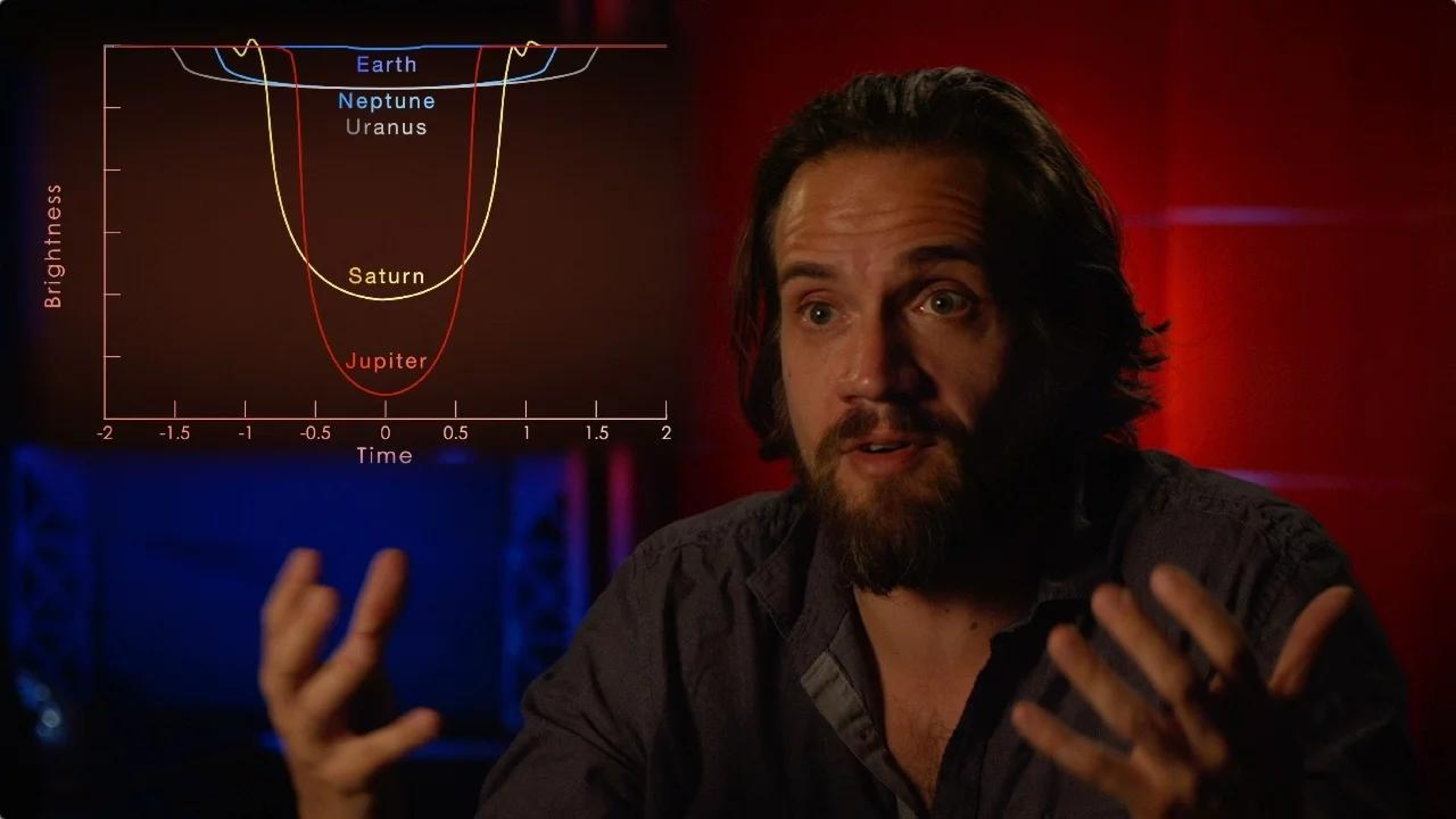
Earth
Neptune
Uranus
Saturn
Jupiter
Brightness
-2
-1.5
-1
-0.5
0
0.5
1
1.5
2
Time

1
00:00:12,090 --> 00:00:04,030
[Music]

2
00:00:12,110 --> 00:00:16,120
Narrator: When it comes to finding planets outside our

3
00:00:16,140 --> 00:00:20,170
solar system, no space mission to date can beat NASA's Kepler

4
00:00:20,190 --> 00:00:24,180
in 5 years it has found more than a thousand confirmed exoplanets,

5
00:00:24,200 --> 00:00:28,220
with thousands more awaiting confirmation. Kepler finds

6
00:00:28,240 --> 00:00:32,260
exoplanets by carefully watching starlight, looking for slight dips in

7
00:00:32,280 --> 00:00:36,300
brightness as a planet passes in front of, or transits, its star. This

8
00:00:36,320 --> 00:00:40,340
technique, called time-series transit photometry, is most effective

9
00:00:40,360 --> 00:00:44,370
for large planets in close orbits. This both maximizes the light

10
00:00:44,390 --> 00:00:48,380
loss during a given transit and the number of transits we observe.

11
00:00:48,400 --> 00:00:52,400
But how far can astronomers go with this technique? Can we

12
00:00:52,420 --> 00:00:56,410
find a twin of Earth? Or even identify whether a planet has moons?

13
00:00:56,430 --> 00:01:00,450

With two transit photometry missions on the horizon--NASA's

14
00:01:00,470 --> 00:01:04,490
TESS and ESA's PLATO--some astronomers have examined the limits

15
00:01:04,510 --> 00:01:08,500
of this technique, with surprising results. Daniel Angerhausen: For our study,

16
00:01:08,520 --> 00:01:12,530
Michael Hippke and I combined the knowledge of the

17
00:01:12,550 --> 00:01:16,580
lessons learned from Kepler with what we know about the future missions like

18
00:01:16,600 --> 00:01:20,610
TESS and PLATO, and we asked ourself the question 'what would we be able

19
00:01:20,630 --> 00:01:24,630
to see if we put these observatories outside our solar system and observed

20
00:01:24,650 --> 00:01:28,650
our solar system.' And the results are that we

21
00:01:28,670 --> 00:01:32,670
probably won't be able to see Mars, or Mercury, but

22
00:01:32,690 --> 00:01:36,690
everything else in our solar system we definitely get a solid detection of

23
00:01:36,710 --> 00:01:40,700
Earth, a solid detection of Venus. Also of the outer planets.

24
00:01:40,720 --> 00:01:44,730
We might even be able to see ring structures like the one around

25
00:01:44,750 --> 00:01:48,750
Saturn, and maybe even moons, Jupiter's moons.

26
00:01:48,770 --> 00:01:52,790
Narrator: In another study, they pushed Kepler to the limit by cleverly

27
00:01:52,810 --> 00:01:56,850
combining almost all extrasolar planet data collected by the telescope

28
00:01:56,870 --> 00:02:00,880
using an understanding of orbital mechanics. Daniel: For example, Jupiter

29
00:02:00,900 --> 00:02:04,930
has so-called trojan asteroids that collect in two

30
00:02:04,950 --> 00:02:08,950
specific areas on its orbit, pretty symmetrically to its orbit.

31
00:02:08,970 --> 00:02:12,990
And in the study that we did on the Kepler data, where we added up

32
00:02:13,010 --> 00:02:17,030
all the phase curves of all 4,000 planets in the Kepler data set, we were even

33
00:02:17,050 --> 00:02:21,050
able to see signatures of asteroids in extrasolar

34
00:02:21,070 --> 00:02:25,090
systems. And with the future missions we might even be able to find that

35
00:02:25,110 --> 00:02:29,130
in individual systems and not just by putting all the data together.

36
00:02:29,150 --> 00:02:33,150
We wanted to figure out what the ultimate limit

37
00:02:33,170 --> 00:02:37,200
is that we can do photometry with, and it turns out

38
00:02:37,220 --> 00:02:41,220

with the next generation of instruments we're already hitting the technical limit and are

39
00:02:41,240 --> 00:02:45,260
mostly limited by the variation of the host stars themselves,

40
00:02:45,280 --> 00:02:49,340
by the huge noise that's coming from the host stars. Narrator: The way to push down

41
00:02:49,360 --> 00:02:53,370
this noise is by observing stars for longer periods to improve

42
00:02:53,390 --> 00:02:57,430
models of the star's behavior, allowing astronomers to tease out the smallest transits.

43
00:02:57,450 --> 00:03:01,440
The work of Hippke and Angerhausen shows

44
00:03:01,460 --> 00:03:05,470
that future missions will be able to detect Earth-size planets orbiting

45
00:03:05,490 --> 00:03:09,510
sun-like stars at distances that would allow liquid water.

46
00:03:09,530 --> 00:03:13,530
These systems will become prime targets for more detailed study, using other

47
00:03:13,550 --> 00:03:17,580
missions, such as NASA's James Webb Space Telescope. Will we

48
00:03:17,600 --> 00:03:21,670
find a copy of our solar system? How common are habitable

49
00:03:21,690 --> 00:03:25,700
worlds, and particularly twins of Earth? The thousands of exoplanets

50
00:03:25,720 --> 00:03:29,740
to be discovered by TESS and PLATO will go a long way to providing answers.

51
00:03:29,760 --> 00:03:33,790
[Music][Beeping]