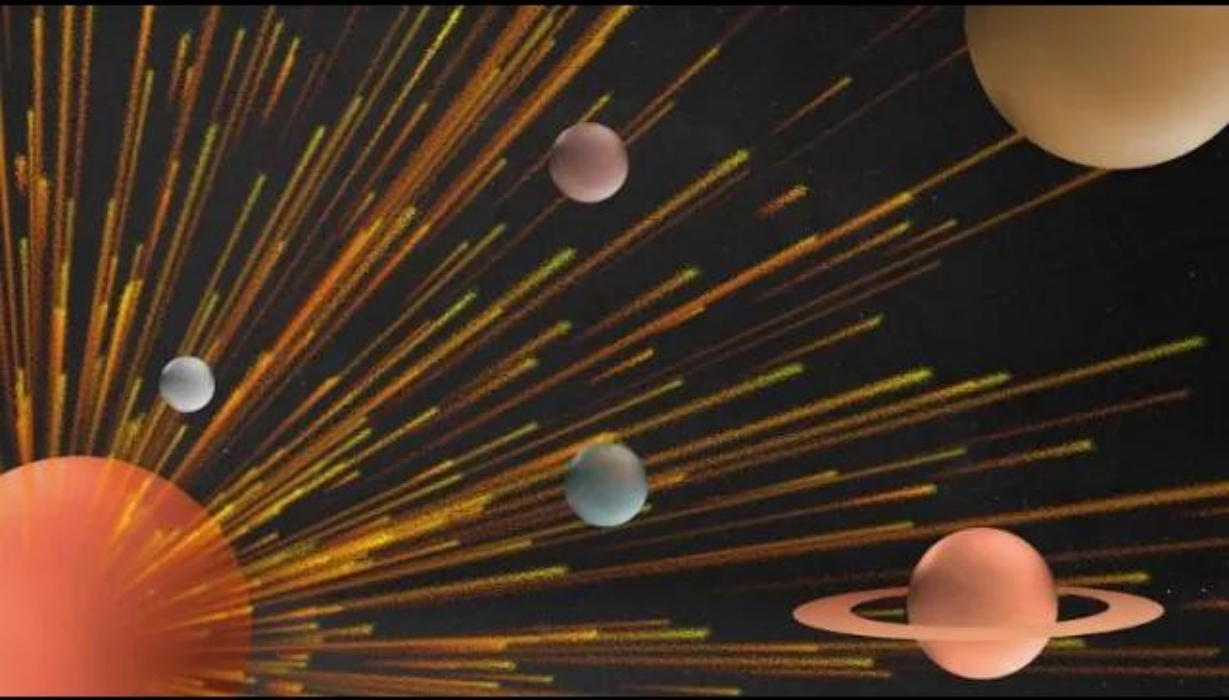

1
00:00:04,789 --> 00:00:02,710
there are a few ways to think about the

2
00:00:08,629 --> 00:00:04,799
edge of the solar system

3
00:00:10,549 --> 00:00:08,639
one is with the extent of the solar wind

4
00:00:12,950 --> 00:00:10,559
this is the constant flow of charged

5
00:00:15,030 --> 00:00:12,960
particles gushing out of the sun at a

6
00:00:17,510 --> 00:00:15,040
million miles per hour and bathing the

7
00:00:19,189 --> 00:00:17,520
planets the wind forms a giant

8
00:00:22,070 --> 00:00:19,199
protective bubble around our solar

9
00:00:24,390 --> 00:00:22,080
system known as the heliosphere

10
00:00:26,470 --> 00:00:24,400
this huge region surfs through the milky

11
00:00:29,029 --> 00:00:26,480
way shielding us from interstellar

12
00:00:32,069 --> 00:00:29,039
radiation and creating an environment

13
00:00:34,950 --> 00:00:32,079

that helps life on earth to flourish

14
00:00:37,350 --> 00:00:34,960
but its borders aren't fixed around 11

15
00:00:39,510 --> 00:00:37,360
billion miles from earth far past the

16
00:00:41,270 --> 00:00:39,520
planets solar wind pushes against

17
00:00:42,869 --> 00:00:41,280
interstellar space

18
00:00:45,270 --> 00:00:42,879
scientists have been monitoring this

19
00:00:47,270 --> 00:00:45,280
boundary over the past decade and

20
00:00:48,000 --> 00:00:47,280
they're seeing it change with the sun's

21
00:00:50,229 --> 00:00:48,010
activity

22
00:00:52,470 --> 00:00:50,239
[Music]

23
00:00:54,630 --> 00:00:52,480
roughly every 11 years the sun's

24
00:00:57,510 --> 00:00:54,640
magnetic field ramps up

25
00:01:00,389 --> 00:00:57,520
this is known as the solar cycle and at

26
00:01:03,270 --> 00:01:00,399
the peak the sun's magnetic poles flip

27
00:01:05,670 --> 00:01:03,280
north becomes south and vice versa

28
00:01:08,550 --> 00:01:05,680
this cycle causes the sun's activity to

29
00:01:10,870 --> 00:01:08,560
sway from calm to turbulent with an

30
00:01:13,429 --> 00:01:10,880
abundance of flares and eruptions which

31
00:01:15,429 --> 00:01:13,439
in turn affects the solar wind

32
00:01:18,070 --> 00:01:15,439
changes from the sun can make the solar

33
00:01:20,950 --> 00:01:18,080
wind gust hard when it does the

34
00:01:23,350 --> 00:01:20,960
heliosphere expands like a balloon

35
00:01:26,550 --> 00:01:23,360
over the past solar cycle scientists

36
00:01:28,469 --> 00:01:26,560
mapped what that looked like

37
00:01:30,310 --> 00:01:28,479
to understand these maps you need to

38
00:01:31,670 --> 00:01:30,320

know how we observe the edge of the

39
00:01:33,830 --> 00:01:31,680
solar system

40
00:01:36,950 --> 00:01:33,840
scientists use nasa's interstellar

41
00:01:39,350 --> 00:01:36,960
boundary explorer or ibex about the size

42
00:01:42,230 --> 00:01:39,360
of a bus tie and in the orbit around

43
00:01:44,950 --> 00:01:42,240
earth ibex maps the heliosphere with a

44
00:01:47,990 --> 00:01:44,960
process similar to sonar but instead of

45
00:01:51,109 --> 00:01:48,000
using sound to detect objects it uses

46
00:01:53,990 --> 00:01:51,119
the echo of solar wind variations

47
00:01:56,469 --> 00:01:54,000
for example starting in 2014 there was a

48
00:01:57,749 --> 00:01:56,479
huge and prolonged increase in solar

49
00:02:00,149 --> 00:01:57,759
wind pressure

50
00:02:03,109 --> 00:02:00,159
nasa spacecraft near earth detected

51
00:02:04,630 --> 00:02:03,119
solar wind gusting 50 harder than

52
00:02:06,550 --> 00:02:04,640
previous years

53
00:02:08,150 --> 00:02:06,560
after traveling outward for a year

54
00:02:09,589 --> 00:02:08,160
solarwind hit the edge of the

55
00:02:11,670 --> 00:02:09,599
heliosphere

56
00:02:13,830 --> 00:02:11,680
first the termination shock and then it

57
00:02:15,830 --> 00:02:13,840
entered the heliosheath that's encased

58
00:02:17,670 --> 00:02:15,840
by the heliopause

59
00:02:19,270 --> 00:02:17,680
solar wind particles spent another year

60
00:02:21,589 --> 00:02:19,280
or so in this region

61
00:02:23,270 --> 00:02:21,599
some collided with interstellar gases in

62
00:02:26,630 --> 00:02:23,280
the heliosheath and turned into

63
00:02:29,430 --> 00:02:26,640

energetic neutral atoms or enas

64
00:02:32,070 --> 00:02:29,440
enas travel in all directions

65
00:02:35,270 --> 00:02:32,080
some even back toward earth and between

66
00:02:37,270 --> 00:02:35,280
2017 and 2019 a few of the returning

67
00:02:39,509 --> 00:02:37,280
enas reached ibex

68
00:02:43,430 --> 00:02:39,519
an echo of where the boundary is and

69
00:02:47,750 --> 00:02:45,750
if you cut the heliosphere and laid it

70
00:02:49,509 --> 00:02:47,760
out onto a flat surface

71
00:02:52,390 --> 00:02:49,519
this is what you would see

72
00:02:55,670 --> 00:02:52,400
this is the nose and this is the tail

73
00:02:57,990 --> 00:02:55,680
the nose shows high ena fluxes which

74
00:03:00,229 --> 00:02:58,000
indicate a strong gust of wind and the

75
00:03:02,229 --> 00:03:00,239
heliosphere ballooning

76
00:03:04,550 --> 00:03:02,239
from tracking this expansion scientists

77
00:03:06,070 --> 00:03:04,560
found that the nose and tail were not

78
00:03:08,149 --> 00:03:06,080
symmetrical

79
00:03:11,270 --> 00:03:08,159
if we compare the maps earnings from

80
00:03:13,350 --> 00:03:11,280
that big 2014 solar wind increase

81
00:03:15,990 --> 00:03:13,360
have returned from the nose but they

82
00:03:17,990 --> 00:03:16,000
haven't returned from the tail yet

83
00:03:20,229 --> 00:03:18,000
suggesting that the tail is much farther

84
00:03:22,070 --> 00:03:20,239
away from the sun than the nose

85
00:03:24,630 --> 00:03:22,080
this indicates that the heliosphere

86
00:03:26,550 --> 00:03:24,640
looks more like a comet rather than a

87
00:03:28,229 --> 00:03:26,560
round bubble

88
00:03:30,869 --> 00:03:28,239

having a full solar cycle of

89
00:03:32,470 --> 00:03:30,879
observations of the heliosphere opens

90
00:03:35,110 --> 00:03:32,480
doors to understanding the only

91
00:03:37,910 --> 00:03:35,120
environment we so far know can support

92
00:03:40,470 --> 00:03:37,920
life and there have been a few surprises

93
00:03:42,470 --> 00:03:40,480
beyond the heliosphere near the nose

94
00:03:45,030 --> 00:03:42,480
there was one region that took two years

95
00:03:46,390 --> 00:03:45,040
longer to respond to the 2014 increase

96
00:03:48,869 --> 00:03:46,400
of solar wind

97
00:03:51,350 --> 00:03:48,879
scientists think these enas bounced out

98
00:03:54,229 --> 00:03:51,360
of the heliopoles and into interstellar

99
00:03:55,670 --> 00:03:54,239
space before heading back toward earth

100
00:03:57,270 --> 00:03:55,680
these are signs that we're still

101
00:04:00,309 --> 00:03:57,280
learning about the quirks of our

102
00:04:01,990 --> 00:04:00,319
heliosphere but one thing's for sure

103
00:04:04,070 --> 00:04:02,000
these characteristics could tell us

104
00:04:06,280 --> 00:04:04,080
about the key ingredients for life

105
00:04:16,710 --> 00:04:06,290
around a star