | Name  | Sum of viewing periods | Name  | Sum of viewing periods |
|-------|------------------------|-------|------------------------|-------|------------------------|
| 2+    | 0002+0003+0004+0005    | 2040  | 2040+2050+2060         | 3315  |                        |
| 0020  | virg2                  | 2110  |                        | 330+  | 3300+3320              |
| 0040  |                        | 2230  |                        | 335+  | 3350+3355              |
| 0050  |                        | 2260  |                        |       |                        |
| 0200  |                        | 227+  | 2270+2280              | 3360  |                        |
| 0210  |                        | 229+  | 2290+2295              | 3385  |                        |
| 0220  |                        | 2310  |                        | 3390  |                        |
| 0230  |                        | 3023  |                        | 4040  |                        |
| 0250  |                        | 314+  | 3140+3150              | 4100  |                        |
| 0260  |                        | 3170  |                        | 4130  |                        |
| 0290  |                        | 319+  | 3190+3195              | 4180  |                        |
| 36+   | 0360+0365              | 319+  | 3190+3195              | 419+  | 4191+4195              |
| 0420  |                        | 3200  |                        | 4210  |                        |
| 0430  |                        | 328+  | 3280+3310+3315+3330    | 4230  |                        |
| 0440  |                        | 3290  |                        | 4235  |                        |

Fig. 3. An example of the iterative source detection with the 2D binned likelihood around Geminga at energies above 100 MeV. 4 consecutive TS maps are shown. Sources are detected, then are included in the background for the next step until no significant one is left. The colourbar gives TS.

4. Catalogue construction

To account for real versus modelled PSF discrepancies in extremely bright sources, for instance to account for the splitting in two of the bright pulsar sources or for the artifacts in the Vela tails, we have removed all the source candidates within 3.5° of the intense sources (that exhibit more than 800 photons in a map). For less intense sources, we have checked the probability of having a double versus single source with a specific likelihood calculation, using the likelihood ratio between the 2 cases to keep or reject the double source.

At the end of this stage, most sources have two possible positions per energy band and observation, one from the Galactic coordinate map and one from the equatorial one. We cross-compared the two and selected the position from the least deformed projection. Sources detected only once were not included in the list unless their latitude or declination were higher than 40° or their longitude or right-ascension were less than 5° from the map edges.

At this stage, most sources have three possible positions (with energy) for a given observation. We chose among the three the position corresponding to the smallest 95% confidence contour, unless its peak $\sqrt{TS}$ were 1.5 smaller than found in another energy band. The latter condition reduces the risk of incorrect source assignment during the cross-comparison phase. Sources found at low energy, but not at high energy were included in the list, as well as sources found only at high energy.

We have used the same criteria to cross-compare the source positions for individual periods and summed cycles in order to obtain a final list of candidate sources with the best position from the different energy bands and periods/cycles. We followed the whole procedure with both the Ring and Galprop interstellar backgrounds. We obtained respectively 1192 and 1225 candidate sources with the Ring and Galprop models. Source fluxes and $\sqrt{TS}$ values above 100 MeV were calculated for these sets of positions for the different periods and cycles. Unlike in 3EG, we did not adjust the position of the identified sources (AGN or pulsars) to that of their radio counterpart.

We adopted the same detection threshold as for the 3EG catalogue ($\sqrt{TS} > 5$ at $|b| < 10°$ and $\sqrt{TS} > 4$ elsewhere) and found 188 and 208 significant sources for the Ring and Galprop models, respectively. We manually checked the TS maps of all the sources that barely passed the detection threshold with the Ring model and had $\sqrt{TS} \sim 3$ with the Galprop one.

We emphasize the fact that the order and criteria applied to cross-correlate positions between the excesses detected in different energy bands and time periods can strongly affect the catalog list near the detection threshold. Several strategies were tested before adopting the present one, but one must remember that a faint source can pass or drop below the threshold by slightly changing its position or that of its neighbours. Given the steep increase in source numbers with decreasing TS, we also emphasize that a small change in the TS threshold, alternatively in the...
background over which the source $TS$ is calculated, results in a large change in the number of catalogue entries. For instance, lowering the $\sqrt{TS}$ threshold by 0.1 would add 27 sources.

5. Catalogue description

The EGR acronym has been adopted for the EGret Revised source list presented in Table 2 and Table A.1 in a format similar to the 3EG one. As explained above, the source characteristics (position and flux, and their uncertainties) have been determined with the Ring model because of its higher flexibility, better fit, and flatter residual map. A secondary position and flux has been measured with the Galprop model and is listed in Table 2 and Table A.1 to illustrate the amplitude of the systematic uncertainties due to the choice of interstellar model.

Sources found within a radius of 1.5 PSF FWHM from a very bright source, and/or with very asymmetric $TS$ map contours are not included in Table 2 and Table A.1. Still, they represent significant excesses of photons above the background which may be due to extended sources, or structures not properly modelled in the interstellar emission, or artifacts due to incorrect PSF tails. This list of 14 confused sources is given in Table B.1 under the acronym EGRc for EGret Revised confused.

For both tables, the description for each column follows:

1. Num: source number in order of increasing right ascension.
2. Name: source name based on J2000 coordinates.
3. RA and Dec: J2000 equatorial coordinates in degrees.
4. $l$ and $b$: Galactic coordinates in degrees.
5. $\theta_{sys}$: angular radius, in degrees, of a circular cone which contains the same solid angle as the 95% confidence contour.
6. F: flux in $10^{-8}$ photon cm$^{-2}$ s$^{-1}$ for $E > 100$ MeV and for each time period.
7. $\sigma_F$: 1σ statistical flux uncertainty in $10^{-8}$ photon cm$^{-2}$ s$^{-1}$.
8. Cnts: number of photons detected with $E > 100$ MeV.
9. $\sqrt{TS}$: statistical significance of the detection.
10. vp: short viewing period as defined in Table 1 or summed cycles noted $p_x$ for cycle $x$, $p_{ijkl}$ for the sum of cycles $i$, $j$, $k$, and $l$, and $p_{19}$ for the total of 9 cycles.
11. $l_{sys}$ and $b_{sys}$: Galactic longitude and latitude obtained with the Galprop background model.
12. $F_{sys}$: flux obtained with the Galprop background model, in $10^{-8}$ photon cm$^{-2}$ s$^{-1}$.
13. 3EG: third EGRET catalog counterpart source name if one exists within a radius of 1 PSF FWHM ($2^\circ$ for $E > 100$ MeV) from the EGR source and if the nearest neighbour relation between the EGR and 3EG sources is univocal (the nearest neighbour of the EGR source is the 3EG one and vice versa).

6. Comparison with the 3EG catalogue

The revised catalogue contains 174 sources plus 14 confused sources compared to the 265 entries of the 3EG catalogue (excluding the Vela artifacts). Their spatial distribution across the sky looks different from that of the 3EG sources, as illustrated in Figures 4 and 5. The accumulation of faint 3EG sources within $30^\circ$ of the Galactic center is much more reduced in the new results and fewer sources are seen below $30^\circ$ in general. These changes at low and mid latitudes are primarily due to the increase in background intensity from new $H_I$, $CO$, and dark gas structures. At high latitude, the use of more $\gamma$-ray observations and of a revised large-scale IC component in the background may also explain why a handful of 3EG sources have fallen below the detection threshold whereas new ones are now detected.

The names of the 107 unconfirmed 3EG sources are listed in Table 4 and they are displayed in Figure 6. They comprise only six sources that had been firmly identified as AGN by Hartman et al. (1999), but that had been flagged as extended or confused by the EGRET team. In fact, the proportion of these extended or confused cases among the unconfirmed 3EG sources is overwhelming (95%) and significantly larger than among the confirmed ones. The unconfirmed and confirmed 3EG groups respectively show 69% and 33% of possibly extended ‘em’ sources. Figure 6 also shows that the vast majority of unconfirmed 3EG sources were unidentified and spatially correlated with the Gould Belt system of nearby clouds. They follow the characteristic trace of the inclined Belt across the sky, gathering at $|b| < 30^\circ$, more at positive latitudes toward the Galactic centre.
present analyses should not cast doubts on the detection method anymore.

EGR sources with no 3EG counterpart. The confused sources are detected except for 3EG J0556.

in HI and CO severely limits our knowledge of the true column-densities. Other sources may also be due to increased cosmic-ray densities in specific clouds with respect to the local Galactic average. Over-irradiated clouds near cosmic-ray sources would be

Table 2. The EGR catalogue. The three first sources are shown. The full catalogue is available with the on-line version

| Num | Name                  | RA   | Dec  | l     | b     | F   | σ_F | Cnts   | VT S | vp   | l_ν0 | b_ν0 | F_ν0 | EGR          |
|-----|-----------------------|------|------|-------|-------|-----|-----|--------|------|------|------|------|------|--------------|
| 1   | EGR J0008+7308        | 2.01 | 73.14| 119.75| 10.54 | 0.20| 39.7| 4.4    | 330  | 10.9 | p19  | 119.75| 10.54| 41.0| 3EGJ0001+7309|
| 2   | EGR J0028+0457        | 7.06 | 4.95 | 112.15| -57.44| 0.51| 14.3| 4.6    | 31   | 4.1  | p34  | 112.15| -57.44| 14.4|
| 3   | EGR J0039-0945        | 9.75 | -9.75| 112.76| -72.38| 0.27| 13.0| 3.5    | 48   | 4.8  | p19  | 112.65| -72.40| 13.1| 3EGJ0038-0949|

Table 3. Names of the 3EG sources with no EGR counterpart

| Name                  | RA   | Dec  | l     | b     | F   | σ_F | Cnts   | VT S | vp   | l_ν0 | b_ν0 | F_ν0 | EGR          |
|-----------------------|------|------|-------|-------|-----|-----|--------|------|------|------|------|------|--------------|
| 3EG J0130-1758        | 3EG J0245+1758 | 3EG J0323+5122 |
| 3EG J0428+3510        | 3EG J0404+0700 | 3EG J0407+1710 |
| 3EG J0416+3650        | 3EG J0426+1333 | 3EG J0435+6137 |
| 3EG J0439+1555        | 3EG J0439+1105 | 3EG J0458+4635 |
| 3EG J0459+0544        | 3EG J0459+3352 | 3EG J0500+2529 |
| 3EG J0510+5545        | 3EG J0520+2586 | 3EG J0521+2147 |
| 3EG J0533+4751        | 3EG J0542+2610 | 3EG J0542+0655 |
| 3EG J0546+3948        | 3EG J0556+0409 | 3EG J0616-0720 |
| 3EG J0622+1139        | 3EG J0628+1847 | 3EG J0634+0521 |
| 3EG J0702-6212        | 3EG J0706-3837 | 3EG J0747-3412 |
| 3EG J0808-5344        | 3EG J0821-5814 | 3EG J0910+6556 |
| 3EG J1103-5915        | 3EG J1104-5705 | 3EG J1045-7630 |
| 3EG J1502+5718        | 3EG J1212+2304 | 3EG J1222+2315 |
| 3EG J1227+4302        | 3EG J1235+0233 | 3EG J1249-8330 |
| 3EG J1310+4506        | 3EG J1308+8744 | 3EG J1308-6112 |
| 3EG J1316-5244        | 3EG J1323+2200 | 3EG J1329+1708 |
| 3EG J1329-4602        | 3EG J1447-3936 | 3EG J1500-3509 |
| 3EG J1527-2358        | 3EG J1600-0351 | 3EG J1616-2221 |
| 3EG J1627-2419        | 3EG J1631-1018 | 3EG J1631-4033 |
| 3EG J1633-3216        | 3EG J1634-1434 | 3EG J1635-1751 |
| 3EG J1639-4702        | 3EG J1646-0704 | 3EG J1649-1611 |
| 3EG J1653-2133        | 3EG J1659-6251 | 3EG J1704-4732 |
| 3EG J1709-0828        | 3EG J1714-3857 | 3EG J1717-2373 |
| 3EG J1718-3313        | 3EG J1720-7820 | 3EG J1733+6017 |
| 3EG J1735-1500        | 3EG J1741-2050 | 3EG J1741-2312 |
| 3EG J1744-0310        | 3EG J1744-3934 | 3EG J1744-3934 |
| 3EG J1757-0711        | 3EG J1800-0146 | 3EG J1806-5000 |
| 3EG J1810-1032        | 3EG J1823-1314 | 3EG J1824+3441 |
| 3EG J1824-1514        | 3EG J1825+2854 | 3EG J1828+0142 |
| 3EG J1834-2803        | 3EG J1836-4933 | 3EG J1850+5903 |
| 3EG J1850-2652        | 3EG J1858-2137 | 3EG J1903+0550 |
| 3EG J1904-1124        | 3EG J1928+1733 | 3EG J1958+2909 |
| 3EG J1958-4443        | 3EG J2016+3657 | 3EG J2020-1545 |
| 3EG J2022+4317        | 3EG J2034-3110 | 3EG J2035+4441 |
| 3EG J2100+6012        | 3EG J2206+6602 | 3EG J2219-7941 |
| 3EG J2255+1943        | 3EG J2359+2041 |
Table 4. Names of the new EGR sources with no 3EG counterpart

| EGR source       | 3EG counterpart       | EGR source       | 3EG counterpart       |
|------------------|-----------------------|------------------|-----------------------|
| EGR J0028+0457   | EGR J0057-7839        | EGR J0100+4927   |                       |
| EGR J0141+1719   | EGR J0243-5930        | EGR J0413-3742   |                       |
| EGR J0509+0550   | EGR J0540+0657        | EGR J1122-5946   |                       |
| EGR J1158-1950   | EGR J1259-2209        | EGR J1619+2223   |                       |
| EGR J1642+3940   | EGR J1740+4946        | EGR J1814+2932   |                       |
| EGR J1920+4625   | EGR J1959+4322        | EGR J2027-4026   |                       |
| EGR J2202+3340   | EGR J2333-4812        | EGR J2258-2745   |                       |
| EGR J2308+3645   | EGRc J0818-4613       | EGRc J0842-4501  |                       |
| EGRc J0912+7146  | EGRc J0927+6054       | EGRc J1038-5724  |                       |
| EGRc J11255-0404 | EGRc J1332-1217       | EGRc J2215+0653  |                       |

Fig. 8. Second stage of the iterative source detection around Geminga (see Figure 3) obtained using the 3EG model (left) and map of the Ring model intensity divided by the 3EG one (right). The excess in the TS map assigned in 3EG to the 3EG J0556+0409 point source corresponds to a local underestimation of the diffuse emission in the 3EG model. Maps are given in 0.5° bins and galactic coordinates.

Fig. 9. Histogram of the relative flux differences $|F_{EGR} - F_{3EG}|/\sigma_{EGR}$ measured between the EGR and 3EG counterparts in units of the statistical error on flux for each source. All fluxes are measured above 100 MeV.

Fig. 10. Histogram of the relative angular separation between the positions found for the EGR and 3EG counterparts in units of the 95% confidence angle for each source.

Fig. 11. Histogram of the relative flux differences $|F_{EGR} - F_{3EG}|/\sigma_{EGR}$ measured with the Ring and Galprop models in units of the statistical error on flux for each source. All fluxes are measured above 100 MeV.

detected as a single or cluster of point sources, depending on their angular scale.

For the 81 EGR sources that do have a 3EG counterpart, we find a reasonable agreement in position and flux from both analyses. On average, we find 3% lower fluxes in the EGR analysis with respect to the 3EG one because of the increase in Galactic background. Figure 9 shows the histogram of ratios of the EGR and 3EG flux difference over the statistical error on flux for each source: $|F_{EGR} - F_{3EG}|/\sigma_{EGR}$. The EGR flux was taken for the observation with highest $\sqrt{TS}$ and compared to the 3EG counterpart flux for the same time period if available. Average P19 fluxes were compared to the 3EG P1234 average for non flaring sources. The flux differences are modest (17% rms dispersion) and in most cases smaller than the statistical uncertainties on flux estimates. Similarly, Figure 10 shows that the angular separations between EGR and 3EG counterparts are often consistent with the $\theta_{95}$ error radii. Yet, thirty sources have been found as far as 0.5° from the 3EG position and this will greatly impact counterpart searches and identification at other wavelengths.

On the other hand, we find 30 new EGR sources with no 3EG counterpart. Their names are listed in Table 4 and they are displayed in Figure 7. Most of them are detected just above the threshold and 11 of them were indeed present in the 3EG complementary list, just below the significance threshold.

7. EGR source distributions and potential counterparts

Because of the new gas data we have used at intermediate latitude, the comparison between the EGR and 3EG source characteristics allows to judge, to some extent, the impact of our limited knowledge of gas mass tracers. The comparison between the flux and positions obtained with the Ring and Galprop models gives an estimate of the systematic uncertainties due to our limited knowledge of the true cosmic-ray distribution across the Galaxy.
Figure 12 and Figure 14 show that, in most cases, the differences are smaller than the statistical uncertainties. The distribution of 95% confidence radii peaks between $\sim 0.2^\circ$ and $\sim 0.7^\circ$. The uncertainty in the background induces an additional systematic error of $\sim 0.2^\circ$ for most sources. It should be kept in mind while looking for counterparts.

We have searched the EGR error circles for potential counterparts of interest such as pulsars from the ATNF catalogue (Manchester et al., 2005), blazar candidates from the ASDC list (Massaro et al., 2005) and the CGRABS list (Healey et al., 2008), other flat radio sources from the CRATES compilation (Healey et al., 2007), supernova remnants from the Green catalogue (Green, 2006), OB associations (Mel’Nik & Efremov (1995)), and X-ray and TeV pulsar wind nebulae (Li et al. (2008) and Grenier, 2008). The results are displayed in Figure 15. We have found 13 radio pulsar associations in addition to the 6 objects firmly identified by EGRET. Thirteen EGR sources coincide with supernova remnants, 9 with pulsar wind nebulae, 7 with OB associations, 53 with blazar candidates, and 19 with other flat radiosources. These associations should not be considered as identification, but as spatial coincidences worthy of further investigations, in particular with the improved angular resolution of GLAST. Yet, they reveal that as many as 87 sources have no obvious counterpart among the well-known $\gamma$-ray emitters despite the large number of pulsars (1775) and radiosources (11 000) that were cross-correlated with the sources and that spread across the entire sky and along the Galactic plane. The lack of blazar counterparts is all the more surprising that the spatial distribution of the sources off the plane is quite reminiscent of an isotropic, therefore extragalactic, distribution. The latitude distribution, shown in Figure 14, is quite consistent above $30^\circ$ with a sample drawn from a uniform population according to the exposure map, as shown by the black curve. The distribution flattens at lower latitude because of the increased background that drastically limits the survey sensitivity. Studying the consistency with an extragalactic population at medium latitudes and the implication of the lack of a flat radioisource is beyond the scope of this paper and will be addressed in a separate one. The sharp peak below $3^\circ$ in latitude indicates young emitters. Their clustering in the inner Galaxy ($l \leq 30^\circ$), toward the direction tangent to the Carina arm, and toward the Cygnus region outlines their close relationship to large molecular complexes and star forming regions at a distance of a few kpc.

8. Discussion on specific sources

There is considerable interest in the physical processes occurring in the Galactic center region. The 3EG catalogue lists one source located toward the Galactic center, 3EG J1744-3011. We find two point sources in this region, EGR J1740-2851 at $l = -0.55^\circ$, $b = 1.05^\circ$ and EGR J1747-2852 at $l = 0.21^\circ$, $b = -0.24^\circ$. Figure 15 display the $TS$-map for photons with energies above 1 GeV above the 3EG and the Ring background models. The $\theta_{65}$ error radius around EGR J1740-2851 and EGR J1747-2852 formerly excludes the Galactic Center but source locations and fluxes in this direction should be taken with extreme caution since the high gas optical depth around the Galactic center and the velocity pile-up toward the center induce large uncertainties in the total gas column densities.

Coincidences with supernova remnants were noted (Sturmer & Dermer (1995)) and are confirmed in the present analysis (see Table 5), but several also host a pulsar wind nebula, as in CTA 1 and IC 443, so we need much higher
resolution $\gamma$-ray images to identify the origin of the emission, especially in these crowded regions. EGRET detections are confirmed toward two TeV-emitting wind nebulae around PSR J1420-6048 (in Kookaburra, EGRJ1418-6040) and PSR J1826-1334 (EGRJ1825-1325). Another interesting candidate is the wind nebula of the 11-kyr old and very energetic pulsar PSR J2229+6114 toward EGRJ2227+6114.

We also note, as shown in Figure 16, the positional coincidence within 0.5° between the new EGR J0028+0457 source and the millisecond X-ray pulsar PSR J0030+0451. This 300 pc distant pulsar, discovered in 2000 (Somer, 2000; D’Amico, 2000), has an X-ray counterpart exhibiting a double peaked pulse profile as seen by ROSAT (Becker et al., 2000). Millisecond pulsars have low magnetic fields, they produce relatively few electron-positron pairs so the electric field is not screened and the spectral cutoff due to pair production attenuation occurs at high energy. They are therefore good candidate for accelerating particles to high energies. Harding et al. (2005) has predicted a $\gamma$-ray flux for PSR J0030+0451 well above the one of the $\gamma$-ray millisecond pulsar PSR J0218+4232 for which a pulsed emission was marginally detected (Kuiper et al., 2000).

Four massive binaries have been detected at TeV energies, namely PSR B1259-63 (Aharonian et al., 2005), LSI +61° 303 (Albert et al., 2006), LS 5039 (Aharonian et al., 2006), and Cyg X-1 (Albert et al., 2007), thus illustrating very efficient particle acceleration in compressed or shocked pulsar winds, as well as in microquasar jets. Inverse Compton scattering of the bright stellar radiation would dominate at GeV energies. We find no interesting EGRET counterpart to these high-energy objects, but for the LSI +61° 303 radiosource. The latter had long been associated with the COS-B source 2CG 135+01 and the EGRET

**Table 5.** Names of the sources and supernova remnants found in spatial coincidence

| EGRJ0008+7308 | G119.5+10.2 | CTA1 |
| EGRJ0617+2238 | G189.1+3.0 | IC443 |
| EGRJ0633+0646 | G205.5+0.5 | Monoceros |
| EGRJ1710-4435 | G343.0-6.0 | RCW114 |
| EGRJ1800-2328 | G6.4-0.1 | W28 |
| EGRJ1800-2328 | G6.5-0.4 | |
| EGRJ1838-0420 | G27.8+0.6 | |
| EGRJ1838-0420 | G28.8+1.5 | |
| EGRJ2020+4019 | G78.2+2.1 | γ Cygni |
| EGRJ2227+6114 | G106.3+2.7 | |
| EGRJ0025+6240 | G132.7+1.3 | HB3 |

**Fig. 13.** The revised EGRET source catalog, shown in Galactic coordinates. The symbols indicate the counterpart types found in the error box: identified pulsars as black squares; other ATNF pulsars as open squares; LSI +61 303, LMC, and solar flare as black triangles; ASDC and CGRaBS blazar candidates as black diamonds; other flat-spectrum radio-sources from CRATES as open diamonds; supernova remnants from the Green catalogue as stars; no counterpart as crosses.

**Fig. 16.** Likelihood TS contours for energies above 100 MeV and periods encompassing PSR J0030+0451. The cross, the plus sign and the black dot respectively mark the EGR catalog position, the position with maximum likelihood and the pulsar location.
Another noticeable new source is EGR J1642+3940 detected at 5.8σ rather close to 3C345. 3C345 is one of the most prominent flat spectrum (α = −0.1) radio-loud, superluminal sources and is therefore an excellent candidate for a γ-ray blazar. EGRET has viewed this region 12 times, in particular during period 5190 when a flare was found. We have analyzed again this particular period with the Ring model since it had not been used in the overall detection search. Figure 17 shows the resulting TS contour for photons with energies above 100 MeV that is well centered on 3C345. The cross corresponds to the EGR position (period 5190), the plus sign to the position with maximum likelihood and the black dots mark the radio positions of 3C345, Mrk 501, and 4C+38.41.

Fig. 17. Likelihood TS contours (50%, 68%, 95% and 99% confidence) for energies above 100 MeV and period 5190. The cross is the EGR catalog position, the plus sign the position with maximum likelihood and the black dots mark the radio positions of 3C345, Mrk 501, and 4C+38.41.

9. Conclusions

We have searched for point-like sources in the reprocessed EGRET data from cycle 1 to 9 using new interstellar background models based on the most recent HI, CO, and dark gas data, as well as two different assumptions for the cosmic-ray distribution (the GALPROP diffusion model or a radial emissivity gradient fitted to the diffuse EGRET data). We have used the 3EG tools, likelihood method, procedure and significance threshold to detect sources, but have expanded the search to 3 different energy bands (above 100 MeV, 0.3-1 GeV, and above 1 GeV). The resulting number of detected sources has decreased by more than a third. Many unidentified sources, in particular among those spatially associated with the Gould Belt, are not confirmed as significant excesses. Their emission can be explained by the additional interstellar emission and its structure. Several interesting counterparts to 3EG sources, such as radiogalaxies, massive binaries, and microquasars, are now found outside the 95% confidence region. We have cross-correlated the new source positions with large pulsar, supernova remnant, pulsar wind nebulae, OB associations, and radio source catalogues, yet half the sample has no attractive counterpart among the potential γ-ray emitters. 30 new possible γ-ray sources have also been found.

This EGR catalog will be available in fits format at the Strasbourg astronomical Data Center (CDS) and in ASCII format at http://www.aim.univ-paris7.fr/EGRET_catalogue/home.html.

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Jean-Marc Casandjian and Isabelle A. Grenier: A revised catalogue of EGRET γ-ray sources, Online Material p 2

Table A.1. The EGR catalogue

| Num | Name       | RA      | Dec     | l        | b        | $\theta_\phi$ | F   | $\sigma_F$ | Cnts | $\sqrt{\chi^2}$ | $\nu_\phi$ | $b_{sys}$ | $F_{sys}$ | 3EG |
|-----|------------|---------|---------|----------|----------|--------------|-----|------------|------|-----------------|------------|----------|----------|-----|---------|
| 1   | EGR J0008+7308 | 2.01    | 73.14   | 119.75   | 10.54    | 0.20         | 39.7| 4.4        | 330  | 10.9           | p19        | 119.75   | 10.54    | 41.0| 3EG0010+7309 |
| 2   | EGR J0028+0457 | 7.06    | 4.95    | 112.15   | -57.44   | 0.51         | 14.3| 4.6        | 31   | 4.1            | p34        | 112.15   | -57.44   | 14.4|         |
| 3   | EGR J0039-0945 | 9.75    | -9.75   | 112.76   | -72.38   | 0.27         | 13.0| 3.5        | 48   | 4.8            | p1         | 112.65   | -72.40   | 13.1| 3EG0038-0949 |
| 4   | EGR J0057-7839 | 14.46   | -78.65  | -57.47   | -38.47   | 0.53         | 10.5| 2.7        | 73   | 4.6            | p12        | 210.0    | 3EG0118+0248 |
| 5   | EGR J0100+4927 | 15.01   | 49.45   | 124.37   | -13.40   | 0.27         | 21.5| 6.1        | 49   | 4.4            | p12        | 3EG0118+0248 |
| 6   | EGR J0117+0254 | 19.41   | 2.91    | 135.83   | -59.30   | 1.15         | 21.2| 5.9        | 37   | 4.6            | p12        | 210.0    | 3EG0118+0248 |
| 7   | EGR J0141+1719 | 25.47   | 17.32   | 139.75   | -43.90   | 0.85         | 18.8| 5.5        | 36   | 4.4            | p12        | 3EG0118+0248 |
| 8   | EGR J0159-3609 | 29.78   | -36.16  | -110.71  | -73.04   | 0.59         | 12.8| 3.7        | 39   | 4.6            | p12        | 3EG0118+0248 |
| 9   | EGR J0204+1505 | 31.00   | 15.09   | 147.75   | -44.26   | 0.48         | 25.9| 5.7        | 68   | 5.8            | p12        | 210.0    | 3EG0210-5058 |
| 10  | EGR J0210-5058 | 32.58   | -50.97  | -83.84   | -61.86   | 0.14         | 85.1| 4.1        | 840  | 31.5           | p12        | 210.0    | 3EG0210-5058 |
| No. | Source Name  | RA      | Dec     | p1  | p2  | p3  | p4  | p5  |
|-----|--------------|---------|---------|-----|-----|-----|-----|-----|
| 11  | EGR J0216+1128 | 34.04   | 11.48   | 153.74 | -46.26 | 0.98 | p789 | 210 |
| 12  | EGR J0223+4300 | 35.80   | 43.01   | 140.25 | -16.75 | 0.21 | 140.25 | -16.75 | 21.3 | 3EGJ0222+4253 |
| 13  | EGR J0238+1659 | 39.61   | 16.99   | 156.47 | -38.81 | 0.34 | 3EGJ0239+2815 |
| 14  | EGR J0240+2812 | 40.03   | 28.20   | 150.28 | -28.84 | 0.55 | 150.26 | -28.83 | 10.9 | 3EGJ0241+6103 |
| 15  | EGR J0240+6112 | 40.12   | 61.20   | 135.68 | 1.06  | 0.12 | 135.57 | 1.15  | 85.5 | 3EGJ0237+1635 |
| 16  | EGR J0243-5930 | 40.94   | -59.50  | -80.08 | -52.32 | 0.95 | -80.41 | -52.25 | 18.1 |
| 17  | EGR J0253-0336 | 43.25   | -3.61   | 179.25 | -52.50 | 0.60 | 179.08 | -52.55 | 15.5 | 3EGJ0253-0345 |
| 18  | EGR J0328+2147 | 52.17   | 21.79   | 164.73 | -28.04 | 0.48 | 164.79 | -28.80 | 16.4 | 3EGJ0329+2149 |
| 19  | EGR J0338-0203 | 54.73   | -2.06   | -171.80 | -42.74 | 0.36 | -171.74 | -42.73 | 87.7 | 3EGJ0340-0201 |
| 20  | EGR J0348-5717 | 57.01   | -57.30  | -90.40 | -46.78 | 0.63 | -90.67 | -46.85 | 23.1 | 3EGJ0348-5708 |
| 21  | EGR J0413-1851 | 63.27   | -18.86  | -146.07 | -43.17 | 1.26 | -143.25 | -42.75 | 27.4 | 3EGJ0412-1853 |
| Source          | RA     | Dec    | RA deg  | Dec deg | RA arcmin | Dec arcmin | RA sec  | Dec sec | RA arcsec | Dec arcsec | RA/Dec dec  | RA/Dec arcmin | RA/Dec arcsec | RA/Dec dec  | RA/Dec arcmin | RA/Dec arcsec |
|-----------------|--------|--------|---------|---------|-----------|------------|---------|--------|-----------|------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|
| EGR J0413-3742  | 63.40  | -37.70 | -119.80 | -46.58  | 0.68      | -119.77    | -46.55  | 9.1    |           |            | 3.5         | 2.4         | 20.16       | 1.6         | 4.2         | p1234       |
| EGR J0423+1723  | 65.94  | 17.40  | 178.27  | -21.95  | 0.50      | 179.25     | -22.12  | 10.0   | 11.3      | 5.0        | 63.40       | 3.8         | 22.0        | 1.6         | 9.1         | 5.1         |
| EGR J0425-0032  | 66.33  | -0.54  | -165.20 | -32.95  | 0.51      | -164.98    | -32.38  | 15.0   | 17.6      | 3.0        | 11.8        | 3.4         | 178.27      | 15.0        | 3.4         | 158.27      |
| EGR J0430+0339  | 67.58  | 3.65   | -168.48 | -28.95  | 0.51      | -168.5     | -29.08  | 15.0   | 17.6      | 3.0        | 11.8        | 3.4         | 178.27      | 15.0        | 3.4         | 158.27      |
| EGR J0433+2906  | 68.34  | 29.11  | 170.47  | -12.64  | 0.17      | 170.4      | -12.63  | 27.2   | 24.8      | 5.2        | 10.1        | 4.0         | 178.27      | 27.2        | 4.0         | 178.27      |
| EGR J0442-0027  | 70.71  | -0.46  | -162.61 | -28.51  | 0.50      | -162.63    | -28.51  | 79.6   | 78.3      | 4.0        | 11.8        | 4.0         | 178.27      | 27.2        | 4.0         | 178.27      |
| EGR J0450+1145  | 72.55  | 11.76  | -172.76 | -20.29  | 0.39      | -172.53    | -20.33  | 94.4   | 101.1     | 18.9       | 10.1        | 139.0       | 178.27      | 94.4        | 139.0       | 178.27      |
| EGR J0456-2334  | 74.15  | -23.57 | -136.15 | -35.04  | 0.69      | -135.75    | -34.95  | 14.3   | 14.6      | 4.2         | 14.6        | 4.2         | 178.27      | 14.3        | 4.2         | 178.27      |
| EGR J0502-0124  | 75.60  | -1.40  | -158.96 | -24.75  | 0.36      | -158.96    | -24.75  | 11.3   | 10.7      | 2.2         | 10.7        | 2.2         | 178.27      | 11.3        | 2.2         | 178.27      |
| Source | RA      | Dec     | CR      | Distance | Transient? | }
|--------|---------|---------|---------|----------|------------|
| 31 EGR J0509+0550 | 77.41   | 5.84    | -164.70 | -19.52   | 0.44       |
| 32 EGR J0512-6148 | 78.14   | -61.81  | -88.78  | -35.29   | 0.40       |
| 33 EGR J0515+2316 | 78.96   | 23.28   | -178.92 | -8.68    | 0.49       |
| 34 EGR J0529-3608 | 82.43   | -36.14  | -119.43 | -31.32   | 0.69       |
| 35 EGR J0530+1331 | 82.71   | 13.52   | -168.64 | -11.04   | 0.16       |
| 36 EGR J0531-2934 | 82.90   | -29.57  | -126.68 | -29.29   | 1.00       |
| 37 EGR J0534+2159 | 83.67   | 21.99   | -175.40 | -5.77    | 0.06       |
| 38 EGR J0537-6946 | 84.33   | -69.78  | -79.73  | -31.71   | 0.39       |
| Source ID       | RA          | Dec         | Decl.           | RA             | Dec             | DM       | IB         | RA Res. | Dec Res. | RA Err. | Dec Err. | P        | Ref. |
|-----------------|-------------|-------------|-----------------|----------------|-----------------|---------|------------|---------|----------|---------|----------|---------|------|
| EGR J0540+0657 | 85.06      | 6.95        | -161.66 -12.41  | 1.07           | 4.1             | 36      | 3.3        | p4      |          |         |          |         |      |
| EGR J0540-4358 | 85.09      | -43.98      | -109.99 -30.80  | 0.37           | 21.9            | 2.9     | 97         | 4.9     | p12      |         |          |         |      |
| EGR J0614+4204 | 93.68      | 42.08       | 171.34 11.55   | 0.37           | 10.5            | 12.8    | 7          | 1.6     | 335      |         |          |         |      |
| EGR J0615-3308 | 93.86      | -33.15      | -119.76 -21.46  | 0.51           | 14.3            | 4.0     | 58         | 4.2     | p3       |         |          |         |      |
| EGR J0617+2238 | 94.32      | 22.65       | -171.01 3.08   | 0.10           | 17.3            | 4.7     | 145        | 4.0     | p1       |         |          |         |      |
| EGR J0633+0646 | 98.28      | 6.77        | -155.18 -0.96  | 0.28           | 4.1             | 3.3     | 368        | 7.1     | p1234    |         |          |         |      |
| EGR J0633+1750 | 98.44      | 17.84       | -164.94 4.27   | 0.04           | 5.4             | 9018    | 126.5      |        | p19      |         |          |         |      |
46. **EGR J0722-5121** 110.60 -51.36 -97.22 -16.34 383.3 411.6 7.9 107 3.9 1.9 2.1 30.8 22.0 4130 419+ 20.8 23.5 543 325 50 p1234 4130 pl134 97.02 -16.25 8.2 3EGI0725-5140 384

47. **EGR J0723+7134** 110.86 71.58 143.72 28.15 20.8 23.5 7.9 107 3.9 1.9 2.1 30.8 22.0 4130 419+ 20.8 23.5 543 325 50 p1234 4130 pl134 97.02 -16.25 8.2 3EGI0725-5140 384

48. **EGR J0726-4715** 111.74 -47.26 -100.78 -13.98 20.5 23.5 7.9 107 3.9 1.9 2.1 30.8 22.0 4130 419+ 20.8 23.5 543 325 50 p1234 4130 pl134 97.02 -16.25 8.2 3EGI0725-5140 384

49. **EGR J0737+1720** 114.43 17.34 -157.84 17.84 20.5 23.5 7.9 107 3.9 1.9 2.1 30.8 22.0 4130 419+ 20.8 23.5 543 325 50 p1234 4130 pl134 97.02 -16.25 8.2 3EGI0725-5140 384

50. **EGR J0743+5438** 115.87 54.65 163.16 29.20 20.5 23.5 7.9 107 3.9 1.9 2.1 30.8 22.0 4130 419+ 20.8 23.5 543 325 50 p1234 4130 pl134 97.02 -16.25 8.2 3EGI0725-5140 384

51. **EGR J0807+4856** 121.79 48.94 170.20 32.24 20.5 23.5 7.9 107 3.9 1.9 2.1 30.8 22.0 4130 419+ 20.8 23.5 543 325 50 p1234 4130 pl134 97.02 -16.25 8.2 3EGI0725-5140 384

52. **EGR J0807+5123** 121.86 51.39 167.32 32.49 20.5 23.5 7.9 107 3.9 1.9 2.1 30.8 22.0 4130 419+ 20.8 23.5 543 325 50 p1234 4130 pl134 97.02 -16.25 8.2 3EGI0725-5140 384

53. **EGR J0812-0624** 123.11 -6.41 -131.70 14.79 20.5 23.5 7.9 107 3.9 1.9 2.1 30.8 22.0 4130 419+ 20.8 23.5 543 325 50 p1234 4130 pl134 97.02 -16.25 8.2 3EGI0725-5140 384

54. **EGR J0829+0510** 127.33 5.18 -140.29 24.10 20.5 23.5 7.9 107 3.9 1.9 2.1 30.8 22.0 4130 419+ 20.8 23.5 543 325 50 p1234 4130 pl134 97.02 -16.25 8.2 3EGI0725-5140 384

55. **EGR J0829+2415** 127.46 24.25 -160.14 31.67 20.5 23.5 7.9 107 3.9 1.9 2.1 30.8 22.0 4130 419+ 20.8 23.5 543 325 50 p1234 4130 pl134 97.02 -16.25 8.2 3EGI0725-5140 384

56. **EGR J0830+7048** 127.57 70.81 143.93 33.57 20.5 23.5 7.9 107 3.9 1.9 2.1 30.8 22.0 4130 419+ 20.8 23.5 543 325 50 p1234 4130 pl134 97.02 -16.25 8.2 3EGI0725-5140 384
| Source | RA (J2000) | DEC (J2000) | Gamma-ray Emission | Emission Rate | Position Angle |
|--------|------------|-------------|--------------------|--------------|---------------|
| EGR J0834-4512 | 128.70 | -45.21 | 1984.6 | 2.88 | 0.03 |
| EGR J0852-4512 | 133.24 | -12.40 | 1984.6 | 2.88 | 0.03 |
| EGR J0853+2015 | 133.46 | 20.25 | 1984.6 | 2.88 | 0.03 |
| EGR J0901-3525 | 135.45 | -35.42 | 1984.6 | 2.88 | 0.03 |
| EGR J0918+4451 | 139.52 | 44.85 | 1984.6 | 2.88 | 0.03 |
| EGR J0956+6524 | 149.24 | 65.41 | 1984.6 | 2.88 | 0.03 |
| EGR J0957+5513 | 149.32 | 55.22 | 1984.6 | 2.88 | 0.03 |
| EGR J1009+4831 | 152.39 | 48.52 | 1984.6 | 2.88 | 0.03 |
| EGR J1021-5831 | 155.37 | -58.53 | 1984.6 | 2.88 | 0.03 |
| EGR J1048-5839 | 162.18 | -58.66 | 1984.6 | 2.88 | 0.03 |
| No.  | Source Name                  | RA       | Dec      | RA       | Dec      | Energy  | Flux     | Count   | pN |
|------|-----------------------------|----------|----------|----------|----------|---------|----------|---------|----|
| 67   | EGR J1058-5221              | 164.63   | -52.36   | -73.98   | 6.76     | 0.19    |          |         |    |
| 68   | EGR J1058-6101              | 164.69   | -61.03   | -70.29   | 1.08     | 0.34    |          |         |    |
| 69   | EGR J1104+3813              | 166.20   | 38.22    | 179.75   | 65.09    | 0.21    |          |         |    |
| 70   | EGR J1122-5946              | 170.55   | -59.77   | -68.09   | 1.18     | 0.31    |          |         |    |
| 71   | EGR J1131-0027              | 172.75   | -0.46    | -95.37   | 56.31    | 0.41    |          |         |    |
| 72   | EGR J1134-1533              | 173.62   | -15.55   | -82.98   | 43.42    | 0.53    |          |         |    |
| 73   | EGR J1158-1950              | 179.68   | -19.84   | -73.67   | 41.33    | 0.80    |          |         |    |
| 74   | EGR J1201+2915              | 180.25   | 29.25    | -160.82  | 78.69    | 0.10    |          |         |    |
| 75   | EGR J1218-1545              | 184.71   | -15.76   | -68.48   | 46.39    | 0.42    |          |         |    |
### Table 1: Revised EGRET $\gamma$-ray Sources

| Source Name          | RA      | Dec     | $E_{\gamma}$ | $\epsilon$ | $\theta$ | $\gamma$ | $\delta$ | $\phi$ | $\alpha$ | $\beta$ |
|----------------------|---------|---------|--------------|-------------|----------|----------|----------|-------|----------|---------|
| EGR J1222+2845       | 185.74  | -163.19 | 83.51        | 0.23        | 12.5     | 1.8      | 179      | 8.3   | p19      | -163.19 |
| EGR J1225+2115       | 186.25  | -104.19 | 81.58        | 0.07        | 11.5     | 1.8      | 190      | 7.8   | p1234    | -104.19 |
| EGR J1229+0203       | 187.25  | -70.12  | 64.36        | 0.26        | 11.5     | 1.8      | 190      | 7.8   | p1234    | -70.12  |
| EGR J1231-1412       | 187.86  | -64.38  | 48.39        | 0.25        | 11.5     | 1.8      | 190      | 7.8   | p1234    | -64.38  |
| EGR J1237+0434       | 189.31  | -66.23  | 67.20        | 0.66        | 11.5     | 1.8      | 190      | 7.8   | p1234    | -66.23  |
| EGR J1247-0733       | 191.75  | -59.00  | 55.31        | 0.24        | 11.5     | 1.8      | 190      | 7.8   | p1234    | -59.00  |
| EGR J1256-0552       | 194.01  | -54.96  | 56.98        | 0.09        | 11.5     | 1.8      | 190      | 7.8   | p1234    | -54.96  |
| Source          | RA      | Dec     | E         | B        | Flux     | Is      | Te         | El         | PA      | Redshift | Type   | RA         | Dec         | E         | B    | Flux     | Is | Te | El | PA | Redshift | Type   |
|-----------------|---------|---------|-----------|-----------|----------|---------|------------|------------|---------|-----------|--------|-----------|-------------|-----------|------|----------|----|----|----|----|----------|--------|
| EGR J1259-2209  | 194.92  | -22.16  | -54.55    | 40.67     | 0.58     |         |            |            |         | -96.63    | 40.60  | 8.00      | 194.92      | -22.16   | -54.55| 40.67    | 0.58|    |    |    |            |         |
| EGR J1309-0535  | 197.29  | -5.59   | -48.96    | 57.00     | 0.32     |         |            |            |         | -98.28    | 57.28  | 7.94      | 197.29      | -5.59   | -48.96| 57.00    | 0.32|    |    |    |            |         |
| EGR J1314-3417  | 198.58  | -34.30  | -51.70    | 28.33     | 0.45     |         |            |            |         | -91.69    | 28.20  | 13.11     | 198.58      | -34.30  | -51.70| 28.33    | 0.45|    |    |    |            |         |
| EGR J1328-4337  | 202.07  | -43.62  | -50.04    | 18.75     | 0.37     |         |            |            |         | -50.04    | 18.75  | 10.86     | 202.07      | -43.62  | -50.04| 18.75    | 0.37|    |    |    |            |         |
| EGR J1337-1310  | 204.45  | -13.17  | -40.02    | 48.16     | 0.63     |         |            |            |         | -39.34    | 47.22  | 26.54     | 204.45      | -13.17  | -40.02| 48.16    | 0.63|    |    |    |            |         |
| EGR J1338+5102  | 204.54  | 51.04   | 105.73    | 64.50     | 0.46     |         |            |            |         | -51.69    | 28.20  | 13.01     | 204.54      | 51.04   | 105.73| 64.50    | 0.46|    |    |    |            |         |
| EGR J1345+2912  | 206.33  | 29.20   | 45.98     | 77.95     | 0.73     |         |            |            |         | -46.62    | 77.52  | 10.66     | 206.33      | 29.20   | 45.98| 77.95    | 0.73|    |    |    |            |         |
| EGR J1409-0736  | 212.27  | -7.61   | -25.88    | 50.50     | 0.25     |         |            |            |         | -25.89    | 50.50  | 100.82    | 212.27      | -7.61   | -25.88| 50.50    | 0.25|    |    |    |            |         |
| EGR J1414-6224  | 213.50  | -62.41  | -47.67    | -1.05     | 0.35     |         |            |            |         | -47.46    | -0.42  | 86.51     | 213.50      | -62.41  | -47.67| -1.05    | 0.35|    |    |    |            |         |
| Source Name | RA      | DEC     | E   | Sigma | Flux | E/Flux | RA      | DEC     | E   | Sigma | Flux | E/Flux |
|------------|---------|---------|-----|-------|------|--------|---------|---------|-----|-------|------|--------|
| EGR J1418-6040 | 214.72  | -60.68  | 46.56 | 0.40  | 0.22 | 38.4  | 17.1  | 76   | 2.4  | 2.9   | 51.7 | 8.2   |
| EGR J1424+3730 | 216.08  | 37.50  | 66.73 | 67.89 | 0.85 | 7.6   | 3.7   | 30   | 3.4  | 9.5   | 9.6   |
| EGR J1458-1904 | 224.56  | -19.07  | -20.00 | 34.52 | 0.59 | 19.9  | 6.7   | 9    | 1.3  | 13.1  | 9.6   |
| EGR J1504-1539 | 226.14  | -15.65  | -16.04 | 36.40 | 0.65 | 37.5  | 10.6  | 32   | 4.9  | 36.4  | 21.4  |
| EGR J1512-0857 | 228.13  | -8.95   | -8.66  | 40.30 | 0.40 | 18.7  | 3.7   | 112  | 6.0  | 22.9  | 15.9  |
| EGR J1516-2536 | 229.18  | -25.60  | -20.34 | 26.72 | 0.69 | 28.6  | 8.3   | 41   | 4.4  | 4.6   | 6.7   |
| EGR J1607+8216 | 241.84  | 82.27   | 116.06 | 32.03 | 0.60 | 9.8   | 2.5   | 73   | 4.6  | 10.8  | 8.8   |
| EGR J1607+1533 | 241.99  | 15.55   | 29.10  | 43.10 | 0.60 | 39.3  | 12.2  | 27   | 4.3  | 39.8  | 11.1  |
| EGR J1608+1051 | 242.04  | 10.85   | 23.37  | 41.09 | 0.39 | 27.5  | 5.2   | 93   | 6.6  | 27.1  | 8.6   |
| EGR J1609-1128 | 242.32  | -11.47  | 0.82   | 28.44 | 0.75 | 83.8  | 27.4  | 24   | 4.2  | 229.  | 92.  |

The table contains the source name, right ascension, declination, error, and flux values for gamma-ray sources. The E/Flux ratio is also provided. The entries are followed by additional information in the form of parentheses and page numbers.
| Source Name          | RA      | Dec     | L            | B            | E       | P       | C       | R       | S     | Type |
|---------------------|---------|---------|--------------|--------------|---------|---------|---------|---------|-------|-------|
| EGR J1615+3426      | 243.90  | 34.44   | 55.52        | 46.00        | 0.16    |         |         |         |       |       |
| EGR J1617-2610      | 244.28  | -26.17  | -9.78        | 17.28        | 0.90    |         |         |         |       |       |
| EGR J1619+2223      | 244.75  | 22.39   | 39.11        | 42.96        | 1.23    |         |         |         |       |       |
| EGR J1625-2505      | 246.26  | -25.09  | -7.69        | 16.69        | 0.25    |         |         |         |       |       |
| EGR J1625-2958      | 246.49  | -29.97  | -11.29       | 13.26        | 0.26    |         |         |         |       |       |
| EGR J1635+3825      | 248.95  | 38.43   | 61.50        | 42.25        | 0.24    |         |         |         |       |       |
| EGR J1638-5157      | 249.61  | -51.95  | -25.98       | -3.34        | 0.45    |         |         |         |       |       |
| EGR J1640-2807      | 250.17  | -28.13  | -7.70        | 12.06        | 0.43    |         |         |         |       |       |
| Source   | RA      | DEC     | E        | z        | D               | Flux 1  | Flux 2 | Flux 3 | Flux 4 |
|----------|---------|---------|----------|----------|-----------------|---------|--------|--------|--------|
| EGR J1642+3940 | 250.51  | 39.68   | 63.26    | 41.12    | 0.93            | 10.9    | 7.5    | 24     | 1.6    |
| EGR J1652-4552 | 253.10  | -45.87  | -19.87   | -1.13    | 0.42            | 12.5    | 8.2    | 24     | 1.4    |
| EGR J1653-0249 | 253.30  | -2.83   | 15.75    | 24.58    | 0.45            | 13.3    | 3.5    | 110    | 4.3    |
| EGR J1710-4435 | 257.68  | -44.59  | -16.88   | -2.89    | 0.11            | 122.6   | 10.1   | 699    | 14.4   |
| EGR J1718-0416 | 259.74  | -4.61   | 17.68    | 18.16    | 0.36            | 11.4    | 3.0    | 157    | 4.1    |
| EGR J1721-0827 | 260.29  | -8.46   | 14.52    | 15.71    | 0.48            | 32.7    | 9.5    | 62     | 4.1    |
| EGR J1727+0416 | 261.99  | 4.28    | 27.08    | 20.50    | 0.77            | 15.8    | 3.9    | 107    | 4.6    |
| Object Name   | RA (deg) | Dec (deg) | RA Epoch | Dec Epoch | Position Angle | Energy (TeV) | Flux (nJy) | Photons (10^5) | p-value |
|--------------|---------|-----------|-----------|-----------|---------------|-------------|-----------|----------------|---------|
| EGR J1732-3126 | 263.06  | -31.44    | 1.11      | 0.25      | 34.8          | 5.9         | 815       | 6.1            | p19     |
| EGR J1734-1315 | 263.55  | -13.26    | 12.02     | 0.48      | 28.1          | 3.1         | 593       | 10.3           | p19     |
| EGR J1740+4946 | 265.09  | 49.77     | 76.72     | 31.57     | 21.5          | 6.2         | 45        | 4.3            | p19     |
| EGR J1740+5213 | 265.19  | 52.22     | 79.60     | 31.73     | 26.3          | 5.7         | 76        | 6.0            | p19     |
| EGR J1743-1002 | 265.94  | -10.04    | 16.05     | 10.11     | 37.4          | 10.4        | 89        | 4.0            | p19     |
| EGR J1758-3923 | 269.62  | -39.40    | -7.71     | -7.58     | 83.5          | 18.2        | 83        | 5.5            | p19     |
| EGR J1800-2328 | 270.20  | -23.48    | 6.43      | -0.16     | 59.2          | 6.3         | 1421       | 9.8            | p19     |

Jean-Marc Casandjian and Isabelle A. Grenier: A revised catalogue of EGRET γ-ray sources, *Online Material p 15*
| Source ID | RA (deg) | Dec (deg) | l (deg) | b (deg) | Flux (10^{-6} erg cm^{-2} s^{-1}) | Energy (MeV) | E (MeV) | C (MeV) | Source | Coordinates | Notes |
|-----------|----------|-----------|---------|---------|-------------------------------|-------------|--------|--------|--------|-------------|-------|
| 125 EGR J1809-2322 | 272.42 | -23.37 | 7.52 | -1.88 | 0.16 | 55.5 | 15.1 | 212 | 3.9 | 50 | 330+ |
| 126 EGR J1812-1316 | 273.04 | -13.27 | 16.66 | 2.47 | 0.22 | 45.6 | 9.5 | 23 | 3.9 | p1234 | 16.76 | 2.29 | 46.2 | 3EGJ1812-1316 |
| 127 EGR J1814+2932 | 273.59 | 29.54 | 56.52 | 20.46 | 0.80 | 17.3 | 4.8 | 63 | 4.3 | p1 | 56.99 | 20.79 | 17.8 |
| 128 EGR J1814-6423 | 273.64 | -64.39 | -29.98 | -20.46 | 0.41 | 14.6 | 3.9 | 66 | 4.5 | p1 | 145.6 | 3EGJ1814-6423 |
| 129 EGR J1820-7920 | 275.16 | -79.35 | -45.39 | -25.22 | 0.44 | 24.4 | 5.8 | 63 | 5.3 | p1 | -45.40 | -25.24 | 23.3 | 3EGJ1820-7920 |
| 130 EGR J1822+1654 | 275.56 | 16.91 | 45.03 | 13.93 | 0.60 | 36.3 | 10.8 | 42 | 4.2 | p1 | 44.95 | 13.90 | 39.7 | 3EGJ1822+1654 |
| 131 EGR J1825-1325 | 276.41 | -13.43 | 18.07 | -0.50 | 0.33 | 38.5 | 8.8 | 1840 | 9.8 | p1 | 18.11 | -0.50 | 145.6 | 3EGJ1825-1325 |

**Legend:**
- **RA (deg):** Right Ascension in degrees.
- **Dec (deg):** Declination in degrees.
- **l (deg):** Galactic longitude in degrees.
- **b (deg):** Galactic latitude in degrees.
- **Flux (10^{-6} erg cm^{-2} s^{-1}):** Fluence in 10^{-6} erg cm^{-2} s^{-1}.
- **Energy (MeV):** Energy in MeV.
- **E (MeV):** E in MeV.
- **C (MeV):** C in MeV.
- **Source:** Source identifier.
- **Coordinates:** Source coordinates.
- **Notes:** Additional notes.

**Notes:**
- **3EGJ1809-2328:** Source 3EGJ1809-2328 is referenced in the notes.
- **3EGJ1812-1316:** Source 3EGJ1812-1316 is referenced in the notes.
- **3EGJ1814-6419:** Source 3EGJ1814-6419 is referenced in the notes.
- **3EGJ1822+1641:** Source 3EGJ1822+1641 is referenced in the notes.
- **3EGJ1825-1302:** Source 3EGJ1825-1302 is referenced in the notes.
| Source            | RA   | Dec   | Z       | E      | H       | RA      | Dec      | Z       | E      | H       |
|-------------------|------|-------|---------|-------|---------|---------|----------|---------|-------|---------|
| EGR J1832-2052    | 278.04 | -20.88 | 12.17   | -5.31 | 0.36    | 12.10   | -5.40    | 12.20   | 30.00 | 9.00    |
| EGR J1835+5919    | 278.86 | 59.33  | 88.75   | 25.08  | 0.13    | 88.75   | 25.08    | 94.00   | 30.00 | 9.00    |
| EGR J1837-0557    | 279.35 | -5.95  | 26.04   | 0.40  | 0.19    | 25.77   | 0.31     | 46.80   | 30.00 | 30.00  |
| EGR J1838-0420    | 279.60 | -4.34  | 27.58   | 0.91  | 0.71    | 27.44   | 1.06     | 31.00   | 30.00 | 30.00  |
| EGR J1847-3220    | 281.85 | -32.34 | 3.18    | -13.34| 0.35    | 3.21    | -13.30   | 25.40   | 30.00 | 30.00  |
| EGR J1856+0235    | 284.23 | 2.59   | 35.86   | -0.04 | 0.52    | 34.54   | -0.71    | 208.20  | 30.00 | 30.00  |
| EGR J1912-2000    | 288.06 | -20.01 | 17.08   | -13.41| 0.44    | 17.12   | -13.37   | 17.40   | 30.00 | 30.00  |
| EGR J1920+4625    | 290.17 | 46.42  | 77.97   | 14.61 | 0.73    | 77.98   | 14.60    | 16.70   | 30.00 | 30.00  |
| 140 | EGR J1921-2014 | 290.41 | -20.24 | 17.79 | -15.51 | 0.56 | 30.5 | 8.2 | 55 | 4.6 | p1234 | 17.83 | -15.51 | 34.7 | 3EGJ1921-2015 |
| 141 | EGR J1932-3946 | 293.07 | -39.77 | -0.91 | -24.39 | 0.45 | 12.1 | 3.1 | 99 | 4.5 | p12 | -1.38 | -25.12 | 64.1 | 3EGJ1935-4022 |
| 142 | EGR J1936-1515 | 294.24 | -15.26 | 24.07 | -16.82 | 0.92 | 57.9 | 19.2 | 26 | 4.0 | 430 | 24.09 | -16.76 | 64.1 | 3EGJ1937-1529 |
| 143 | EGR J1940-0123 | 295.08 | -1.39 | 37.32 | -11.50 | 0.73 | 38.4 | 10.5 | 59 | 4.5 | 330+ | 37.32 | -11.80 | 42.9 | 3EGJ1940-0121 |
| 144 | EGR J1949-3439 | 297.41 | -34.66 | 5.58 | -26.31 | 0.57 | 49.5 | 12.5 | 46 | 5.4 | p1234 | 4.97 | -26.29 | 51.4 | 3EGJ1949-3456 |
| 145 | EGR J1955-1338 | 298.78 | -13.64 | 27.53 | -20.17 | 0.76 | 18.8 | 3.9 | 206 | 5.3 | p1234 | 78.33 | 7.14 | 18.5 | 3EGJ1955-1414 |
| 146 | EGR J1959+4322 | 299.78 | 43.38 | 78.44 | 7.18 | 0.22 | 14.6 | 3.2 | 114 | 5.3 | p19 | 96.51 | 17.00 | 15.1 | 3EGJ1959+6342 |
| 147 | EGR J1959+6322 | 299.90 | 63.37 | 96.32 | 16.90 | 0.37 | 14.6 | 3.2 | 114 | 5.3 | p19 | 96.51 | 17.00 | 15.1 | 3EGJ1959+6342 |
| 148 | EGR J2010-2424 | 302.60 | -24.41 | 18.06 | -27.53 | 0.76 | 16.8 | 4.4 | 75 | 4.5 | p19 | 19.27 | -26.18 | 16.7 | 3EGJ2006-2321 |
| 149 | EGR J2019+3722 | 304.79 | 37.37 | 75.43 | 0.72 | 0.18 | 11.4 | 3.3 | 77 | 3.9 | 328+ | 75.45 | 0.86 | 81.9 | 3EGJ2021+3716 |
| 150 | EGR J2020+4019 | 305.19 | 40.32 | 78.04 | 2.13 | 0.13 | 11.7 | 6.7 | 1867 | 20.0 | p1234 | 78.03 | 2.16 | 115.0 | 3EGJ2020+4017 |
| EGR J2025-0810 | 306.25 | -8.17 | 36.25 | -24.49 | 0.24 | 132.9 | 17.8 | 323 | 8.6 | 328+ | 3.9 | 72.3 | 35.2 | 39 | 2.2 | 3315 | 36.13 | -24.37 | 26.5 | 3EGJ2025-0744 |
|----------------|--------|-------|------|--------|------|-------|------|-----|-----|-----|-----|------|-----|------|------|-----|------|------|-----|------|------|----------------|
| EGR J2027-4206 | 306.79 | -42.11 | -1.20 | -35.00 | 1.12 | 16.3 | 4.8 | 46 | 4.2 | 72.3 | 35.2 | 39 | 2.2 | 3315 | 36.13 | -24.37 | 26.5 | 3EGJ2025-0744 |
| EGR J2032+1226 | 308.02 | 12.44 | 56.25 | -15.74 | 0.68 | 13.5 | 3.0 | 130 | 5.1 | 5.8 | 3.6 | 31 | 1.7 | 1 | 2 | 32 | 2.2 | 200 |
| EGR J2033+4117 | 308.37 | 41.30 | 80.24 | 0.75 | 0.22 | 51.9 | 6.6 | 828 | 8.4 | 49.9 | 10.1 | 357 | 5.3 | 2 | 328+ | 3.9 | 55.60 | -20.17 | 10.1 | 3EGJ2033+4118 |
| EGR J2045+0935 | 311.45 | 9.59 | 55.70 | -20.12 | 0.33 | 11.5 | 2.9 | 98 | 4.6 | 11.2 | 3.7 | 63 | 3.8 | 1 | 2 | 328+ | 3.9 | 55.60 | -20.17 | 10.1 | 3EGJ2046+0933 |
| EGR J2057-4658 | 314.32 | -46.97 | -7.06 | -40.56 | 0.28 | 20.4 | 5.8 | 44 | 4.4 | 10.3 | 3.4 | 46 | 3.5 | 1 | 2 | 328+ | 3.9 | 55.60 | -20.17 | 10.1 | 3EGJ2046+0933 |
| EGR J2200-3015 | 330.00 | -30.25 | 17.73 | -52.49 | 0.38 | 20.9 | 2.9 | 151 | 9.4 | 4.3 | 3.9 | 11 | 1.2 | 1 | 2 | 328+ | 3.9 | 55.60 | -20.17 | 10.1 | 3EGJ2046+0933 |
| EGR J2202+3340 | 330.63 | 33.68 | 87.10 | -17.19 | 0.45 | 9.8 | 2.6 | 95 | 4.4 | 9.1 | 3.2 | 45 | 3.3 | 1 | 2 | 328+ | 3.9 | 55.60 | -20.17 | 10.1 | 3EGJ2046+0933 |
| EGR J2204+4225 | 331.01 | 42.43 | 92.88 | -10.47 | 0.40 | 159.6 | 22.2 | 97 | 11.0 | 9.1 | 5.6 | 27 | 1.7 | 1 | 2 | 328+ | 3.9 | 55.60 | -20.17 | 10.1 | 3EGJ2046+0933 |
| Source                        | RA       | Dec      | RA       | Dec      | RA       | Dec       | RA       | Dec       | RA       | Dec       | RA       | Dec       | RA       | Dec       | RA       | Dec       | RA       | Dec       | RA       | Dec       | RA       | Dec       | RA       | Dec       | RA       | Dec       | RA       | Dec       | RA       | Dec       | RA       | Dec       |
|-------------------------------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|
| EGR J2208+2351               | 332.03   | 81.41    | 23.85    | -25.57   | 0.31     |          | 34.7     | 10.2     | 35       | 4.4      | 4100     | p12      | 81.34    | -25.58   | 12.8     | 3EGJ2209+2401 |
| EGR J2227+6114               | 336.76   | 61.24    | 106.44   | 3.08     | 0.30     |          | 30.4     | 10.6     | 70       | 3.2      |          | p19      | 106.58   | 3.22     | 37.7     | 3EGJ2227+6122 |
| EGR J2233-4812               | 338.46   | -48.21   | -14.70   | -56.03   | 0.76     |          | 10.7     | 3.3      | 47       | 4.1      |          | p1       | 5.7      | 3.7      | 15       | 1.8      | p4       | 3.0      | 2.9      | 12.1     | 1.1      | p3       | 7.9      | 2.3      | 70       | 3.9      | p4       | 31.3     | 10.7     | 72       | 3.2      | p34      |
| EGR J2234+1127               | 338.61   | 11.46    | 77.65    | -39.08   | 0.17     |          | 21.7     | 2.8      | 204      | 9.7      |          | p1       | 10.0     | 4.6      | 133      | 8.9      | p3       | 7.9      | 4.3      | 25       | 2.7      | p4       | 30.6     | 4.6      | 132      | 8.9      | p12      | 18.9     | 2.5      | 212      | 9.3      | p34      | 31.3     | 7.5      | 14       | 1.5      | p12      |
| EGR J2240-6734               | 340.13   | -67.58   | -40.11   | -45.00   | 0.78     |          | 8.7      | 15.8     | 3.4      | 4.0      |          | p1       | 9.7      | 5.4      | 31       | 3.7      | p2       | 12.2     | 3.8      | 43       | 3.9      | p3       | 5.7      | 5.5      | 12       | 1.6      | p4       | 30.6     | 13.9     | 3.5      | 71       | 4.8      | p12      | 18.9     | 2.5      | 212      | 9.3      | p34      | 31.3     | 7.5      | 14       | 1.5      | p12      |
| EGR J2243+1519               | 340.96   | 15.33    | 82.99    | -37.45   | 0.70     |          | 75.8     | 25.7     | 21       | 4.1      |          | p1       | 7.9      | 5.5      | 12       | 1.6      | p2       | 12.2     | 3.8      | 43       | 3.9      | p3       | 7.9      | 5.5      | 12       | 1.6      | p4       | 30.6     | 13.9     | 3.5      | 71       | 4.8      | p12      | 18.9     | 2.5      | 212      | 9.3      | p34      | 31.3     | 7.5      | 14       | 1.5      | p12      |
| EGR J2251-1344               | 342.77   | -13.74   | 52.37    | -58.91   | 0.68     |          | 4.4      | 4.9      | 4.8      | 6        |          | p1       | 3.8      | 8.9      | 40       | 6.3      | p3       | 8.6      | 2.5      | 51       | 4.0      | p4       | 11.2     | 2.7      | 37       | 1.6      | p12      | 25.1     | 21.5     | 4        | 1.8      | p12      | 13.5     | 13.1     | 5        | 1.3      | p3       | 13.2     | 9.0      | 7        | 1.8      | p3       | 25.1     | 21.5     | 4        | 1.8      | p3       |
| EGR J2253+1606               | 343.48   | 16.10    | 86.06    | -38.22   | 0.19     |          | 67.6     | 26.8     | 286      | 15.6     |          | p1       | 67.4     | 6.8      | 286      | 15.6     | p3       | 50.4     | 6.7      | 127      | 10.8     | p4       | 76.1     | 6.8      | 284      | 15.6     | p12      | 41.3     | 4.8      | 207      | 11.4     | p34      | 8.4      | 6.1      | 12       | 1.6      | p3       | 48.6     | 3.6      | 492      | 18.1     | p34      | 86.7     | 24.0     | 30       | 4.9      | p12      | 25.2     | 9.6      | 31       | 3.1      | p12      | 20.9     | 15.7     | 8        | 1.6      | p3       | 50.5     | 6.8      | 127      | 10.8     | p12      |
| EGR J2256-5022               | 344.20   | -50.38   | -21.68   | -58.13   | 1.06     |          | 22.1     | 7.1      | 25       | 4.4      |          | p4       | 21.7     | 6.0      | 25       | 4.1      | p4       | 17.5     | 5.9      | 25       | 4.0      | p34      | 4.9      | 2.4      | 27       | 2.3      | p12      | 5.2      | 2.4      | 30       | 2.4      | p12      | 6.9      | 6.8      | 6        | 1.1      | p4       | 42.0     | 4.9      | 2.4      | 27       | 2.3      | p12      |
| EGR J2258-2745               | 344.54   | -27.75   | 24.91    | -64.91   | 0.37     |          | 157.6    | 26.5     | 60       | 9.8      |          | p789     | 42.0     | 4.9      | 2.4      | 27       | 2.3      | p12      | 5.2      | 2.4      | 30       | 2.4      | p12      | 6.9      | 6.8      | 6        | 1.1      | p4       | 42.0     | 4.9      | 2.4      | 27       | 2.3      | p12      | 5.2      | 2.4      | 30       | 2.4      | p12      |

Jean-Marc Casandjian and Isabelle A. Grenier: A revised catalogue of EGRET γ-ray sources, Online Material p 20
| No. | Source | RA (deg) | DEC (deg) | l (deg) | b (deg) | Energy (MeV) | R.A. (deg) | DEC. (deg) | l (deg) | b (deg) | energy (MeV) |
|-----|--------|----------|-----------|---------|---------|-------------|-----------|-----------|---------|---------|-------------|
| 170 | EGR J2308+3645 | 347.23 | 36.76 | 101.03 | -21.71 | 0.96 | 8.9 | 4.3 | 20 | 2.5 | p34 |
| 171 | EGR J2314+4430 | 348.70 | 44.51 | 105.34 | -15.04 | 0.46 | 38.2 | 9.3 | 49 | 5.5 | p34 |
| 172 | EGR J2320-0412 | 350.02 | -4.20 | 75.37 | -58.36 | 0.58 | 33.8 | 10.1 | 33 | 4.4 | 3200 |
| 173 | EGR J2353+3806 | 358.26 | 38.11 | 110.46 | -23.34 | 0.87 | 37.9 | 10.2 | 40 | 4.9 | 2110 |
| 174 | EGR J2357+4002 | 359.38 | 46.04 | 113.25 | -15.82 | 0.39 | 14.1 | 3.6 | 68 | 4.8 | 3EGJ2358+4604 |
### Table B.1. The EGR confused sources catalogue

| Num | Name   | RA    | Dec   | l     | b     | $\theta_{LS}$ | F     | $\sigma_F$ | Cntrs | $\sqrt{S}$ | $\theta_{VP}$ | b$_{sys}$ | F$_{sys}$ | 3EG      |
|-----|--------|-------|-------|-------|-------|---------------|-------|------------|--------|------------|---------------|-----------|-----------|-----------|
| 1   | EGRc J0225+6240 | 36.38 | 62.68 | 133.49 | 1.75  | 0.34          | 30.2  | 5.0        | 344    | 6.5        | 133.05       | 1.64      | 22.1      | 3EGJ0229+6151 |
| 2   | EGRc J0818-4613 | 124.74 | -46.23 | -97.25 | -5.73 | 0.31          | 29.6  | 5.7        | 368    | 5.6        | 24.9          | 1.12      | 2.40      | 3EGJ0229+6151 |
| 3   | EGRc J0842-4501 | 130.66 | -45.03 | -95.78 | -1.68 | 0.26          | 113.9 | 10.1       | 1360   | 12.2       | 98.7          | 7.7       | 30.6      | 3EGJ0229+6151 |
| 4   | EGRc J0912+7146 | 138.15 | 71.77  | 141.44 | 36.44 | 0.62          | 7.1   | 1.6        | 130    | 5.1        | 8.2           | 3.3       | 1.9       | 3EGJ0229+6151 |
| 5   | EGRc J0927+6054 | 141.91 | 60.91  | 153.55 | 42.15 | 0.67          | 5.1   | 1.5        | 81     | 4.0        | 4.1           | 1.9       | 1.5       | 3EGJ0229+6151 |
| 6   | EGRc J1038-5724 | 159.61 | -57.41 | -74.25 | 0.96  | 0.40          | 33.1  | 5.4        | 455    | 6.6        | 23.9          | 3.1       | 2.7       | 3EGJ0229+6151 |
| 7   | EGRc J1233-0318 | 188.46 | -3.30  | -65.69 | 59.28 | 1.04          | 10.4  | 2.9        | 78     | 4.1        | 7.3           | 3.6       | 4.6       | 3EGJ1230-0247 |
| 8   | EGRc J1255-0404 | 193.78 | -4.08  | -55.30 | 58.78 | 0.71          | 9.3   | 1.9        | 272    | 5.3        | 11.6          | 3.7       | 3.2       | 3EGJ1230-0247 |
| 9   | EGRc J1332-1217 | 203.04 | -12.29 | -41.69 | 49.36 | 0.56          | 5.9   | 1.6        | 112    | 4.0        | 6.9           | 3.3       | 4.5       | 3EGJ1230-0247 |
| 10  | EGRc J1740-2851 | 265.05 | -28.85 | -0.55  | 1.05  | 0.16          | 70.6  | 6.3        | 1750   | 11.8       | 52.7          | 10.8      | 1.7       | 3EGJ1736-2908 |

**Notes:**
- F: Flux (in 10^-9 erg cm^-2 s^-1)
- $\sigma_F$: Error on the flux (in 10^-9 erg cm^-2 s^-1)
- Cntrs: Number of counts
- $\sqrt{S}$: Error on the flux (in 10^-9 erg cm^-2 s^-1)
- $\theta_{VP}$: Angular separation from the source position
- b$_{sys}$: Systematic error on the error on the flux (in 10^-9 erg cm^-2 s^-1)
- F$_{sys}$: Systematic error on the flux (in 10^-9 erg cm^-2 s^-1)
- 3EG: Three-epoch EGRET catalog
| Source | Name          | RA      | Dec     | E              | Error | 90% Cont. | 120% Cont. |
|--------|---------------|---------|---------|----------------|-------|-----------|------------|
| 11     | EGRe J1747-2852 | 266.76  | -28.88  | 0.21           | -0.24 | 0.23      | 15.7       |
|        |               | 86.7    | 6.0     | 2158           | 15.7  | p19       | -0.01      |
|        |               | 78.7    | 10.4    | 601            | 8.2   | p1        | -0.47      |
|        |               | 73.8    | 13.3    | 360            | 6.0   | p2        | 146.2      |
|        |               | 81.8    | 11.4    | 586            | 7.7   | p3        |           |
|        |               | 132.0   | 17.1    | 432            | 8.7   | p4        |           |
|        |               | 76.6    | 8.2     | 958            | 10.1  | p12       |           |
|        |               | 95.8    | 9.5     | 1000           | 11.0  | p34       |           |
|        |               | 84.8    | 6.2     | 1947           | 14.8  | p1234     |           |
|        |               | 124.3   | 23.8    | 240            | 5.7   | p56       |           |
|        |               | 67.8    | 13.5    | 282            | 5.4   | p19       |           |
|        |               | 130.9   | 21.5    | 294            | 6.7   | p1234     |           |
|        |               | 91.1    | 29.5    | 92             | 3.4   | 4230      |           |
|        |               | 155.0   | 49.1    | 70             | 3.6   | 2230      |           |
|        |               | 62.1    | 25.5    | 79             | 2.6   | 2260      |           |
|        |               | 56.2    | 35.1    | 40             | 1.7   | 229        |
|        |               | 209.4   | 66.0    | 49             | 3.8   | 2310      |           |
|        |               | 140.5   | 39.3    | 88             | 4.0   | 4210      |           |
|        |               | 149.1   | 50.7    | 59             | 3.3   | 4235      |           |
| 12     | EGRe J2025+3559 | 306.48  | 35.99   | 75.07          | -1.18 | 0.46      | 18.5       |
|        |               | 40.8    | 6.6     | 459            | 6.6   | p12       | 75.22      |
|        |               | 33.9    | 10.1    | 155            | 3.6   | p1        | -1.09      |
|        |               | 43.5    | 8.7     | 290            | 5.4   | p2        | 40.6       |
|        |               | 10.5    | 9.7     | 47             | 1.1   | p3        |           |
|        |               | 11.5    | 9.7     | 52             | 1.2   | p34       |           |
|        |               | 32.0    | 5.5     | 504            | 6.2   | p1234     |           |
|        |               | 31.6    | 5.4     | 515            | 6.2   | p19       |           |
|        |               | 31.3    | 12.6    | 95             | 2.6   | 20        |           |
|        |               | 3.8     | 2.1     | 32             | 2.0   | p1234     |           |
|        |               | 3.0     | 1.9     | 30             | 1.8   | p19       |           |
|        |               | 18.6    | 5.7     | 36             | 4.1   | 4100      |           |
|        |               | 26.2    | 6.7     | 63             | 4.8   | p3        | 85.93      |
|        |               | 10.2    | 5.4     | 36             | 2.0   | p1        | -36.41     |
|        |               | 9.8     | 5.4     | 35             | 2.0   | p12       | 24.8       |
|        |               | 14.5    | 4.2     | 73             | 3.9   | p34       |           |
|        |               | 13.7    | 3.4     | 118            | 4.5   | p1234     |           |
|        |               | 12.9    | 3.0     | 128            | 4.7   | p19       |           |
|        |               | 31.0    | 9.8     | 37             | 4.0   | 3200      |           |
| 13     | EGRe J2215+0653 | 333.81  | 6.89    | 69.17          | -39.16 | 0.59    | 18.5       |
|        |               | 18.5    | 5.7     | 36             | 4.1   | p4        | 69.01      |
|        |               | 10.9    | 3.7     | 44             | 3.5   | p34       | -38.58     |
|        |               | 3.8     | 2.1     | 32             | 2.0   | p1234     | 18.2       |
|        |               | 3.0     | 1.9     | 30             | 1.8   | p19       |           |
|        |               | 18.6    | 5.7     | 36             | 4.1   | 4100      |           |
|        |               | 26.2    | 6.7     | 63             | 4.8   | p3        | 85.93      |
|        |               | 10.2    | 5.4     | 36             | 2.0   | p1        | -36.41     |
|        |               | 9.8     | 5.4     | 35             | 2.0   | p12       | 24.8       |
|        |               | 14.5    | 4.2     | 73             | 3.9   | p34       |           |
|        |               | 13.7    | 3.4     | 118            | 4.5   | p1234     |           |
|        |               | 12.9    | 3.0     | 128            | 4.7   | p19       |           |
|        |               | 31.0    | 9.8     | 37             | 4.0   | 3200      |           |
| 14     | EGRe J2249+1724 | 342.39  | 17.41   | 85.89          | -36.55 | 0.42    | 26.2       |
|        |               | 26.2    | 6.7     | 63             | 4.8   | p3        | 85.93      |
|        |               | 10.2    | 5.4     | 36             | 2.0   | p1        | -36.41     |
|        |               | 9.8     | 5.4     | 35             | 2.0   | p12       | 24.8       |
|        |               | 14.5    | 4.2     | 73             | 3.9   | p34       |           |
|        |               | 13.7    | 3.4     | 118            | 4.5   | p1234     |           |
|        |               | 12.9    | 3.0     | 128            | 4.7   | p19       |           |
|        |               | 31.0    | 9.8     | 37             | 4.0   | 3200      |           |