
Magnetic Field Line
Gamma Rays

1
00:00:12,140 --> 00:00:04,040
Sound Effect

2
00:00:12,160 --> 00:00:16,200
Narrator: At any given moment about 1,800 thunderstorms are in

3
00:00:16,220 --> 00:00:20,200
progress somewhere on the globe. New observations by NASA's

4
00:00:20,220 --> 00:00:24,220
Fermi Gamma-ray Space Telescope show that thunderstorms make antimatter.

5
00:00:24,240 --> 00:00:28,280
The process starts with a terrestrial gamma-ray flash,

6
00:00:28,300 --> 00:00:32,280
or TGF; an intense pulse of gamma rays originating from thunderstorms.

7
00:00:32,300 --> 00:00:36,300
These dots mark TGF's observed by

8
00:00:36,320 --> 00:00:40,340
Fermi's Gamma-ray Burst Monitor during the spacecraft's first eight months of

9
00:00:40,360 --> 00:00:44,360
operations. Researchers estimate that there may be as many as five

10
00:00:44,380 --> 00:00:48,430
hundred TGF's each day.

11
00:00:48,450 --> 00:00:52,610
On December 14, 2009, as Fermi passed over Egypt, it

12
00:00:52,630 --> 00:00:56,640
spotted a TGF produced by a thunderstorm in Zambia

13
00:00:56,660 --> 00:01:00,730

The TGF was over the spacecraft's horizon where Fermi couldn't see it.

14
00:01:00,750 --> 00:01:04,780
So how could FermiI have detected it? Scientists

15
00:01:04,800 --> 00:01:08,810
believe that the TGF process begins with thunderstorm's intense electrical

16
00:01:08,830 --> 00:01:12,850
field. Electrons within this field become accelerated upward

17
00:01:12,870 --> 00:01:16,920
above the storm where the air is thin, the electrons can ramp up to speeds

18
00:01:16,940 --> 00:01:20,930
nearly as fast as the speed of light.

19
00:01:20,950 --> 00:01:24,960
When these ultra-fast electrons encounter an atom, they emit gamma rays.

20
00:01:24,980 --> 00:01:29,010
Very rarely, one of these gamma-ray photons grazes an atom

21
00:01:29,030 --> 00:01:33,030
and transforms into a pair of particles. One, an electron,

22
00:01:33,050 --> 00:01:37,070
is normal matter; the other is antimatter, the electron's opposite,

23
00:01:37,090 --> 00:01:41,100
called a positron. The gamma rays travel in straight

24
00:01:41,120 --> 00:01:45,150
lines, but the charged particles spiral along lines of Earth's magnetic field.

25
00:01:45,170 --> 00:01:49,250
And that was the route to Fermi. The particles created

26
00:01:49,270 --> 00:01:53,260
by the TGF rode upwards on magentic field lines and then struck

27
00:01:53,280 --> 00:01:57,290
the spacecraft. The positrons annihilated when they struck electrons in

28
00:01:57,310 --> 00:02:01,320
Fermi creating a flash of gamma rays. For an instant

29
00:02:01,340 --> 00:02:05,350
Fermi became a gamma-ray source and set off its own detectors.

30
00:02:05,370 --> 00:02:09,410
A fraction of a second later, some of the particles were bounced back

31
00:02:09,430 --> 00:02:13,420
along the same magnetic field line. They again passed through Fermi and again

32
00:02:13,440 --> 00:02:17,470
produced gamma rays. The spacecraft has observed this phenomenon

33
00:02:17,490 --> 00:02:21,520
in at least four other occasion. So the next time lightning flashes

34
00:02:21,540 --> 00:02:25,610
and thunder roars remember-you may be witnessing antimatter

35
00:02:25,630 --> 00:02:29,700
in the making.

36
00:02:29,720 --> 00:02:33,740
Music