1
00:00:00,050 --> 00:00:04,080
Waves

2
00:00:16,150 --> 00:00:08,080
Music

3
00:00:16,170 --> 00:00:20,210
Narrator: Everywhere we look in nature, patterns repeat themselves. The curl of a surfing wave, for example,

4
00:00:20,230 --> 00:00:24,220
is mirrored in clouds and on other planets like saturn,

5
00:00:24,240 --> 00:00:28,270
and now they've been spotted in the sun's atmosphere. This shape of wave is often

6
00:00:28,290 --> 00:00:32,300
formed by something called a Kelvin-Helmholtz, or K-H, instability, in which two

7
00:00:32,320 --> 00:00:36,330
fluids flow by each other with different speeds or densities. Leon Ofman: For in example in clouds,

8
00:00:36,350 --> 00:00:40,360
you have one layer where there is a cloud,

9
00:00:40,380 --> 00:00:44,400
and then a higher layer where you have a jet

10
00:00:44,420 --> 00:00:48,420
stream. So at the boundary between these two regions you start seeing

11
00:00:48,440 --> 00:00:52,480
this cloud rolling up. If you look at water waves, the wind will sort-of

12
00:00:52,500 --> 00:00:56,510
cause it to roll-up into a bigger and bigger wave, but eventually

13
00:00:56,530 --> 00:01:00,560

this wave will break. This is very similar to the Kelvin-Helmholtz instability

14
00:01:00,580 --> 00:01:04,610
that takes place on the sun, where we have erupting plasma

15
00:01:04,630 --> 00:01:08,650
and we have stationary plasmas. Narrator: Spotting a repeating pattern like this is always

16
00:01:08,670 --> 00:01:12,700
good news. Since scientists already know that the movement of the waves transfers energy

17
00:01:12,720 --> 00:01:16,750
to the water, they know that the same thing should be happening in the sun.

18
00:01:16,770 --> 00:01:20,810
That extra energy helps explain how the sun's atmosphere, or corona, heats up to some

19
00:01:20,830 --> 00:01:24,840
1,000 times hotter than the sun's surface. These waves were spotted in the

20
00:01:24,860 --> 00:01:28,860
second coronal mass ejection, or CME, recorded by the Solar Dynamics Observatory

21
00:01:28,880 --> 00:01:32,910
which began looking at the sun in March 2010. Leon Ofman: We were able

22
00:01:32,930 --> 00:01:36,940
to see as the CME erupted

23
00:01:36,960 --> 00:01:40,950
it generated basically a region where the plasma was evacuated. Since

24
00:01:40,970 --> 00:01:44,980
the material from the CME lifted up into space, we see

25
00:01:45,000 --> 00:01:49,000
a dark region that corresponds to the low density

26
00:01:49,020 --> 00:01:53,040
region evacuated by the CME and we see just

27
00:01:53,060 --> 00:01:57,060
adjacent to it a brighter region where we have denser plasma.

28
00:01:57,080 --> 00:02:01,110
So, now, we see a region where the vortices start to roll-up.

29
00:02:01,130 --> 00:02:05,140
Narrator: Astronomers have long thought that turbulence in the corona might help heat it up,

30
00:02:05,160 --> 00:02:09,160
but solar observations still can't see the way the atmosphere moves at small scales.

31
00:02:09,180 --> 00:02:13,200
Each of the rolling surfing waves spotted by SDO was about the size of the United

32
00:02:13,220 --> 00:02:17,240
States. And they likely became more and more turbulent the same way that a breaking water

33
00:02:17,260 --> 00:02:21,280
wave froths at its crest. Leon Ofman: So it is a way of taking out the energy

34
00:02:21,300 --> 00:02:25,340
from the shear flow and converting it, eventually, into heat.

35
00:02:25,360 --> 00:02:29,370
Narrator: Some scientists thought that the sun's powerful magnetic fields would prevent

36
00:02:29,390 --> 00:02:33,410
K-H waves from forming, so the heliophysicists who observed the turbulence on the sun

37
00:02:33,430 --> 00:02:37,450
needed additional evidence. Leon Ofman: To support this interpretation, we also developed

38
00:02:37,470 --> 00:02:41,490

a model, a computational-numerical model. We set up

39
00:02:41,510 --> 00:02:45,520
this model to resemble what takes place in this region,

40
00:02:45,540 --> 00:02:49,560
and we see that, indeed, this kind of shear can form

41
00:02:49,580 --> 00:02:53,580
Kelvin-Helmholtz instability and generate the waves that are similar to

42
00:02:53,600 --> 00:02:57,610
the waves we observe in nature. Narrator: A good surfer understands

43
00:02:57,630 --> 00:03:01,640
those waves intuitively. Thankfully, scientists understand them physically too.

44
00:03:01,660 --> 00:03:05,660
Watching how they roll around the sun opens the door for more research and better solar

45
00:03:05,680 --> 00:03:09,700
models, helping scientists predict the activity of the star we live with.