1
00:00:00,030 --> 00:00:04,600
Like a lot of kids, I grew up reading about neutrinos

2
00:00:04,600 --> 00:00:08,280
and people speculating about doing neutrino astronomy.

3
00:00:08,300 --> 00:00:12,470
And here I am, doing neutrino astronomy, I feel like I need

4
00:00:12,490 --> 00:00:16,680
to pinch myself. My name is Roopesh Ojha,

5
00:00:16,700 --> 00:00:20,520
and I'm an astronomer working at the Goddard Space Flight Center.

6
00:00:20,520 --> 00:00:24,880
I work with the Fermi Gamma-ray Space Telescope. What we

7
00:00:24,910 --> 00:00:29,050
have been able to establish, for the first time, is an individual

8
00:00:29,070 --> 00:00:33,150
blazar as a potential birthplace of an individual neutrino.

9
00:00:33,170 --> 00:00:37,210
The Fermi Gamma-ray Space Telescope has an instrument called the Large Area Telescope, which

10
00:00:37,230 --> 00:00:41,330
we use to monitor the gamma-ray sky-the highest-energy electromagnetic band.

11
00:00:41,350 --> 00:00:45,410
And we just noticed that there was a tremendous

12
00:00:45,430 --> 00:00:49,510
increase in the amount of gamma-ray light coming from this one extra-galactic blazar.

13
00:00:49,530 --> 00:00:53,710

A blazar is an extremely powerful, variable,

14
00:00:53,730 --> 00:00:57,890
galaxy that is powered by a supermassive black hole.

15
00:00:57,910 --> 00:01:02,080
It went up not by a little bit, not by a few percent, it

16
00:01:02,100 --> 00:01:06,180
went up, like, 15 to 30 times its average flux.

17
00:01:06,200 --> 00:01:10,230
So we knew something was afoot, later on it

18
00:01:10,250 --> 00:01:14,360
turned out to be coincident, both in time and in space, with

19
00:01:14,380 --> 00:01:18,420
the neutrino that was detected by IceCube.

20
00:01:18,440 --> 00:01:22,570
IceCube is a neutrino telescope located at the South Pole, or to be

21
00:01:22,590 --> 00:01:26,170
more precise, under it.

22
00:01:26,170 --> 00:01:30,660
It consists of over 5,000 detectors that are spread out into a

23
00:01:30,680 --> 00:01:34,790
cube about a kilometer on each side.

24
00:01:34,810 --> 00:01:38,840
It's the world's biggest and it's coolest telescope.

25
00:01:38,860 --> 00:01:43,000
So a neutrino is an incredibly small

26
00:01:43,020 --> 00:01:47,100
particle, it moves almost at the speed of light,

27
00:01:47,120 --> 00:01:51,160
it is nearly massless, it's incredibly plentiful,

28
00:01:51,180 --> 00:01:55,300
but, it's very, very hard to detect because it

29
00:01:55,320 --> 00:01:59,380
will not interact with just about anything. If you could detect

30
00:01:59,400 --> 00:02:03,430
them though, because they have traveled through the universe essentially undeflected,

31
00:02:03,450 --> 00:02:07,500
they have information that you could not access in any other way.

32
00:02:07,520 --> 00:02:11,690
IceCube has detected a handful of extremely energetic

33
00:02:11,710 --> 00:02:15,740
neutrinos. One of them, which is called Big Bird, has an energy of

34
00:02:15,760 --> 00:02:19,870
about 2 peta-electron volts. To give you an idea of how much energy

35
00:02:19,890 --> 00:02:24,020
that is, it is about a million, million times the

36
00:02:24,040 --> 00:02:28,040
energy of dental X-ray. IceCube sees too large

37
00:02:28,060 --> 00:02:32,100
a patch of sky to let us determine exactly which blazar Big Bird

38
00:02:32,120 --> 00:02:36,220

came from. The enormous increase in gamma-ray flux seen by

39
00:02:36,240 --> 00:02:40,310
LAT and radio flux by other TANAMI telescopes let us finger

40
00:02:40,330 --> 00:02:44,410
the exact blazar which is responsible for Big Bird.

41
00:02:44,430 --> 00:02:48,600
We have long suspected that blazars are the birthplaces

42
00:02:48,620 --> 00:02:52,660
of such neutrinos. What we have been able to establish, for the

43
00:02:52,680 --> 00:02:56,740
first time, is an individual blazar as a potential

44
00:02:56,760 --> 00:03:00,810
birthplace of an individual neutrino. This is the first time that we can point

45
00:03:00,830 --> 00:03:04,960
and say "That blazar is where this neutrino came from."

46
00:03:04,980 --> 00:03:09,140
Blazars are the brightest steadily shining

47
00:03:09,160 --> 00:03:13,180
objects in the universe. However, many of the most basic questions

48
00:03:13,200 --> 00:03:17,290
about them, such as what is producing this tremendous amount of

49
00:03:17,310 --> 00:03:21,360
energy, remain open, and unanswered. The same process

50
00:03:21,380 --> 00:03:25,480
that produces this neutrino could also produce gamma rays,

51
00:03:25,500 --> 00:03:29,670
and that would move us closer to an understanding of emission from near black holes

52
00:03:29,690 --> 00:03:33,710
in blazars. [Music]

53
00:03:45,860 --> 00:03:37,760
[Music]