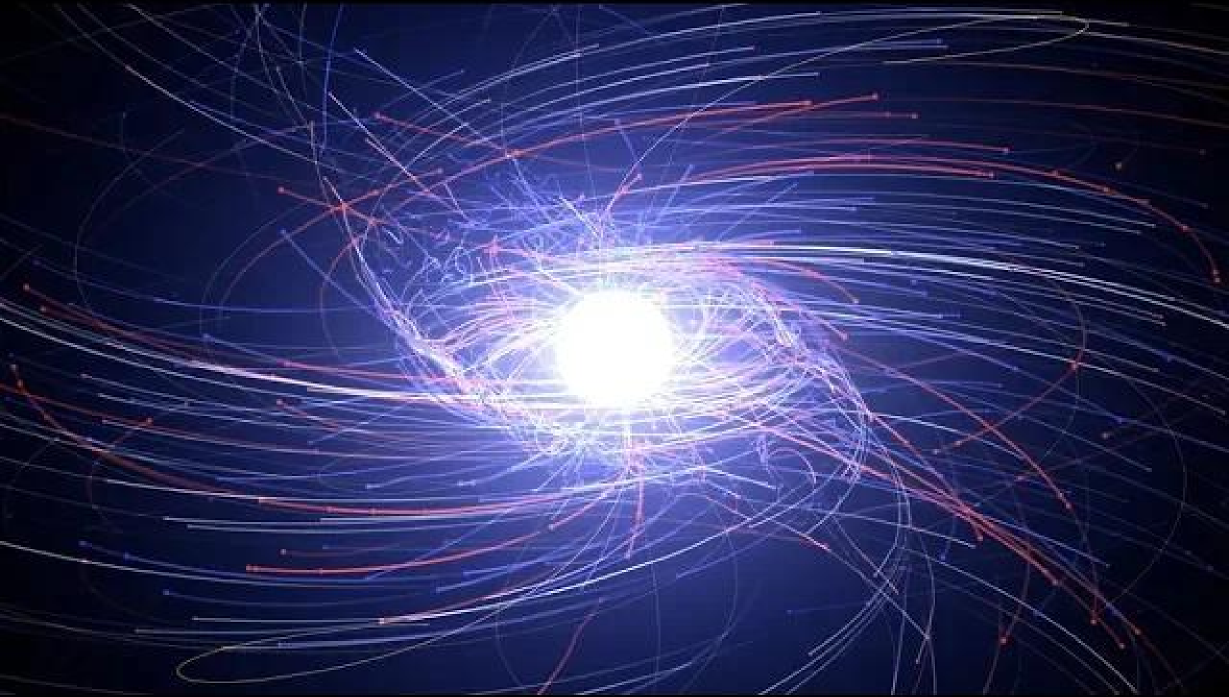

1
00:00:00,020 --> 00:00:03,280
[Music] Narrator: A pulsar is the

2
00:00:03,280 --> 00:00:08,160
crushed core of an exploded star. Theorists have been

3
00:00:08,170 --> 00:00:12,260
trying to understand the details of how pulsars work ever since they were discovered

4
00:00:12,260 --> 00:00:16,390
in 1967 -- especially how they emit precisely

5
00:00:16,390 --> 00:00:20,610
timed pulses at radio to gamma-ray energies.

6
00:00:20,610 --> 00:00:24,670
Now, new computer simulations are providing surprising insights.

7
00:00:24,670 --> 00:00:28,710
A pulsar contains some of the strongest magnetic fields known

8
00:00:28,710 --> 00:00:32,770
and can spin thousands of times a second. That means it's a

9
00:00:32,770 --> 00:00:36,880
powerful dynamo, generating an electric field so strong

10
00:00:36,880 --> 00:00:41,060
particles are ripped out of the surface and accelerated into space.

11
00:00:41,060 --> 00:00:45,150
New computer simulations clearly show these incredible movements for the

12
00:00:45,150 --> 00:00:49,220
first time. Most of these particles are electrons and their

13
00:00:49,220 --> 00:00:53,320

antimatter counterparts, positrons. In these simulations,

14
00:00:53,320 --> 00:00:57,470
their colors get lighter as they attain higher energies.

15
00:00:57,470 --> 00:01:01,530
Electrons tend to race outward from the magnetic poles.

16
00:01:01,530 --> 00:01:05,650
Positrons mostly flow out at lower latitudes along a relatively thin structure

17
00:01:05,650 --> 00:01:09,840
called the current sheet. Ultimately, these

18
00:01:09,840 --> 00:01:13,980
outflows lead to the formation of a powerful wind that extends far from

19
00:01:13,980 --> 00:01:18,090
the pulsar. Magnetic field lines

20
00:01:18,090 --> 00:01:22,250
and the particles moving with them, sweep back and extend outward as the

21
00:01:22,250 --> 00:01:26,440
pulsar spins. Their rotational speed rises with greater distance,

22
00:01:26,440 --> 00:01:30,510
but there's a wall created by the ultimate speed limit --

23
00:01:30,510 --> 00:01:34,560
the speed of light. Astronomers call this the light cylinder.

24
00:01:34,560 --> 00:01:38,660
Matter can't travel at the speed of light, so something has to give

25
00:01:38,660 --> 00:01:42,770
before the particles get this far. Just before reaching

26
00:01:42,770 --> 00:01:46,820
the light cylinder, these simulations show that a population of medium-energy

27
00:01:46,820 --> 00:01:50,890
electrons scatter wildly -- sometimes even back toward the pulsar.

28
00:01:50,890 --> 00:01:54,940
Some speed up, others slow. Most

29
00:01:54,940 --> 00:01:59,100
eventually slip past the light cylinder and head out into space.

30
00:01:59,100 --> 00:02:03,250
The simulations also show that a small percentage of positrons

31
00:02:03,250 --> 00:02:07,280
likely hold the secret to a pulsar's gamma-ray emission.

32
00:02:07,280 --> 00:02:11,390
Some of these particles become boosted to tremendous energies at points within

33
00:02:11,390 --> 00:02:15,560
the current sheet where magnetic field lines meet. These simulations

34
00:02:15,560 --> 00:02:19,760
bring scientists one step closer to understanding the incredible physics

35
00:02:19,760 --> 00:02:23,840
of pulsars, something that has kept theorists busy for decades.

36
00:02:23,840 --> 00:02:27,900
[Music stops]

37
00:02:30,700 --> 00:02:36,140
[These visualizations use data from simulations by Brambilla et al., 2018]