
esa

1
00:00:12,850 --> 00:00:04,330
[Music]

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00:00:12,870 --> 00:00:16,900
Ira Thorpe: LISA Pathfinder is a mission led by the European Space Agency

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00:00:16,920 --> 00:00:21,050
to demonstrate technologies for a future space-based gravitational wave observatory.

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00:00:21,070 --> 00:00:25,270
We've just had a very historic event with the

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00:00:25,290 --> 00:00:29,430
successful detection of gravitational waves from the ground, and that was using these instruments called LIGO

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00:00:29,450 --> 00:00:33,530
For detecting gravitational waves in space you need a slightly different kind of detector,

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00:00:33,550 --> 00:00:37,690
and the detector that we all are working towards has a name LISA, for Laser

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00:00:37,710 --> 00:00:41,310
Interferometer Space Antenna. So that's where we get the name LISA Pathfinder.

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00:00:41,310 --> 00:00:45,900
So basically it demonstrates some of the technologies that we will use on LISA

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00:00:45,930 --> 00:00:50,110
to eventually build a space-based gravitational wave detector. You're looking for these very

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00:00:50,130 --> 00:00:54,170
small distortions in space and time, and so you need to have some object

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00:00:54,190 --> 00:00:58,200
that you can use to reference space and time, basically something that's falling.

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00:00:58,220 --> 00:01:02,230

And any object in space, in principle it's sort of just falling, it's just feeling gravity.

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00:01:02,250 --> 00:01:06,420
But when you look at very exquisite detail you find there's other forces that are pushing

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00:01:06,440 --> 00:01:10,480
that object around, and so this technology called drag-free control was developed,

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00:01:10,500 --> 00:01:14,520
where the test mass actually sits inside the satellite, and the satellite's

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00:01:14,540 --> 00:01:18,550
flying around it like a flying shield. And so we needed to demonstrate this technology

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00:01:18,570 --> 00:01:22,600
and show that we could really place that test mass in absolutely perfect free fall,

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00:01:22,620 --> 00:01:26,790
and that's what we've done. The test was incredibly successful. The level that's been measured

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00:01:26,810 --> 00:01:30,900
you know, not only meets our requirement for LISA Pathfinder, but actually approaches

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00:01:30,920 --> 00:01:34,920
the requirement for doing the full-scale detector, for LISA, and so we're just absolutely thrilled

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00:01:34,940 --> 00:01:39,100
What that will allow us to do when we build the full scale detector is

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00:01:39,120 --> 00:01:43,150
detect gravitational waves from things like merging supermassive black holes at the edge of the

24
00:01:43,170 --> 00:01:47,220
universe. What's shown

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00:01:47,240 --> 00:01:51,300
in the graph here is basically how imperfect this test mass

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00:01:51,320 --> 00:01:55,390
is in free fall. Right? So we'd like it to be perfect, it's not quite perfect,

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00:01:55,410 --> 00:01:59,500
and we're measuring the imperfection. This is directly what we measure with the

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00:01:59,520 --> 00:02:03,630
instrument and the very exciting thing is that it's far below the LISA Pathfinder

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00:02:03,650 --> 00:02:07,780
requirements. The first thing we noticed was at the very lowest frequencies

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00:02:07,800 --> 00:02:11,960
we had this increase in noise. This was actually due to the fact that the

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00:02:11,980 --> 00:02:15,990
spacecraft is jittering about in angle. And we can actually measure how the spacecraft jitters

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00:02:16,010 --> 00:02:20,070
and we can subtract it. The final thing we did was

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00:02:20,090 --> 00:02:24,110
we looked at the noise in this middle-frequency band here, and we determined that this is actually due to

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00:02:24,130 --> 00:02:28,170
some sort of subtle imperfections in the construction of the instrument.

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00:02:28,190 --> 00:02:32,240
And so we can fit these, and subtract them from the data, and we get down to this next line.

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00:02:32,260 --> 00:02:36,320
And this is exactly what we'd expect from a gravitational wave detector and tells

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00:02:36,340 --> 00:02:40,450
us that we're getting a very good understanding of our instrument.

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00:02:40,470 --> 00:02:44,570

The really exciting thing is if we place on this graph the requirement for the full-scale

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00:02:44,590 --> 00:02:48,730
detector, for the LISA detector. And you'll see that although we weren't these

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00:02:48,750 --> 00:02:52,760
requirements, we very nearly made these requirements. Here, essentially, we, you know,

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00:02:52,780 --> 00:02:56,860
turned it on out of the box and it just worked. If you were to take the performance of

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00:02:56,880 --> 00:03:00,890
LISA Pathfinder today and just build LISA with that same performance, you would get

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00:03:00,910 --> 00:03:04,950
the vast majority of the science that we've all been going after for all this time.

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00:03:04,970 --> 00:03:08,980
And, you know, this idea, the idea for LISA, the space-based gravitational wave detector, dates back

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00:03:09,000 --> 00:03:13,030
you know, more than 40 years, it's older than I am. And, you know, we haven't flown

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00:03:13,050 --> 00:03:17,090
the full mission yet, but we've flown a mission, you know, LISA Pathfinder, that's shown this is possible,

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00:03:17,110 --> 00:03:21,180
that you can actually do this. And, you know, some of these people that invested, you know, the past several

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00:03:21,200 --> 00:03:25,290
decades of their lives, you know, developing this mission and to see it work, it was just

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00:03:25,310 --> 00:03:29,320
totally inspiring. [Music]