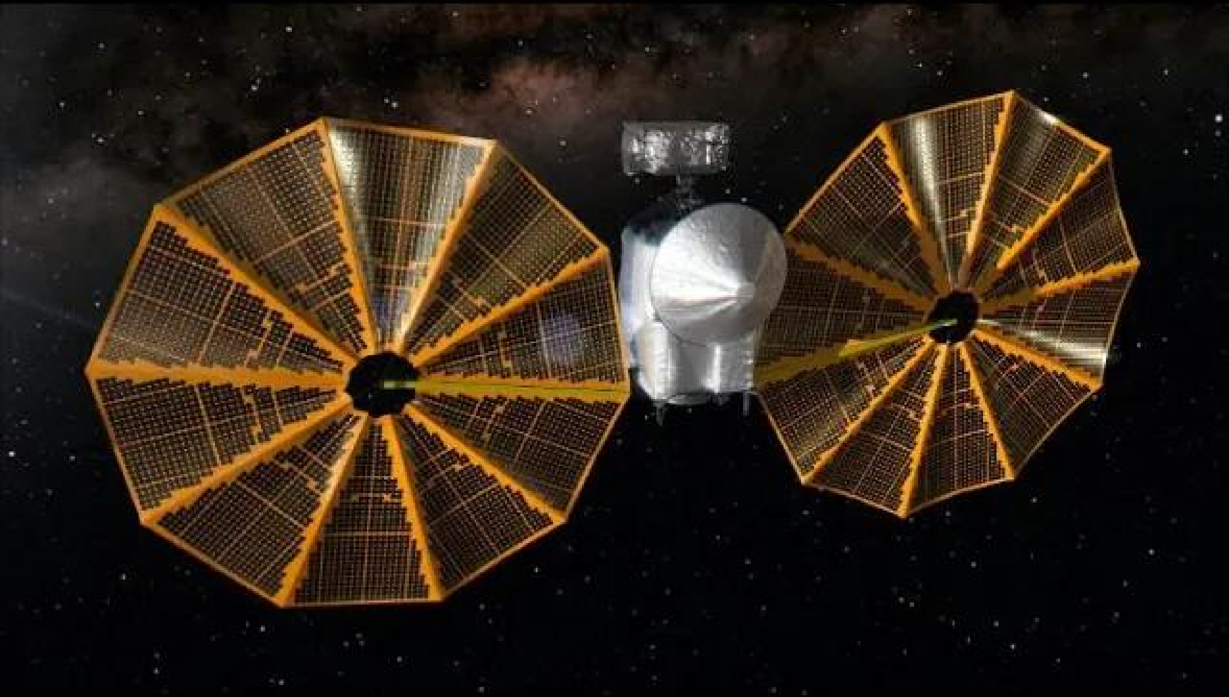

1
00:00:00,100 --> 00:00:01,401
■■■

2
00:00:01,401 --> 00:00:04,137
NASA’s Lucy mission is going to be the first mission

3
00:00:04,137 --> 00:00:06,506
to explore the Trojan asteroids.

4
00:00:06,506 --> 00:00:09,242
These are asteroids that live in two swarms:

5
00:00:09,242 --> 00:00:12,946
one that’s ahead of Jupiter, and another that’s behind Jupiter,

6
00:00:12,946 --> 00:00:16,282
and we want to go and look at these building blocks of the planets,

7
00:00:16,282 --> 00:00:18,985
the ones that didn’t get accumulated into the planets,

8
00:00:18,985 --> 00:00:23,189
to really learn about the evolution of our solar system.

9
00:00:23,189 --> 00:00:26,893
Lagrange points are these stable regions of space.

10
00:00:26,893 --> 00:00:29,763
They’re around pretty much every planet in the solar system.

11
00:00:29,763 --> 00:00:33,500
Jupiter, by virtue of being the largest planet in the solar system,

12
00:00:33,500 --> 00:00:36,202
it also has the biggest Lagrange points.

13
00:00:36,202 --> 00:00:39,372

And these are little stable reservoirs where asteroids get in,

14
00:00:39,372 --> 00:00:40,673
but they never come out.

15
00:00:40,673 --> 00:00:44,044
In reality, what we have is sort of a snapshot

16
00:00:44,044 --> 00:00:47,347
of what the solar system looked like billions of years ago.

17
00:00:47,347 --> 00:00:51,818
Early in the solar system, the giant planets were migrating outward,

18
00:00:51,818 --> 00:00:56,389
away from the Sun, and at one point there was chaos in the solar system.

19
00:00:56,389 --> 00:00:59,626
Some small bodies were ejected out of the solar system,

20
00:00:59,626 --> 00:01:03,063
others could have been trapped in these Lagrange points,

21
00:01:03,063 --> 00:01:07,033
and that’s one theory for how the Trojan asteroids

22
00:01:07,033 --> 00:01:09,102
came to be where they are today.

23
00:01:09,102 --> 00:01:15,275
■■■

24
00:01:15,275 --> 00:01:19,045
My job as a mission architect here at Lockheed Martin it’s very interesting,

25
00:01:19,045 --> 00:01:22,949
and it sort of encompasses the biggest picture of the mission.

26
00:01:22,949 --> 00:01:24,350
What is the trajectory?

27
00:01:24,350 --> 00:01:27,320
What sort of propulsion do you need to fly that trajectory?

28
00:01:27,320 --> 00:01:29,122
What does the spacecraft look like?

29
00:01:29,122 --> 00:01:31,024
So in the case of, for example, Lucy, it’s like:

30
00:01:31,024 --> 00:01:34,694
“Okay, it’s going out five times further from the Sun than the Earth is,

31
00:01:34,694 --> 00:01:38,264
and so it’s going to need big, huge solar arrays just because of that.”

32
00:01:38,264 --> 00:01:42,268
Lucy has three scientific instruments on board the spacecraft,

33
00:01:42,268 --> 00:01:45,905
and we’ll also be using two of the spacecraft’s subsystems

34
00:01:45,905 --> 00:01:48,174
to contribute to the science investigation.

35
00:01:48,174 --> 00:01:51,277
With the LORRI instrument we’ll be able to get panchromatic images,

36
00:01:51,277 --> 00:01:55,315
which will tell us about the geology and the crater history,

37
00:01:55,315 --> 00:01:57,617
which gives us the age of the surface.

38
00:01:57,617 --> 00:02:00,386

With the TES instrument we’ll be able to measure the temperature

39
00:02:00,386 --> 00:02:02,088
of the surface at different points,

40
00:02:02,088 --> 00:02:04,557
and with the Ralph instrument we’ll be able to measure

41
00:02:04,557 --> 00:02:07,460
the composition of the surfaces.

42
00:02:07,460 --> 00:02:10,497
■■■

43
00:02:10,497 --> 00:02:15,301
The Jupiter Trojans, they have a variety of surface characteristics.

44
00:02:15,301 --> 00:02:18,438
They have different colors and different surface compositions,

45
00:02:18,438 --> 00:02:21,908
and that leads us to believe that maybe they formed somewhere else.

46
00:02:21,908 --> 00:02:25,445
In choosing the Lucy targets, we wanted to be able to compare

47
00:02:25,445 --> 00:02:30,250
different objects that have different surface properties, but a very similar orbit.

48
00:02:30,250 --> 00:02:35,288
Lucy will visit one main-belt asteroid and seven Trojan asteroids.

49
00:02:35,288 --> 00:02:39,492
I don’t think there’s been a single NASA mission that will have visited

50
00:02:39,492 --> 00:02:43,663
as many objects on separate orbits in the solar system

51
00:02:43,663 --> 00:02:45,331
as the Lucy mission will.

52
00:02:45,331 --> 00:02:47,667
We launch in October of 2021.

53
00:02:47,667 --> 00:02:50,537
That trajectory just basically does a one-year loop around the Sun

54
00:02:50,537 --> 00:02:53,573
and comes back to Earth in October of 2022,

55
00:02:53,573 --> 00:02:56,843
and that will slingshot us out now onto a trajectory that takes

56
00:02:56,843 --> 00:02:59,345
a little more than two years to come back to the Earth.

57
00:02:59,345 --> 00:03:01,748
Now we’re moving a whole lot faster than we were.

58
00:03:01,748 --> 00:03:05,518
We get that trajectory set up, and that second Earth gravity assist

59
00:03:05,518 --> 00:03:08,988
takes that velocity and redirects it in the direction we want

60
00:03:08,988 --> 00:03:11,391
that will take us out to the Trojan space.

61
00:03:11,391 --> 00:03:14,561
On our way out to the L4 swarm of the Trojans,

62
00:03:14,561 --> 00:03:16,896
we’re going to visit a main-belt asteroid.

63
00:03:16,896 --> 00:03:19,966

That main-belt asteroid is named Donaldjohanson,

64
00:03:19,966 --> 00:03:23,136
after the discoverer of the Lucy fossil.

65
00:03:23,136 --> 00:03:26,506
We named the Lucy mission in honor of the Lucy fossil

66
00:03:26,506 --> 00:03:30,577
because we learned so much about hominid development and evolution

67
00:03:30,577 --> 00:03:33,580
from that fossil, just like we’re going to learn about

68
00:03:33,580 --> 00:03:36,916
the solar system evolution from the Lucy mission.

69
00:03:36,916 --> 00:03:40,587
From there, we take a couple of years off and we continue to cruise up,

70
00:03:40,587 --> 00:03:44,057
until we get to August 2027,

71
00:03:44,057 --> 00:03:48,962
and there we encounter our first Trojan asteroid, it’s called Eurybates.

72
00:03:48,962 --> 00:03:52,365
It’s the product of a huge collision that happened

73
00:03:52,365 --> 00:03:54,200
millions and millions of years ago.

74
00:03:54,200 --> 00:03:56,636
Something big hit it and just blew it apart,

75
00:03:56,636 --> 00:04:01,641
and so Eurybates is the biggest chunk of that cataclysmic impact.

76
00:04:01,641 --> 00:04:04,744
And it’s a C-class asteroid, which is kind of interesting because

77
00:04:04,744 --> 00:04:07,113
there’s a lot of C-class asteroids in the main belt,

78
00:04:07,113 --> 00:04:09,349
there’s very few of them in Trojan space.

79
00:04:09,349 --> 00:04:11,651
So that’s one of the mysteries we’re going to get at – is, okay,

80
00:04:11,651 --> 00:04:13,920
why is Eurybates so different?

81
00:04:13,920 --> 00:04:16,756
As we’ve studied it and tried to refine its orbit,

82
00:04:16,756 --> 00:04:18,625
we’ve discovered it’s got a little moon, and so we’re going

83
00:04:18,625 --> 00:04:21,327
to try to get pictures of that too as we fly by.

84
00:04:21,327 --> 00:04:24,998
And about a month later, in September of 2027,

85
00:04:24,998 --> 00:04:28,635
we’re encountering our second Trojan asteroid: Polymele.

86
00:04:28,635 --> 00:04:30,637
So it’s one of the smaller objects.

87
00:04:30,637 --> 00:04:34,974
We’re flying by at about six, seven kilometers per second.

88
00:04:34,974 --> 00:04:36,909

We have to take pictures like crazy as we fly by,

89
00:04:36,909 --> 00:04:38,678
but we’re not stopping at any of these.

90
00:04:38,678 --> 00:04:43,082
We come to our next object, Leucus, and it’s “wash, rinse, repeat.”

91
00:04:43,082 --> 00:04:46,386
And so we snap pictures like crazy at Leucus and then about seven months

92
00:04:46,386 --> 00:04:50,490
after that, we do the exact same thing at another object called Orus.

93
00:04:50,490 --> 00:04:55,061
And that’s the last L4 swarm object that we’re going to be visiting,

94
00:04:55,061 --> 00:04:58,898
and from there we start dropping down back into the inner solar system, now.

95
00:04:58,898 --> 00:05:02,001
So, we were out past Jupiter’s orbit a little ways,

96
00:05:02,001 --> 00:05:04,270
now we’re falling back in towards the Earth,

97
00:05:04,270 --> 00:05:08,474
so the trajectory is sort of set up to sort of return back to Earth for free.

98
00:05:08,474 --> 00:05:13,079
And we use that to redirect the trajectory now towards our final Trojan asteroid,

99
00:05:13,079 --> 00:05:15,882
and so this is an object out in the L5 swarm,

100
00:05:15,882 --> 00:05:18,751
so it’s trailing Jupiter by about sixty degrees.

101
00:05:18,751 --> 00:05:23,990
It’s a roughly equal-mass binary system called Patroclus and Menoetius.

102
00:05:23,990 --> 00:05:27,727
You can imagine it’s sort of like this dumbbell in space.

103
00:05:27,727 --> 00:05:30,296
So imagine a great big dumbbell spinning around, you know,

104
00:05:30,296 --> 00:05:33,666
but there’s no bar there, it’s just the objects orbiting each other.

105
00:05:33,666 --> 00:05:37,003
It’s a very rare thing to find in the inner solar system,

106
00:05:37,003 --> 00:05:39,839
however, if you look out past the orbit of Pluto,

107
00:05:39,839 --> 00:05:42,408
equal-mass binaries are kind of common out there.

108
00:05:42,408 --> 00:05:46,679
Another clue, it’s like – okay, are these objects in the Trojan swarm,

109
00:05:46,679 --> 00:05:50,650
are they maybe related to the Kuiper belt objects out there past Jupiter?

110
00:05:50,650 --> 00:05:53,553
And if they are, this would be amazing, we can go and visit

111
00:05:53,553 --> 00:05:56,889
Kuiper belt objects by just going out to Jupiter.

112
00:05:56,889 --> 00:06:01,527
We really have never seen Trojan asteroids up close before,

113
00:06:01,527 --> 00:06:04,197

and we want to understand their geology,

114
00:06:04,197 --> 00:06:08,401
look at the craters on the surface to understand the history of their surfaces,

115
00:06:08,401 --> 00:06:11,437
understand the composition of their surfaces so that we can maybe

116
00:06:11,437 --> 00:06:13,940
learn something about where they formed.

117
00:06:13,940 --> 00:06:17,343
And all of those will be clues to help us understand