
The Comet Nucleus
Sample Return Mission

1
00:00:00,010 --> 00:00:04,130
Since the beginning of the

2
00:00:04,150 --> 00:00:08,310
space age NASA has explored our solar system, bringing back

3
00:00:08,330 --> 00:00:12,480
unprecedented scientific knowledge, but only a handful of missions

4
00:00:12,500 --> 00:00:16,680
over the past 50 years have actually collected and returned samples

5
00:00:16,700 --> 00:00:20,870
from these far off places. Astronauts

6
00:00:20,890 --> 00:00:25,020
on the Apollo program traveled to our Moon, bringing back over 800 lbs

7
00:00:25,040 --> 00:00:29,530
of moon rock. Stardust was an unmanned mission that collected samples

8
00:00:29,550 --> 00:00:33,700
from the coma of comet Wild 2 before returning them to Earth for in-depth

9
00:00:33,720 --> 00:00:37,860
scientific study. OSIRIS-Rex is the most recently funded

10
00:00:37,880 --> 00:00:42,010
sample return mission that will launch in 2016 and return surface

11
00:00:42,030 --> 00:00:46,190
samples from an asteroid in 2023.

12
00:00:46,210 --> 00:00:50,320
The Comet Nucleus Sample Return mission will collect subsurface samples

13
00:00:50,340 --> 00:00:54,430

from a comet and return them to Earth. Comets and Asteroids are

14
00:00:54,450 --> 00:00:58,530
leftover remnants from the early solar system and by studying samples from these

15
00:00:58,550 --> 00:01:02,620
objects, we can learn more about the formation of our solar system and

16
00:01:02,640 --> 00:01:06,680
may find clues to the origin of life on Earth. Collecting a sample

17
00:01:06,700 --> 00:01:10,710
from a comet is a challenging feat for many reasons, including how far

18
00:01:10,730 --> 00:01:14,730
away they are from Earth and how little gravity they provide. In our

19
00:01:14,750 --> 00:01:18,910
concept, harpoons are used to collect and retrieve samples from interesting locations

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00:01:18,930 --> 00:01:23,090
on these exotic objects. Traditionally,

21
00:01:23,110 --> 00:01:27,270
when collecting samples on Earth, we use scoops, shovels, or coring drills,

22
00:01:27,290 --> 00:01:31,450
but on comets and asteroids there is so little gravity that you would

23
00:01:31,470 --> 00:01:35,640
push yourself off the surface if you used one of these methods. Harpoons allow

24
00:01:35,660 --> 00:01:39,860
you to grapple to the surface while taking a sample, allowing rapid sample collection

25
00:01:39,880 --> 00:01:43,990
and retrieval. First, we choose a specific interesting

26
00:01:44,010 --> 00:01:48,200
area to take a sample from and then fire a sample collecting harpoon into that

27
00:01:48,220 --> 00:01:52,330
spot. As the harpoon penetrates into the comet, it fills its inner sample

28
00:01:52,350 --> 00:01:56,440
cartridge with subsurface material as it goes deeper. When it reaches its

29
00:01:56,460 --> 00:02:00,550
maximum depth the sample cartridge closure mechanism shuts, trapping all

30
00:02:00,570 --> 00:02:04,640
the material inside it. The sample cartridge is then with drawn from the outer harpoon

31
00:02:04,660 --> 00:02:08,700
sheath and pulled back into the space craft. The sample is

32
00:02:08,720 --> 00:02:12,750
then brought back to a terrestrial laboratory where scientists examine the collected

33
00:02:12,770 --> 00:02:16,790
samples in a pristine environment.

34
00:02:16,810 --> 00:02:20,970
Before we journey here, we need to work here

35
00:02:20,990 --> 00:02:25,150
in the lab, studying comet and asteroid analogs.

36
00:02:25,170 --> 00:02:29,320
In order to determine how much energy is required to penetrate different depths

37
00:02:29,340 --> 00:02:33,500
in various density material, we've designed and built a harpoon

38
00:02:33,520 --> 00:02:37,670

test laboratory. Although the actual mission will use a cannon,

39
00:02:37,690 --> 00:02:41,860
for safety reasons, we've employed a ballista to fire the harpoons.

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00:02:41,880 --> 00:02:46,040
By correlating the imparted energy versus the penetration depth, we will

41
00:02:46,060 --> 00:02:50,190
know how to size the explosive charge for the actual mission.

42
00:02:50,210 --> 00:02:54,340
The harpoon lab also allows us to study how the tip geometry, cross

43
00:02:54,360 --> 00:02:58,500
section and mass of the harpoon affect its penetration.

44
00:02:58,520 --> 00:03:02,610
This has allowed us to optimize the harpoon sheath for a range of

45
00:03:02,630 --> 00:03:06,700
possible comet densities. Although sample return missions can be quite

46
00:03:06,720 --> 00:03:10,770
costly and complex, they offer important advantages over missions

47
00:03:10,790 --> 00:03:14,820
that study their subjects from a distance. Sample return missions allow

48
00:03:14,840 --> 00:03:18,860
terrestrial laboratories to study in far greater detail, with a variety