What Does NASA's Kepler Mean to You?

#MorePlanetsThanStars

1
00:00:00,000 --> 00:00:08,010
(Music)

2
00:00:08,010 --> 00:00:11,010
Eugene Tu: The idea that there are more planets

3
00:00:11,010 --> 00:00:13,970
than stars is just incredible to think about.

4
00:00:13,970 --> 00:00:15,410
We know that there are billions and billions

5
00:00:15,410 --> 00:00:18,540
of stars in our galaxy and to think that

6
00:00:18,540 --> 00:00:20,890
there are even more planets...

7
00:00:20,890 --> 00:00:22,490
it completely changes our thinking,

8
00:00:22,490 --> 00:00:24,520
and our place in the universe.

9
00:00:24,520 --> 00:00:27,690
Jon Jenkins: I remember being a child sitting in a...

10
00:00:27,690 --> 00:00:29,480
lying down in the summer grass, looking up into

11
00:00:29,480 --> 00:00:31,670
the night sky and wondering whether there were

12
00:00:31,670 --> 00:00:35,230
planets orbiting the stars I was looking at

13
00:00:35,230 --> 00:00:38,620

with beings on the surface of their planets

14
00:00:38,620 --> 00:00:41,220
looking in our direction asking the same question.

15
00:00:41,220 --> 00:00:43,650
And, so what more planets than stars means to me

16
00:00:43,650 --> 00:00:47,330
is that we have the hope to eventually find out

17
00:00:47,330 --> 00:00:49,790
whether the answer to that question is yes or no.

18
00:00:49,790 --> 00:00:52,670
Natalie Batalha: For me, it's been transformative

19
00:00:52,670 --> 00:00:56,770
in that it has really catalyzed a third pathway

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00:00:56,770 --> 00:00:59,740
for the search for life in the universe or the

21
00:00:59,740 --> 00:01:00,890
search for life beyond Earth.

22
00:01:00,890 --> 00:01:04,780
You know, before Kepler we had SETI searches,

23
00:01:04,780 --> 00:01:08,720
to listen for techno-signatures in the galaxy.

24
00:01:08,720 --> 00:01:10,630
We had solar system exploration that was

25
00:01:10,630 --> 00:01:13,610
searching for life, you know, hiding in niches

26
00:01:13,610 --> 00:01:15,350
in the solar system, maybe in a subterranean cave

27
00:01:15,350 --> 00:01:19,100
on Mars or underneath the ice on Europa's...

28
00:01:19,100 --> 00:01:22,170
Europa or Enceladus.

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00:01:22,170 --> 00:01:27,420
But a third pathway was opened up, I think,

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00:01:27,420 --> 00:01:31,790
by the sudden realization that the nearest

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00:01:31,790 --> 00:01:33,200
potentially habitable planet could just be

32
00:01:33,200 --> 00:01:35,000
a stone's throw away.

33
00:01:35,000 --> 00:01:36,520
That there are tens of billions of these planets

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00:01:36,520 --> 00:01:37,730
in our galaxy alone.

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00:01:37,730 --> 00:01:40,480
Paul Hertz: I think one of things that was most

36
00:01:40,480 --> 00:01:44,460
amazing about the Kepler mission was after

37
00:01:44,460 --> 00:01:49,370
the two reaction wheels died, and I was convinced

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00:01:49,370 --> 00:01:51,250

that the mission couldn't continue because nobody

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00:01:51,250 --> 00:01:53,570
had ever considered operating Kepler

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00:01:53,570 --> 00:01:55,620
with only two reaction wheels.

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00:01:55,620 --> 00:01:57,570
And the brilliant scientists and engineers

42
00:01:57,570 --> 00:02:01,770
who were working on Kepler, came up with

43
00:02:01,770 --> 00:02:04,790
this scheme that we've used successfully for several

44
00:02:04,790 --> 00:02:09,350
years to operate Kepler's K2 mission of using

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00:02:09,350 --> 00:02:13,020
the solar pressure, the pressure from the sun's light

46
00:02:13,020 --> 00:02:14,840
to hold Kepler in place instead

47
00:02:14,840 --> 00:02:16,050
of a third reaction wheel.

48
00:02:16,050 --> 00:02:18,520
I mean, that just makes you think that, you know,

49
00:02:18,520 --> 00:02:19,990
when something breaks on a satellite,

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00:02:19,990 --> 00:02:23,500
wow, we can figure it out, we can make it work.

51
00:02:23,500 --> 00:02:26,110
That's fabulous.

52
00:02:26,110 --> 00:02:28,390
Nick Gautier: Ever since I was a little kid I was

53
00:02:28,390 --> 00:02:30,100
interested in space, I wanted to be an astronaut,

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00:02:30,100 --> 00:02:32,700
you know, but things like the glasses, you know,

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00:02:32,700 --> 00:02:33,300
meant that I couldn't do that.

56
00:02:33,300 --> 00:02:36,810
So, I became an astronomer instead.

57
00:02:36,810 --> 00:02:39,090
And when the opportunity to join the Kepler project,

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00:02:39,090 --> 00:02:42,350
to discover new planets around other stars,

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00:02:42,350 --> 00:02:43,360
I grabbed that immediately.

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00:02:43,360 --> 00:02:44,600
I really wanted to do that.

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00:02:44,600 --> 00:02:48,400
It's been a really inspiring mission because

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00:02:48,400 --> 00:02:52,100
we got to discover all of this new stuff

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00:02:52,100 --> 00:02:54,840

that nobody ever saw before.

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00:02:54,840 --> 00:02:56,460
Courtney Dressing: Growing up I read a lot of

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00:02:56,460 --> 00:02:58,150
science fiction and watched a lot

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00:02:58,150 --> 00:02:59,920
of science fiction films.

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00:02:59,920 --> 00:03:01,640
In all of those movies and books it was

68
00:03:01,640 --> 00:03:04,790
taken for granted that planetary systems were common.

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00:03:04,790 --> 00:03:07,410
So, I think I grew up with that expectation.

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00:03:07,410 --> 00:03:09,010
But until the Kepler mission, there was no basis

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00:03:09,010 --> 00:03:11,080
to assume that planetary systems

72
00:03:11,080 --> 00:03:13,110
were really that common.

73
00:03:13,110 --> 00:03:14,590
With Kepler, we've hinted that perhaps some of those

74
00:03:14,590 --> 00:03:16,910
science fiction stories could become reality

75
00:03:16,910 --> 00:03:19,660
in the future.

76
00:03:19,660 --> 00:03:21,820
Geert Barentsen: By studying this universe,

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00:03:21,820 --> 00:03:24,830
we ultimately start to understand our place in it,

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00:03:24,830 --> 00:03:26,550
and understand where we come from, what our future

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00:03:26,550 --> 00:03:29,330
will be, and why we exist.

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00:03:29,330 --> 00:03:31,630
Which I think is one of the most fundamental questions

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00:03:31,630 --> 00:03:34,680
we can ask as a human species, is where does all this,

82
00:03:34,680 --> 00:03:37,100
where does all this stuff come from?

83
00:03:37,100 --> 00:03:40,390
And Kepler has provided key answers by answering

84
00:03:40,390 --> 00:03:43,440
the fact that planet Earth is not alone.

85
00:03:43,440 --> 00:03:46,520
There's planets everywhere in our galaxy.

86
00:03:46,520 --> 00:03:49,070
Leslie Livesay: There was no buzz about exoplanets

87
00:03:49,070 --> 00:03:52,060
when we really launched Kepler, but after

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00:03:52,060 --> 00:03:55,690

its results I think everyone, if you got to stop and

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00:03:55,690 --> 00:03:57,760
talk with someone on the street, they'll be able

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00:03:57,760 --> 00:03:58,770
to talk to you about what they think about

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00:03:58,770 --> 00:04:00,530
exoplanets and what they know,

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00:04:00,530 --> 00:04:02,880
and that's a real difference.

93
00:04:02,880 --> 00:04:06,430
Roger Hunter: I saw this... an article recently

94
00:04:06,430 --> 00:04:09,580
and it's depicting a cave wall painting

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00:04:09,580 --> 00:04:12,600
from 17 to 18 thousand years ago.

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00:04:12,600 --> 00:04:16,900
And it showed, for example, the first time

97
00:04:16,900 --> 00:04:20,910
that our ancestors were thinking abstractly.

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00:04:20,910 --> 00:04:22,800
And this cave wall painting was fascinating.

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00:04:22,800 --> 00:04:24,270
It showed what their everyday life was like

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00:04:24,270 --> 00:04:26,050
and they were hunting, they were gathering,

101
00:04:26,050 --> 00:04:27,840
and this is how they existed.

102
00:04:27,840 --> 00:04:30,050
But, in this cave wall painting there were some

103
00:04:30,050 --> 00:04:36,840
unusual articles in the painting, and they were stars.

104
00:04:36,840 --> 00:04:39,210
And it's one of the first times that we have evidence

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00:04:39,210 --> 00:04:40,620
that our ancestors we actually

106
00:04:40,620 --> 00:04:41,970
looking up at the heavens.

107
00:04:41,970 --> 00:04:43,890
They might not have known what they were looking at,

108
00:04:43,890 --> 00:04:47,460
but fast forward thousands of years to, you know,

109
00:04:47,460 --> 00:04:49,040
the twenty-first century and here we are

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00:04:49,040 --> 00:04:51,360
with a machine that has now proving those stars,

111
00:04:51,360 --> 00:04:53,590
allowing us to find planets.

112
00:04:53,590 --> 00:04:56,480
Riley Duran: Most people that I, in fact everybody

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00:04:56,480 --> 00:04:58,730

that I work with on the project, this wasn't a

114
00:04:58,730 --> 00:05:00,180
9-to-5 job for them and they wouldn't

115
00:05:00,180 --> 00:05:02,590
have lasted if it had.

116
00:05:02,590 --> 00:05:03,460
Because this mission, you know, this is

117
00:05:03,460 --> 00:05:05,780
eight, ten, twenty years of some people's lives.

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00:05:05,780 --> 00:05:08,830
What kept them motivated is they were, you know,

119
00:05:08,830 --> 00:05:10,580
everybody was passionate about the science.

120
00:05:10,580 --> 00:05:13,000
They were excited about finding those exoplanets.

121
00:05:13,000 --> 00:05:15,750
Christina Hedges: We've found so many fantastic

122
00:05:15,750 --> 00:05:17,820
and exciting planet systems out there,

123
00:05:17,820 --> 00:05:21,020
none of which look quite like what we have at home.

124
00:05:21,020 --> 00:05:23,110
And for me, the most exciting part of all of this

125
00:05:23,110 --> 00:05:24,890
is not just the sheer number of planets.

126
00:05:24,890 --> 00:05:28,730
We found thousands, but the fact that we found

127
00:05:28,730 --> 00:05:31,760
so many varied planets.

128
00:05:31,760 --> 00:05:35,350
We found massive, puffy hot Jupiters that

129
00:05:35,350 --> 00:05:38,680
have orbits shorter than Mercury, and we found

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00:05:38,680 --> 00:05:41,370
mini-Neptunes where we don't know if they are

131
00:05:41,370 --> 00:05:45,270
solid and rocky or are they puffy and gassy.

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00:05:45,270 --> 00:05:48,700
We found brand new forming planets and old planets, too.

133
00:05:48,700 --> 00:05:53,270
And I'm really excited about the zoo of variability

134
00:05:53,270 --> 00:05:55,310
in planets that we found.

135
00:05:55,310 --> 00:05:56,570
Steve Howell: I think it's a great discovery,

136
00:05:56,570 --> 00:05:58,180
I'm glad we found that.

137
00:05:58,180 --> 00:05:59,550
But the reason it's not a surprise is

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00:05:59,550 --> 00:06:00,740

you see this in everyday life.

139
00:06:00,740 --> 00:06:03,370
Go out into your gravel parking lot

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00:06:03,370 --> 00:06:04,720
and look around at rocks.

141
00:06:04,720 --> 00:06:06,740
There's more small rocks than big rocks.

142
00:06:06,740 --> 00:06:08,270
Go look at birds.

143
00:06:08,270 --> 00:06:10,010
There's more small birds than big birds.

144
00:06:10,010 --> 00:06:11,530
Go look at bugs.

145
00:06:11,530 --> 00:06:12,930
Anyway, there's always more small things than large things.

146
00:06:12,930 --> 00:06:14,310
And for us as humans, that's great.

147
00:06:14,310 --> 00:06:16,540
Because small planets, rocky planets like the Earth

148
00:06:16,540 --> 00:06:18,980
are what we can call home.

149
00:06:18,980 --> 00:06:22,000
So, it's fabulous that there's more planets than stars.

150
00:06:22,000 --> 00:06:24,080
Jessie Dotson: Before Kepler, we knew exoplanets existed

151
00:06:24,080 --> 00:06:28,020
and we suspected they were common, but now we know

152
00:06:28,020 --> 00:06:29,900
they're common and once we know they're common,

153
00:06:29,900 --> 00:06:34,080
that really opens up the possibility to have missions

154
00:06:34,080 --> 00:06:36,650
like TESS, where you look for planets around nearby stars

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00:06:36,650 --> 00:06:38,420
that are good for follow up.

156
00:06:38,420 --> 00:06:41,470
Or some of the ground-based instruments right now

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00:06:41,470 --> 00:06:44,490
that are working on doing initial direct imaging

158
00:06:44,490 --> 00:06:47,470
of exoplanets.

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00:06:47,470 --> 00:06:49,460
Some of the technology going on that, you know,

160
00:06:49,460 --> 00:06:51,320
twenty years from now might be able to directly image

161
00:06:51,320 --> 00:06:56,020
and measure the spectra of an exoplanet.

162
00:06:56,020 --> 00:06:57,650
We needed to know that planets were common

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00:06:57,650 --> 00:06:59,640

before we could invest in those things.

164
00:06:59,640 --> 00:07:01,620
And the fact that we know they're common and

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00:07:01,620 --> 00:07:06,410
all those things are starting to happen is really exciting.

166
00:07:06,410 --> 00:07:09,260
Andrew Vanderburg: This is the golden age of exoplanets.

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00:07:09,260 --> 00:07:13,130
Kepler has given us this tremendous data set,

168
00:07:13,130 --> 00:07:15,980
this gift that we can continue studying for decades.

169
00:07:15,980 --> 00:07:17,340
And all in the meantime, there are new missions,

170
00:07:17,340 --> 00:07:20,430
new telescopes, and new technologies that are coming along