Blazar Census

1
00:00:08,150 --> 00:00:04,050
Music

2
00:00:08,170 --> 00:00:12,160
Announcer: Five, four, three,

3
00:00:12,180 --> 00:00:16,180
engines start, one, zero, and

4
00:00:16,200 --> 00:00:20,220
liftoff of the Delta rocket carrying GLAST, a

5
00:00:20,240 --> 00:00:24,290
gamma-ray telescope searching for unseen physics in the stars of the

6
00:00:24,310 --> 00:00:28,320
galaxies. Narrator: Launched on June 11, 2008,

7
00:00:28,340 --> 00:00:32,370
GLAST, renamed the Fermi Gamma-ray Space Telescope, has

8
00:00:32,390 --> 00:00:36,440
been collecting gamma-ray data for five years. In that time

9
00:00:36,460 --> 00:00:40,610
it has made some astounding observations of some of the most powerful events

10
00:00:40,630 --> 00:00:44,650
and objects in the universe. Including some right on our doorstep.

11
00:00:44,670 --> 00:00:48,680
Narrator 2: Fermi looks at gamma rays, the highest energy form of light,

12
00:00:48,700 --> 00:00:52,740
and it just surprised everyone with a discovery about the fabric of space and time.

13
00:00:52,760 --> 00:00:56,910

Julie McEnery: Because Fermi saw no delay in the arrival time of the two photons, it

14
00:00:56,930 --> 00:01:00,980
confirms that space and time is smooth and continuous as

15
00:01:01,000 --> 00:01:05,050
Einstein had predicted. Narrator 3: With Fermi,

16
00:01:05,070 --> 00:01:09,230
astronomers have made the most accurate measurement of starlight in the universe, and

17
00:01:09,250 --> 00:01:13,300
used it to establish the total amount of light from all the stars that have ever shown.

18
00:01:13,320 --> 00:01:17,400
Narrator 4: In April 2013,

19
00:01:17,420 --> 00:01:21,430
a shockingly bright blast of gamma rays from a dying in a

20
00:01:21,450 --> 00:01:25,480
distant galaxy, produced the highest-energy light ever detected from such an event.

21
00:01:25,500 --> 00:01:29,560
Elizabeth Hays: Every three hours

22
00:01:29,580 --> 00:01:33,580
the Large Area Telescope on board Fermi builds up a picture of the sky in

23
00:01:33,600 --> 00:01:37,630
gamma rays. One thing it sees a lot of is blazars--active galaxies

24
00:01:37,650 --> 00:01:41,710
whose emissions are powered by supermassive black holes. Because we're

25
00:01:41,730 --> 00:01:45,740
watching them all the time, we can track their activity and alert other telescopes to

26
00:01:45,760 --> 00:01:49,800
new flare-ups. Narrator 5: Two years of scanning the sky with Fermi's

27
00:01:49,820 --> 00:01:53,890
Large Area Telescope have set the strongest limits yet for WIMP

28
00:01:53,910 --> 00:01:57,990
dark matter. The longer Fermi operates, the better its ability either

29
00:01:58,010 --> 00:02:02,020
to box in the nature of dark matter, or to find actual evidence of what it is.

30
00:02:02,040 --> 00:02:06,140
Narrator 6: Scientists have recently discovered a gigantic,

31
00:02:06,160 --> 00:02:10,250
mysterious structure in our galaxy. This never-before-seen feature looks like

32
00:02:10,270 --> 00:02:14,300
a pair of bubbles extending above and below our galaxy's center.

33
00:02:14,320 --> 00:02:18,360
Narrator 7: New images show where supernova remnants

34
00:02:18,380 --> 00:02:22,460
emit gamma rays a billion times more energetic than visible light.

35
00:02:22,480 --> 00:02:26,480
This glow suggests that the remnants are a source of cosmic rays--

36
00:02:26,500 --> 00:02:30,560
protons and electrons accelerated to near light speed.

37
00:02:30,580 --> 00:02:34,590
Narrator 8: Observations of two supernova remnants by NASA's Fermi Gamma-ray

38
00:02:34,610 --> 00:02:38,660

Space Telescope conclusively show these supernova remnants are accelerating

39
00:02:38,680 --> 00:02:42,700
protons. When they strike protons in nearby molecular clouds,

40
00:02:42,720 --> 00:02:46,800
they produce the gamma-ray emission Fermi sees.

41
00:02:46,820 --> 00:02:50,830
Narrator 9: Recently, astronomers have observed incredible flares in the nebula that theorists are hard-pressed

42
00:02:50,850 --> 00:02:54,890
to explain. The gamma rays most likely arise from electrons moving near the speed of

43
00:02:54,910 --> 00:02:58,980
light, but to account for these flares, the electrons must have the highest energies

44
00:02:59,000 --> 00:03:03,020
ever seen in cosmic sources. Narrator 10: In three

45
00:03:03,040 --> 00:03:07,060
years Fermi has detected more than 100 gamma-ray pulsars. And about a third of gamma-ray

46
00:03:07,080 --> 00:03:11,140
pulsars were discovered by Fermi on the basis of their gamma-ray pulsations alone.

47
00:03:11,160 --> 00:03:15,160
Narrator 11: In late 2010, NASA's Fermi Gamma-ray Space

48
00:03:15,180 --> 00:03:19,220
Telescope watched the system glow with faint gamma emission as the pulsar first

49
00:03:19,240 --> 00:03:23,260
approached the disk. Astronomers expected the same behavior in early 2011

50
00:03:23,280 --> 00:03:27,320
when the outbound pulsar grazed the disk again, but, instead,

51
00:03:27,340 --> 00:03:31,410
Fermi detected intense and puzzling gamma-ray flares.

52
00:03:31,430 --> 00:03:35,450
Roger Romani: We managed to get enough observations of the object to piece together its orbital period.

53
00:03:35,470 --> 00:03:39,520
And found, remarkably, that it was an incredibly heated

54
00:03:39,540 --> 00:03:43,650
object--blue white on one side, deep, deep red on the other--

55
00:03:43,670 --> 00:03:47,750
and it was orbiting around an energetic pulsar with an orbital period of about one-and-a-half

56
00:03:47,770 --> 00:03:51,770
hours. The gamma rays are blasting the companion at point-blank range.

57
00:03:51,790 --> 00:03:55,860
Narrator 12: Fermi found that star birth and

58
00:03:55,880 --> 00:03:59,890
death in the Cygnus X star factory corrals particles and

59
00:03:59,910 --> 00:04:03,940
boosts them to cosmic-ray energies. Narrator 13: In

60
00:04:03,960 --> 00:04:08,020
early March 2012, a powerful flare erupted on the sun

61
00:04:08,040 --> 00:04:12,130
During this event, the LAT detected the highest energy light every recorded from a

62
00:04:12,150 --> 00:04:16,220
solar flare. Narrator 14: New observations by NASA's Fermi

63
00:04:16,240 --> 00:04:20,380

Gamma-ray Space Telescope show that thunderstorms make antimatter.

64
00:04:20,400 --> 00:04:24,420
The process starts with a terrestrial gamma-ray flash, or TGF;

65
00:04:24,440 --> 00:04:28,460
an intense pulse of gamma rays originating from thunderstorms.

66
00:04:28,480 --> 00:04:32,520
Narrator 15: Scientists have discovered that radio signals, once thought to be produced by the lighting

67
00:04:32,540 --> 00:04:36,590
that triggers a TGF, are in fact broadcast by TGFs themselves.

68
00:04:36,610 --> 00:04:40,650
Eric Stoneking: There was a defunct Russian satellite

69
00:04:40,670 --> 00:04:44,710
in an orbit that would intersect Fermi's orbit in about a week. Julie McEnery: Those two spacecraft

70
00:04:44,730 --> 00:04:48,820
were occupying the same space within 30 milliseconds of each other.

71
00:04:48,840 --> 00:04:52,930
That's why this was scary. Having done the maneuver, and avoided

72
00:04:52,950 --> 00:04:57,070
a collision means we continue operating, so continue doing

73
00:04:57,090 --> 00:05:01,090
the great science that we have been doing over the past four-and-a-half years.

74
00:05:01,110 --> 00:05:04,110
Music