1
00:00:00,000 --> 00:00:08,258
■
A team of observatories, including NASA’s Swift satellite,
recently joined forces to trace a hard-to-detect cosmic particle

2
00:00:08,258 --> 00:00:11,219
back to its dramatic origin.

3
00:00:11,219 --> 00:00:16,099
The particle, called a high-energy neutrino,
was likely produced by a tidal disruption event,

4
00:00:16,099 --> 00:00:19,561
which occurs when a star passes too close to a black hole.

5
00:00:19,561 --> 00:00:24,441
There, extreme gravity causes the star to bulge
and break apart into a stream of gas,

6
00:00:24,441 --> 00:00:30,030
with some of the material swinging around to form an accretion disk.

7
00:00:30,030 --> 00:00:36,161
Neutrinos vastly outnumber all the atoms in the universe,
but they have almost no mass and rarely interact with other matter,

8
00:00:36,161 --> 00:00:38,246
so they’re very hard to pin down.

9
00:00:38,246 --> 00:00:43,376
However, scientists have detected them coming from
extreme objects like exploding stars.

10
00:00:43,376 --> 00:00:46,421
High-energy neutrinos come from even more bizarre places,

11
00:00:46,421 --> 00:00:51,301
like super-fast particle jets driven by supermassive black holes.

12
00:00:51,301 --> 00:00:55,680
Scientists suspected that tidal disruptions could also produce
high-energy neutrinos.

13
00:00:55,680 --> 00:01:00,602
But they weren’t sure where or when in the process
the particles might appear.

14
00:01:00,602 --> 00:01:04,064
Some suggested powerful jets would create these neutrinos.

15
00:01:04,064 --> 00:01:10,570
Regardless of how they’re made, though, astronomers expected
they’d appear early on, when the event is brightest.

16
00:01:10,570 --> 00:01:18,161
However, a high-energy neutrino arriving from a tidal disruption
called AT2019dsg offered new insights.

17
00:01:18,161 --> 00:01:23,708
An observatory called the Zwicky Transient Facility in California
discovered the event in April 2019,

18
00:01:23,708 --> 00:01:31,674
but it wasn’t until October that the IceCube Neutrino Observatory in Antarctica
detected a high-energy neutrino astronomers linked to this event.

19
00:01:31,674 --> 00:01:38,348
Measurements by Swift and other observatories show that the tidal disruption’s
visible and ultraviolet light peaked and appeared to plateau,

20
00:01:38,348 --> 00:01:40,683
and its X-rays dimmed quickly.

21
00:01:40,683 --> 00:01:44,646
However, radio telescopes saw its emission steadily increase.

22
00:01:44,646 --> 00:01:50,902
This meant some particles were being accelerated

even though super-fast particle jets were never detected.

23
00:01:50,902 --> 00:01:57,450
So, AT2019dsg had the right environment to accelerate particles
and produce high-energy neutrinos --

24
00:01:57,450 --> 00:02:01,329
and maintained it for a longer period than scientists expected.

25
00:02:01,329 --> 00:02:05,208
Astronomers think the neutrino may have come from one of three regions:

26
00:02:05,208 --> 00:02:10,880
in the disk close to the black hole, where particles colliding with
X-rays could produce neutrinos;

27
00:02:10,880 --> 00:02:14,717
further out in the disk, where particles could interact with UV light;

28
00:02:14,717 --> 00:02:19,013
or in broad outflows where particles could collide with each other.

29
00:02:19,013 --> 00:02:24,519
This is only the second time a high-energy neutrino
has been tied to a source beyond our galaxy.

30
00:02:24,519 --> 00:02:29,983
Scientists are searching for links between
previous tidal disruptions and other high-energy neutrinos.