
That's
orbiting...

1
00:00:00,496 --> 00:00:01,501
- If we wanted to get something

2
00:00:01,501 --> 00:00:02,659
all the way to another planet,

3
00:00:02,659 --> 00:00:03,837
why can't we just throw it

4
00:00:03,837 --> 00:00:05,857
in the right direction really hard?

5
00:00:05,857 --> 00:00:07,064
Sometimes working with gravity

6
00:00:07,064 --> 00:00:08,656
instead of against it is the easiest way

7
00:00:08,656 --> 00:00:11,677
to get something where we want it to go.

8
00:00:11,677 --> 00:00:13,753
- [Neil Armstrong] That's
one small step for man.

9
00:00:13,753 --> 00:00:15,174
(upbeat music)

10
00:00:15,174 --> 00:00:17,160
- [Narrator] Traveling
through space is hard.

11
00:00:17,160 --> 00:00:18,819
That's why NASA's space launch system

12
00:00:18,819 --> 00:00:21,480
will have to be the most
powerful rocket in the world.

13
00:00:21,480 --> 00:00:23,000
How does SLS able to meet the challenges

14
00:00:23,000 --> 00:00:24,855
of exploring deep space?

15
00:00:24,855 --> 00:00:27,459
Well, when it comes to our
journey to Mars and beyond,

16
00:00:27,459 --> 00:00:29,542
there are no small steps.

17
00:00:31,539 --> 00:00:32,680
- So let's talk about orbit.

18
00:00:32,680 --> 00:00:34,296
We've talked about how we initially escape

19
00:00:34,296 --> 00:00:35,480
Earth's gravity to get into space,

20
00:00:35,480 --> 00:00:38,520
but to stay there, we'll
basically have to ride orbit.

21
00:00:38,520 --> 00:00:39,913
First, let's look at what that means

22
00:00:39,913 --> 00:00:42,135
if we want to send stuff to the
International Space Station.

23
00:00:42,135 --> 00:00:43,741
For that, we'll need some help.

24
00:00:43,741 --> 00:00:45,256

Meet Terrence.

25
00:00:45,256 --> 00:00:46,339
Here's Earth.

26
00:00:48,358 --> 00:00:50,600
And here's the space station's orbit.

27
00:00:50,600 --> 00:00:52,419
Now let's say we wanted
to send a cargo capsule

28
00:00:52,419 --> 00:00:53,576
to the ISS.

29
00:00:53,576 --> 00:00:55,598
If our capsule rode a vehicle straight up,

30
00:00:55,598 --> 00:00:57,560
then gravity would just pull
it straight back down again.

31
00:00:57,560 --> 00:01:00,579
Instead, the vehicle needs
to go sideways really fast

32
00:01:00,579 --> 00:01:02,760
as well as up, so fast that as gravity

33
00:01:02,760 --> 00:01:06,920
pulls it back down, it keeps
missing the Earth instead.

34
00:01:06,920 --> 00:01:11,320
That's orbiting, the art of
constantly falling sideways.

35
00:01:11,320 --> 00:01:13,779
Once we're in orbit, our

vehicle fires its engines,

36
00:01:13,779 --> 00:01:15,560
pushing the opposite side of its orbit

37
00:01:15,560 --> 00:01:17,038
further away from Earth.

38
00:01:17,038 --> 00:01:18,280
This creates an elliptical orbital

39
00:01:18,280 --> 00:01:20,520
better matching the ISS's.

40
00:01:20,520 --> 00:01:23,367
Once we match ISS, we
fire our engines again

41
00:01:23,367 --> 00:01:25,341
to regain our circular orbit.

42
00:01:25,341 --> 00:01:26,734
It's called a Hohmann Transfer,

43
00:01:26,734 --> 00:01:29,400
and the same technique can get is to Mars.

44
00:01:29,400 --> 00:01:31,187
Let's reset the stage.

45
00:01:31,187 --> 00:01:33,566
First, let's replace
the Earth with the sun,

46
00:01:33,566 --> 00:01:35,987
which both the Earth
and Mars orbit around.

47

00:01:35,987 --> 00:01:38,320
Then, let's scale things up.

48
00:01:40,926 --> 00:01:42,440
A lot.

49
00:01:42,440 --> 00:01:44,147
Yeah, the Earth and
Mars a lot further apart

50
00:01:44,147 --> 00:01:45,565
than the Earth and the ISS,

51
00:01:45,565 --> 00:01:47,283
but with a powerful rocket like the SLS,

52
00:01:47,283 --> 00:01:48,787
we can make up the difference.

53
00:01:48,787 --> 00:01:50,067
When we start our trip to Mars,

54
00:01:50,067 --> 00:01:52,307
we fire our engine strategically,

55
00:01:52,307 --> 00:01:53,784
spiraling further and further out,

56
00:01:53,784 --> 00:01:56,904
creating an elliptical curve
that overlaps Mars' orbit.

57
00:01:56,904 --> 00:01:59,166
We coast until we get there
when we fire engines again

58
00:01:59,166 --> 00:02:02,003
to orbit Mars and eventually
enter its atmosphere.

59
00:02:02,003 --> 00:02:03,566
Pretty simple, huh?

60
00:02:03,566 --> 00:02:04,707
No?

61
00:02:04,707 --> 00:02:06,547
Well at this point, it
really is the easiest way

62
00:02:06,547 --> 00:02:07,688
to hop planets.

63
00:02:07,688 --> 00:02:08,961
It's also the most efficient.

64
00:02:08,961 --> 00:02:10,685
Imagine how much fuel we'd have to burn

65
00:02:10,685 --> 00:02:12,904
to push a rocket all the way to Mars.

66
00:02:12,904 --> 00:02:14,467
Why not just coast?

67
00:02:14,467 --> 00:02:16,307
Another element to consider is distance.

68
00:02:16,307 --> 00:02:18,963
Every two years or so, for
a short period of time,

69
00:02:18,963 --> 00:02:20,264
the Earth and Mars are as close together

70
00:02:20,264 --> 00:02:21,359
as they can be.

71
00:02:21,359 --> 00:02:23,187
This gives us a very narrow launch window.

72
00:02:23,187 --> 00:02:24,824
Launch too early or too late,

73
00:02:24,824 --> 00:02:26,225
and we don't have enough fuel,

74
00:02:26,225 --> 00:02:27,726
and the results could be disastrous.

75
00:02:27,726 --> 00:02:30,344
The whole thing is like
trying to hit a moving target

76
00:02:30,344 --> 00:02:31,704
while you're also moving,

77
00:02:31,704 --> 00:02:33,871
and you only get one shot.

78
00:02:35,187 --> 00:02:37,443
Thankfully, the folks at
NASA aren't just smart.

79
00:02:37,443 --> 00:02:39,122
They're patient, and they're thorough.

80
00:02:39,122 --> 00:02:40,766
Next time, we'll talk about how the SLS

81
00:02:40,766 --> 00:02:42,880
is going to manage the long trip to Mars.

82
00:02:42,880 --> 00:02:45,105
Thanks for watching No Small Steps.