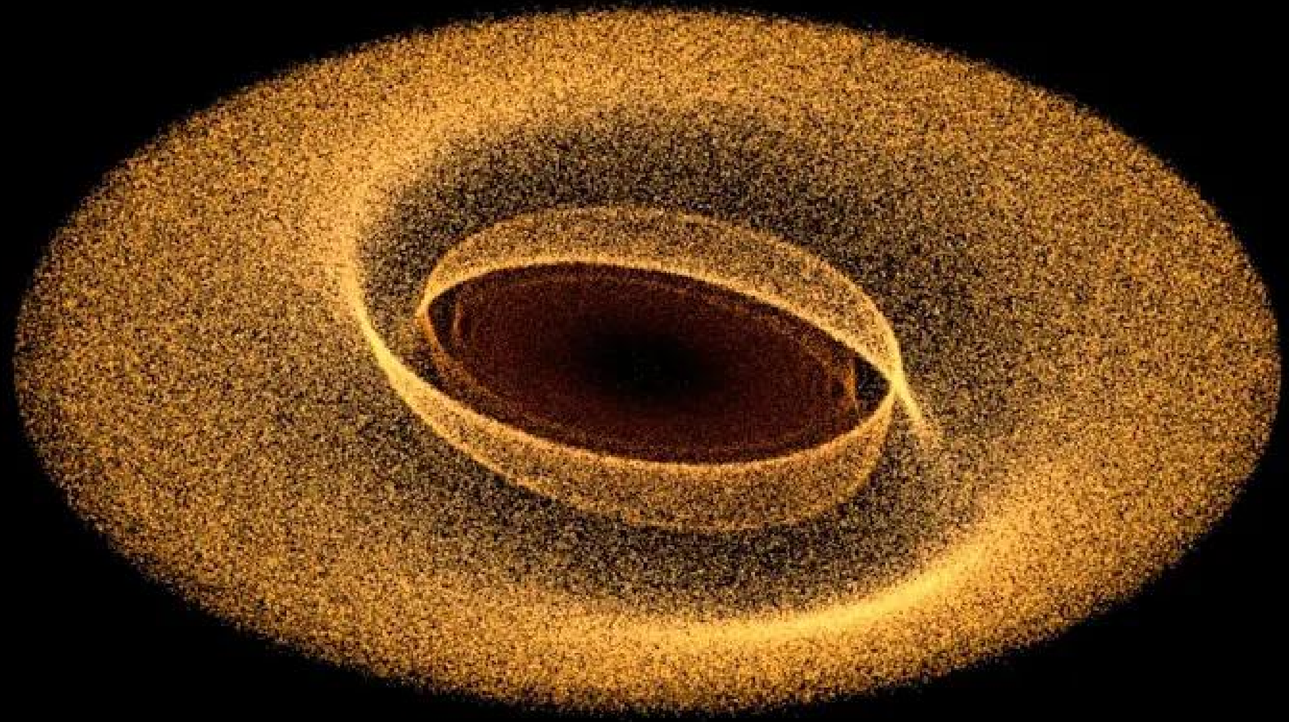

1
00:00:12,120 --> 00:00:04,040
[Music]

2
00:00:12,140 --> 00:00:16,160
Erika Nesvold: Beta Pictoris is a star about 60 light years from the Earth.

3
00:00:16,180 --> 00:00:20,230
And it's surrounded by this huge disk of chunks of rock and ice

4
00:00:20,250 --> 00:00:24,330
that we call a debris disk. Marc Kuchner: Inside that disk is

5
00:00:24,350 --> 00:00:28,420
a central clearing in the larger planetesimals and inside that central

6
00:00:28,440 --> 00:00:32,440
clearing is a planet more massive than any in our solar system.

7
00:00:32,460 --> 00:00:36,520
Erika Nesvold: We see the Beta Pictoris debris disk edge-on, so we just see the

8
00:00:36,540 --> 00:00:40,600
thin strip of it from the edge. But there's an interesting feature that

9
00:00:40,620 --> 00:00:44,660
we can see just from that edge-on view. Marc Kuchner: When we view Beta Pictoris at

10
00:00:44,680 --> 00:00:48,670
longer wavelengths, people claim that there is a "warp" in the center of the

11
00:00:48,690 --> 00:00:52,730
disk. At shorter wavelengths, it looks more like an "X."

12
00:00:52,750 --> 00:00:56,740
And we haven't really understood until now, how those patterns were related.

13
00:00:56,760 --> 00:01:00,800

But Erika Nesvold and I created a new kind of

14
00:01:00,820 --> 00:01:04,860
model, which shows us the connection between those patterns. Erika Nesvold: Our model is called

15
00:01:04,880 --> 00:01:08,890
SMACK, which stands for the Super-particle Method Algorithm for

16
00:01:08,910 --> 00:01:12,930
Collisions in Kuiper Belts. We're creating a virtual solar system

17
00:01:12,950 --> 00:01:16,960
inside the computer, and by tweaking the parameters of the

18
00:01:16,980 --> 00:01:21,010
system, we can control what this virtual debris disk looks like.

19
00:01:21,030 --> 00:01:25,030
Then we can compare our results to the actual images of the debris

20
00:01:25,050 --> 00:01:29,050
disk we see and understand how the planet could be creating these

21
00:01:29,070 --> 00:01:33,140
different shapes in the disk. Marc Kuchner: The model painted one picture of Beta

22
00:01:33,160 --> 00:01:37,150
Pictoris that showed us the origin of the "X" pattern, the origin

23
00:01:37,170 --> 00:01:41,200
of the warp, and also a bunch of other details about the system.

24
00:01:41,220 --> 00:01:45,220
Erika Nesvold: Our simulation is the first model that can capture

25
00:01:45,240 --> 00:01:49,260
the 3D structure of the disk, as well as the collisions that are

26
00:01:49,280 --> 00:01:53,340
occurring between the planetesimals in the disk. And our simulation is the

27
00:01:53,360 --> 00:01:57,440
first model that can explain these multiple different features that we

28
00:01:57,460 --> 00:02:01,460
observe when we look at the Beta Pictoris Disk. So if we look at our simulation

29
00:02:01,480 --> 00:02:05,500
results edge-on--the same way that we see the real Beta Pictoris disk--

30
00:02:05,520 --> 00:02:09,540
then we see this warp structure that's created because the planet is

31
00:02:09,560 --> 00:02:13,590
orbiting tilted with respect to the disk. If we look at our

32
00:02:13,610 --> 00:02:17,630
simulation results face-on--which is a way we can't see the real disk--

33
00:02:17,650 --> 00:02:21,730
then this face-on simulation shows this spiral

34
00:02:21,750 --> 00:02:25,770
density structure of the planetesimals. And this spiral is created

35
00:02:25,790 --> 00:02:29,810
because the planet is on an eccentric orbit. It's not a perfect circle, it's an ellipse.

36
00:02:29,830 --> 00:02:33,880
When the spiral created by the eccentricity of the planet

37
00:02:33,900 --> 00:02:37,970
intersects with that vertical wave from the inclination of the

38
00:02:37,990 --> 00:02:42,060

planet, the collisions are enhanced in some places and

39
00:02:42,080 --> 00:02:46,110
damped out in others, which creates this clumpy collision structure.

40
00:02:46,130 --> 00:02:50,180
Marc Kuchner: If you look at our model in cross-section, you can see the crests and

41
00:02:50,200 --> 00:02:54,210
troughs of the wave where the collisions are enhanced. Like and ocean

42
00:02:54,230 --> 00:02:58,240
wave, in front of the wave it's calm, but then the crest comes

43
00:02:58,260 --> 00:03:02,290
along and lifts the planetesimals out of the plane. And then there's a trough

44
00:03:02,310 --> 00:03:06,380
and then the wave starts wrapping around tighter and tighter

45
00:03:06,400 --> 00:03:10,470
and then it's almost like foam on the backside of the wave. The planetesimals get all

46
00:03:10,490 --> 00:03:14,540
stirred up and start colliding with one another and breaking into dust.

47
00:03:14,560 --> 00:03:18,570
We've learned so much about Beta Pictoris over the years

48
00:03:18,590 --> 00:03:22,590
but all the little pieces of evidence didn't seem to fit together before.

49
00:03:22,610 --> 00:03:26,670
This model has tied together in a nice, neat

50
00:03:26,690 --> 00:03:30,760
package, the story of Beta Pictoris and its planet.

51
00:03:30,780 --> 00:03:34,770
Erika Nesvold: In the future, we'll be able to use our SMACK models to

52
00:03:34,790 --> 00:03:38,820
study other debris disk systems and use our observations of

53
00:03:38,840 --> 00:03:42,870
those disks to predict the presence exoplanets that we

54
00:03:42,890 --> 00:03:46,910
otherwise wouldn't be able to detect.