



1

00:00:00,020 --> 00:00:04,070

The solar system is a dangerous place.

2

00:00:04,090 --> 00:00:08,110

One hazard is impacts from rocky debris

3

00:00:08,130 --> 00:00:12,130

traveling tens of thousands of miles an hour.

4

00:00:12,150 --> 00:00:16,190

Large fragments can tear a spacecraft apart, but even the smallest

5

00:00:16,210 --> 00:00:20,270

pieces gradually take their toll, eroding spacecraft surfaces

6

00:00:20,290 --> 00:00:24,320

and components. Dust-sized particles shed

7

00:00:24,340 --> 00:00:28,340

from comets and asteroids and smaller than a single grain of sand,

8

00:00:28,360 --> 00:00:32,450

traverse the solar system at speeds reaching 40,000 miles an hour.

9

00:00:32,470 --> 00:00:36,590

Our best knowledge of these tiniest meteoroids

10

00:00:36,610 --> 00:00:40,720

comes from measurements made near Earth.

11

00:00:40,740 --> 00:00:44,910

Now, a clever new technique using the LISA Pathfinder spacecraft is measuring

12

00:00:44,930 --> 00:00:49,100

this population of particles at nearly a million miles away.

13

00:00:49,120 --> 00:00:53,170

Launched in 2015, LISA Pathfinder is a

14

00:00:53,190 --> 00:00:57,210

technology demonstrator for the space-based detection of gravitational waves

15

00:00:57,230 --> 00:01:01,270

led by the European Space Agency and with participation

16

00:01:01,290 --> 00:01:05,360

by NASA. The full observatory would work by tracking

17

00:01:05,380 --> 00:01:09,440

reference objects called proof masses that move under the

18

00:01:09,460 --> 00:01:13,460

influence of gravity, which means the spacecraft must reduce all

19

00:01:13,480 --> 00:01:17,590

other forces to an astonishing degree. Tests show

20

00:01:17,610 --> 00:01:21,730

LISA Pathfinder is the most precise tool for measuring accelerations

21

00:01:21,750 --> 00:01:25,930

ever flown, reducing non-gravitational forces to levels

22

00:01:25,950 --> 00:01:30,120

required to detect passing gravitational waves.

23

00:01:30,140 --> 00:01:34,310

Because LISA Pathfinder is extremely sensitive to its environment,

24

00:01:34,330 --> 00:01:38,420

it's also sensitive to those tiny nudges from micrometeoroids.

25

00:01:38,440 --> 00:01:42,460

These impacts would be reflected in motions of the proof masses,

26

00:01:42,480 --> 00:01:46,500

how the spacecraft thrusters fired to counteract the impact, and other data.

27

00:01:46,520 --> 00:01:50,570

Using software originally written to sift out the the faint signatures of

28

00:01:50,590 --> 00:01:54,620

gravitational waves in ground-based detectors, the science team found

29

00:01:54,640 --> 00:01:58,670

several impacts. When it is struck, the impact

30

00:01:58,690 --> 00:02:02,750

both pushes and twists the spacecraft. Onboard sensors

31

00:02:02,770 --> 00:02:06,820

detect this change and fire the Pathfinder's ultra-precise thrusters to

32

00:02:06,840 --> 00:02:10,890

compensate. At full power, each of these only generates about as much

33

00:02:10,910 --> 00:02:14,950

force as the weight of a mosquito. Knowing what it took to restore

34

00:02:14,970 --> 00:02:19,010

the spacecraft's orientation gives scientists information

35

00:02:19,030 --> 00:02:23,070

on the original direction of the particle, its momentum, and where it struck the

36

00:02:23,090 --> 00:02:27,250

spacecraft. LISA Pathfinder is located at Earth-sun L1,

37

00:02:27,270 --> 00:02:31,430

a gravitational balance point about million miles from Earth's

38

00:02:31,450 --> 00:02:35,540

sunward side. This is essentially unexplored territory for

39

00:02:35,560 --> 00:02:39,590

understanding the solar system's dust distribution. By comparing

40

00:02:39,610 --> 00:02:43,640

how often Pathfinder is hit, and the particles' origins,

41

00:02:43,660 --> 00:02:47,690

scientists can refine their models of solar system composition and formation.

42

00:02:47,710 --> 00:02:51,790

By improving our understanding of the solar system's

43

00:02:51,810 --> 00:02:55,840

dust environment, LISA Pathfinder will also help pave the way

44

00:02:55,860 --> 00:02:59,900

for future giant telescopes whose large optics could be degraded

45

00:02:59,920 --> 00:03:03,990

by these impacts. It's an intriguing side benefit from testing spacecraft

46

00:03:04,010 --> 00:03:08,110

technology that will one day be used to observe merging black holes

47

00:03:08,130 --> 00:03:12,240

billions of light years away.

48

00:03:12,260 --> 00:03:16,280

[Music]