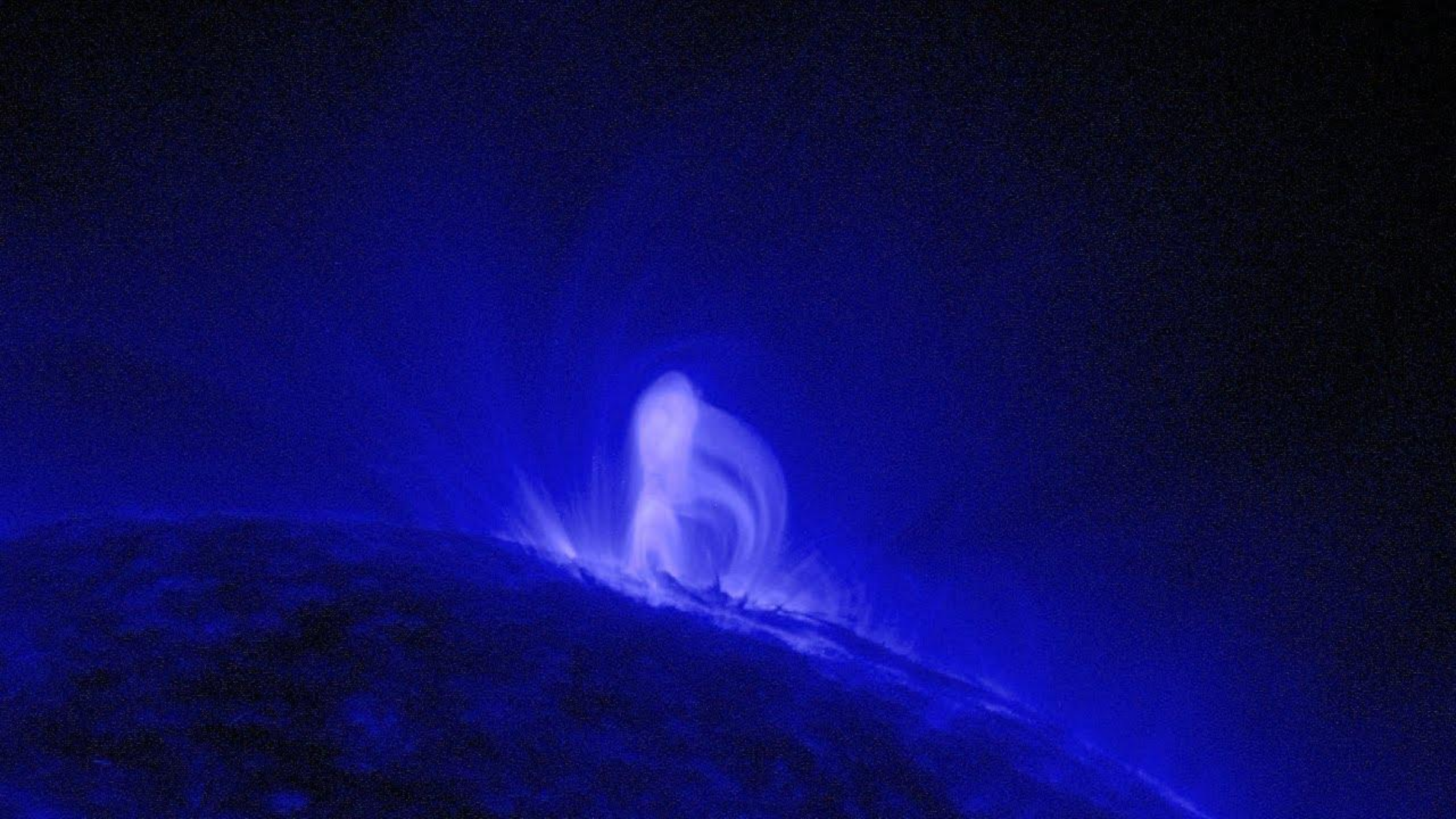

1
00:00:00,010 --> 00:00:08,020
Bell tone

2
00:00:08,040 --> 00:00:12,040
Narrator: Coronal mass ejections, or CMEs, are huge

3
00:00:12,060 --> 00:00:16,050
clouds of plasma and magnetic field occasionally thrown off by the sun.

4
00:00:16,070 --> 00:00:20,070
Scientists study them because the massive bursts pose a threat to space-based technology

5
00:00:20,090 --> 00:00:24,080
and even power grids on the ground. Within each CME lies a

6
00:00:24,100 --> 00:00:28,110
kernel known as a flux rope: tightly wound groups of magnetic field lines that can

7
00:00:28,130 --> 00:00:32,150
contain and transport solar material. Astronomers

8
00:00:32,170 --> 00:00:36,180
have seen them as the CME bursts off the sun, but they have been next to impossible to

9
00:00:36,200 --> 00:00:40,200
detect on the sun itself. New research using NASA's Solar

10
00:00:40,220 --> 00:00:44,230
Dynamics Observatory has now shown that they can been seen in just one of its cameras,

11
00:00:44,250 --> 00:00:48,250
which shows the very hottest material on the sun. By

12
00:00:48,270 --> 00:00:52,280
watching a flux rope form and eject as a CME, the research has brought some closure to

13
00:00:52,300 --> 00:00:56,290

one long-standing mystery: whether ropes form before or during the

14
00:00:56,310 --> 00:01:00,330
CME's eruption. It's impossible to actually see the flux ropes,

15
00:01:00,350 --> 00:01:04,350
or any of the sun's powerful magnetic fields involved with CMEs and flares,

16
00:01:04,370 --> 00:01:08,380
because these fields are invisible. But scientists can map them by observing

17
00:01:08,400 --> 00:01:12,410
plasma trapped by these fields, which shows up as thin lines in extreme ultraviolet

18
00:01:12,430 --> 00:01:16,430
light. Since Earth's atmosphere naturally filters this UV

19
00:01:16,450 --> 00:01:20,450
light, scientists must observe it using telescopes in space, such as

20
00:01:20,470 --> 00:01:24,490
NASA's SDO, so there have been relatively few detailed observations of

21
00:01:24,510 --> 00:01:28,520
CMEs, particularly at higher temperatures. SDO images

22
00:01:28,540 --> 00:01:32,570
the sun at high image and time resolution, it is also the first satellite to

23
00:01:32,590 --> 00:01:36,600
consistently observe light with a wavelength of 131 Angstroms, which highlights

24
00:01:36,620 --> 00:01:40,650
plasma at temperatures of around 10 million degrees. This

25
00:01:40,670 --> 00:01:44,780
wavelength is usually reserved for studying solar flares, but NASA and

26
00:01:44,800 --> 00:01:48,920
Naval Research Laboratory scientists found, is that the flux ropes associated with

27
00:01:48,940 --> 00:01:52,930
CMEs could only be seen at this temperature. On July 19,

28
00:01:52,950 --> 00:01:56,960
2012, a CME erupted from the visible edge, or limb, of the sun.

29
00:01:56,980 --> 00:02:00,990
Because it was on the limb, the flux ropes were in profile and particularly

30
00:02:01,010 --> 00:02:05,030
visible. Even more important, the flux ropes appeared about 7 hours

31
00:02:05,050 --> 00:02:09,050
earlier in the same location. The ropes were visible as a line of

32
00:02:09,070 --> 00:02:13,100
figure eights that looked exactly the way theorists predicted they would.

33
00:02:13,120 --> 00:02:17,130
This is the first direct evidence that flux ropes form well before a coronal

34
00:02:17,150 --> 00:02:21,150
mass ejection. Footage of the CME from the

35
00:02:21,170 --> 00:02:25,180
SOHO spacecraft confirmed the presence of the flux ropes.

36
00:02:25,200 --> 00:02:29,210
By adding footage from the STEREO A spacecraft, which is viewing the sun from

37
00:02:29,230 --> 00:02:33,250
an entirely different angle, the researchers were able to create a three dimensional picture

38
00:02:33,270 --> 00:02:37,300

of the flux ropes. For the most part, they follow the classic

39
00:02:37,320 --> 00:02:41,330
figure eight pattern previously observed and predicted by solar models, but

40
00:02:41,350 --> 00:02:45,350
some of these ropes also had feet which extended farther away than scientists expected.

41
00:02:45,370 --> 00:02:49,390
This deviation from the models is interesting, and requires

42
00:02:49,410 --> 00:02:53,430
further study. Besides showing proof of early

43
00:02:53,450 --> 00:02:57,500
flux rope formation, this study also paves the way for future flux rope and CME

44
00:02:57,520 --> 00:03:01,570
research by literally finding a new light to observe them in. The

45
00:03:01,590 --> 00:03:05,630
possibility of using flux rope formation as an early warning system for CMEs

46
00:03:05,650 --> 00:03:09,670
means that this line of research can have some very practical and far-reaching applications.

47
00:03:09,690 --> 00:03:13,690
And it can also help wrap up some of the long standing mysteries

48
00:03:13,710 --> 00:03:17,720
of the sun.