



This all-sky image, constructed from two years of observations by NASA's Fermi Gamma-ray Space Telescope, shows how the sky appears at light energies greater than 1 billion electron volts (1 GeV). As a comparison, the x-rays used by your dentist to search for cavities have energies of only about 5,000 electron volts (5 KeV). In the false-color diagram above, brighter colors like red orange and yellow, indicate brighter gamma-ray sources.

Earlier this year, the Fermi team released its second catalog of sources detected by the satellite's Large Area Telescope (LAT), producing an inventory of 1,873 gamma-ray point-sources found in their survey. The resulting classifications of the sources are shown in the lower-left table.

A much smaller study of 11 of these 572 unidentified Fermi/LAT sources by the Japanese Suzaku X-ray Observatory revealed that 6 could be identified as pulsars, 3 were unknown, 1 was a normal flaring star and 1 was a blazar-type galaxy.

Problem 1 – Based upon the results from the second Suzaku Survey of the ‘unknown’ objects, and assuming that the Suzaku objects were randomly selected from the Fermi/LAT ‘unknowns’ , what are the new percentages for the 6 categories?

Problem 2 – What is the probability that the remaining unknown Fermi/LAT survey sources are very faint supernovae and pulsars within our own Milky Way galaxy?

Type of Object	Number
Blazar galaxy	1069
Pulsars	115
Supernovae	77
Active Galaxies	20
Normal galaxies and stars	20
Unknown objects	572

The original percentages are listed in the table below and the actual pie graph provided by the Fermi/LAT research report.

Type of Object	Number	Percentage
Blazar galaxy	1069	57%
Pulsars	115	6%
Supernovae	77	4%
Active Galaxies	20	1%
Normal galaxies and stars	20	1%
Unknown objects	572	31%

Problem 1 – Answer: Suzaku survey says that the 11 sources are distributed as follows:
572

Pulsars = 6/11
 Unknown = 3/11
 Normal star = 1/11
 Blazar = 1/11

If the 572 unknowns in the Fermi/LAT are distributed in the same way, there should be

Pulsars = $6/11 \times 572 = 312$ sources
 Unknown = $3/11 \times 572 = 156$ sources
 Normal star = $1/11 \times 572 = 52$ sources
 Blazar = $1/11 \times 572 = 52$ sources.

Adding these to the already identified Fermi/LAT source types we get the new distribution:

Type of Object	Number (N=1873)	Percentage
Blazar galaxy	$1069 + 52 = 1121$	60%
Pulsars	$115 + 312 = 427$	23%
Supernovae	$77 = 77$	4%
Active Galaxies	$20 = 20$	1%
Normal galaxies and stars	$20 + 52 = 72$	4%
Unknown objects	156	8%

Problem 2 – What is the probability that the remaining unknown Fermi/LAT survey sources are very faint supernovae and pulsars in our Milky Way galaxy?

Answer: $4\% + 23\% = 27\%$