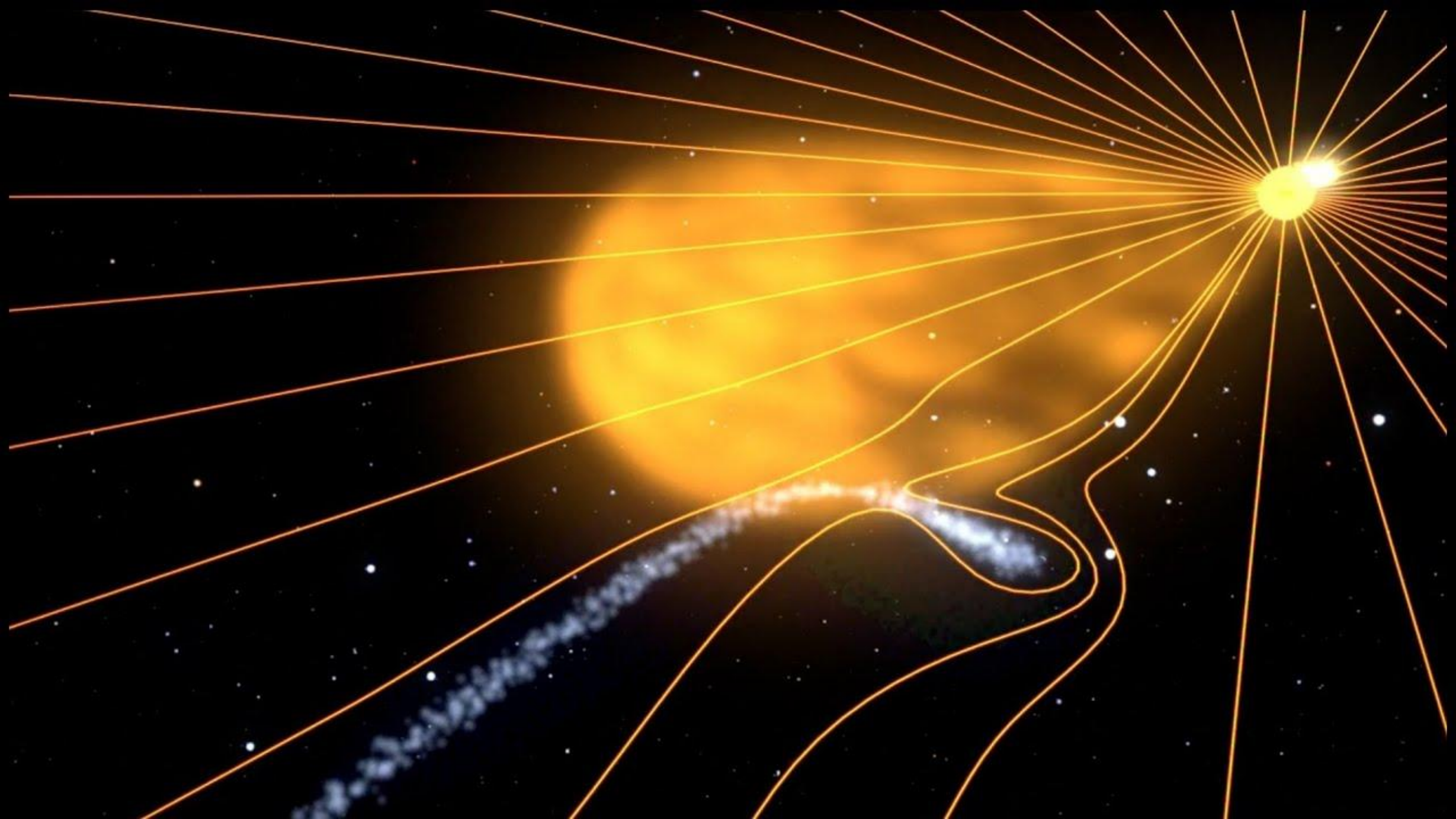

1
00:00:00,020 --> 00:00:08,020
Bell tone

2
00:00:08,040 --> 00:00:12,060
Narrator: On December 15, 2011,

3
00:00:12,080 --> 00:00:16,100
NASA's Solar Dynamics Observatory captured this footage of Come Lovejoy

4
00:00:16,120 --> 00:00:20,120
approaching the sun. An hour later, it watched as Lovejoy came around the far side

5
00:00:20,140 --> 00:00:24,150
of the sun and began its long trip back to the outer reaches of the solar system.

6
00:00:24,170 --> 00:00:28,200
Other NASA spacecraft, such as SOHO and STEREO, also

7
00:00:28,220 --> 00:00:32,230
saw Lovejoy's close encounter. Lovejoy marked one of the few times that

8
00:00:32,250 --> 00:00:36,250
orbiting telescopes have been able to watch a so-called "sun grazing" comet survive its

9
00:00:36,270 --> 00:00:40,280
trip around the sun. Most are not so lucky.

10
00:00:40,300 --> 00:00:44,300
Besides being interesting to watch, the images and data collected by NASA's

11
00:00:44,320 --> 00:00:48,330
solar observing fleet can also help scientists learn more about the sun itself.

12
00:00:48,350 --> 00:00:52,360
One of the biggest features that comets help reveal is the sun's magnetic field.

13
00:00:52,380 --> 00:00:56,450

Since magnetic fields are invisible, we can only observe them indirectly, like using

14
00:00:56,470 --> 00:01:00,500
iron filings over a bar magnet. On the sun,

15
00:01:00,520 --> 00:01:04,550
astronomers can look at where hot plasma in the sun's atmosphere is trapped by fields to see their

16
00:01:04,570 --> 00:01:08,600
complicated loop structure. But farther away from the sun, where the

17
00:01:08,620 --> 00:01:12,640
plasma is less dense, this approach doesn't work. Comet

18
00:01:12,660 --> 00:01:16,680
tails, with their ionized gases, are affected by magnetic fields and so they can act

19
00:01:16,700 --> 00:01:20,730
as brief tracers. On April 20, 2007,

20
00:01:20,750 --> 00:01:24,780
Comet Encke had its tail stripped off abruptly by a coronal mass ejection

21
00:01:24,800 --> 00:01:28,850
that carried a strong parcel of magnetic field through the solar system.

22
00:01:28,870 --> 00:01:32,900
Even closer to the sun, astronomers were astounded to Comet Lovejoy's tail glowing

23
00:01:32,920 --> 00:01:36,920
in extreme ultraviolet light as it approached the sun. They now think

24
00:01:36,940 --> 00:01:40,950
the glow is caused by energetic electrons in the sun's corona interacting with

25
00:01:40,970 --> 00:01:44,970
oxygen from the comet. The glowing tail followed and illuminated some

26
00:01:44,990 --> 00:01:49,000
of the sun's magnetic field lines. Careful analysis of the frames

27
00:01:49,020 --> 00:01:53,030
allows scientists to reconstruct where the field lines were and even, to some

28
00:01:53,050 --> 00:01:57,050
degree, how strong they were. These comet "tracers" also illuminate

29
00:01:57,070 --> 00:02:01,090
small structures in the sun's upper atmosphere where they are usually too faint to be

30
00:02:01,110 --> 00:02:05,140
visible. Continued observation of sun grazing comets will also help

31
00:02:05,160 --> 00:02:09,180
astronomers understand how hot material in the sun's corona cools, and where

32
00:02:09,200 --> 00:02:13,250
that energy goes. Finally, long term observations

33
00:02:13,270 --> 00:02:17,340
of sun grazing comets will help us learn more about the solar wind. Some of

34
00:02:17,360 --> 00:02:21,450
the particles in the corona are traveling fast enough to escape and travel through the solar

35
00:02:21,470 --> 00:02:25,550
system. They begin moving at roughly 250,000 miles

36
00:02:25,570 --> 00:02:29,660
an hour, but start accelerating when they reach around a million miles from the sun's surface.

37
00:02:29,680 --> 00:02:33,700
By 5 million miles out, they are traveling at up to

38
00:02:33,720 --> 00:02:37,730

1 million miles per hour. The exact mechanism for this acceleration

39
00:02:37,750 --> 00:02:41,760
is not known. Comet tails that are blown off by the sun travel with the

40
00:02:41,780 --> 00:02:45,790
solar wind, and can act like a dye tracer in a river. Because they are

41
00:02:45,810 --> 00:02:49,820
made of different materials than the usual solar wind, they are distinct and easy to pick out.

42
00:02:49,840 --> 00:02:53,860
So they can show exactly how the acceleration unfolds.

43
00:02:53,880 --> 00:02:57,880
Because we are in a period of high sun grazing comet activity, scientists can expect many more

44
00:02:57,900 --> 00:03:01,980
chances to watch these natural research satellites in the coming years.

45
00:03:02,000 --> 00:03:06,020
In fact, another large comet is expected to have a close solar pass on

46
00:03:06,040 --> 00:03:10,120
November 28, 2013. This comet is roughly the size of Hale-Bopp,

47
00:03:10,140 --> 00:03:14,150
so it should give quite a show. It will also undoubtedly be a treasure

48
00:03:14,170 --> 00:03:18,190
trove of information for scientists and who knows what new solar secret it