
NASA
Hubble Constant
An Expanding Universe

1
00:00:10,070 --> 00:00:02,450
[Music]

2
00:00:13,570 --> 00:00:12,049
we know that the universe is expanding

3
00:00:16,369 --> 00:00:13,580
we've known that for almost 100 years

4
00:00:18,410 --> 00:00:16,379
the rate at which the universe expands

5
00:00:19,490 --> 00:00:18,420
is a number we refer to as the Hubble

6
00:00:21,230 --> 00:00:19,500
constant

7
00:00:23,269 --> 00:00:21,240
when Hubble was launched one of its main

8
00:00:24,710 --> 00:00:23,279
objectives was to measure the Hubble

9
00:00:27,769 --> 00:00:24,720
constant the expansion rate of the

10
00:00:30,349 --> 00:00:27,779
universe by resolving individual stars

11
00:00:32,150 --> 00:00:30,359
in distant galaxies Hubble was really

12
00:00:35,090 --> 00:00:32,160
the first telescope that allowed us to

13
00:00:38,030 --> 00:00:35,100

easily resolve the individual components

14
00:00:40,549 --> 00:00:38,040
the stars in a distant Galaxy to gauge

15
00:00:42,110 --> 00:00:40,559
its distance and that's part of the

16
00:00:44,569 --> 00:00:42,120
ingredients you need to measure the

17
00:00:46,670 --> 00:00:44,579
expansion rate of the universe over time

18
00:00:48,709 --> 00:00:46,680
Hubble also was improved by a series of

19
00:00:51,110 --> 00:00:48,719
servicing missions that increased the

20
00:00:52,970 --> 00:00:51,120
sensitivity resolution and also

21
00:00:55,610 --> 00:00:52,980
ultimately allowed us to make

22
00:00:58,369 --> 00:00:55,620
observations in the near infrared which

23
00:00:59,930 --> 00:00:58,379
reduces the effects of dust dust is

24
00:01:01,610 --> 00:00:59,940
scattered throughout the Universe and if

25
00:01:03,349 --> 00:01:01,620
you're looking at a distant light and

26
00:01:05,390 --> 00:01:03,359
trying to tell how far away it is dust

27
00:01:07,730 --> 00:01:05,400
can dim the light and fool you into the

28
00:01:09,410 --> 00:01:07,740
gates further away than it is Hubble has

29
00:01:11,450 --> 00:01:09,420
sort of all of these tools on its

30
00:01:14,810 --> 00:01:11,460
utility belt that allow us to measure

31
00:01:16,070 --> 00:01:14,820
the expansion rate as well as it's been

32
00:01:18,410 --> 00:01:16,080
measured to date

33
00:01:19,730 --> 00:01:18,420
Hubble found that the expansion rate of

34
00:01:22,730 --> 00:01:19,740
the universe is speeding up it's

35
00:01:24,380 --> 00:01:22,740
accelerating due to a new component of

36
00:01:26,270 --> 00:01:24,390
the universe that we call dark energy

37
00:01:29,390 --> 00:01:26,280
[Music]

38
00:01:32,270 --> 00:01:29,400

Dark Energy actually reverses the sign

39
00:01:34,550 --> 00:01:32,280
of gravity it actually gives rise to a

40
00:01:36,170 --> 00:01:34,560
repulsive gravity which is sounds very

41
00:01:38,149 --> 00:01:36,180
strange and it's not something that

42
00:01:40,789 --> 00:01:38,159
Isaac Newton would have understood but

43
00:01:42,649 --> 00:01:40,799
it is a feature in Einstein's theory of

44
00:01:44,870 --> 00:01:42,659
general relativity Einstein's theory of

45
00:01:47,210 --> 00:01:44,880
gravity that replacement theory of

46
00:01:50,149 --> 00:01:47,220
gravity and in that theory you can have

47
00:01:51,770 --> 00:01:50,159
such a material if you have a constant

48
00:01:54,230 --> 00:01:51,780
energy and empty space that's

49
00:01:56,450 --> 00:01:54,240
unavoidable then it will give rise to

50
00:01:59,870 --> 00:01:56,460
this repulsive gravity because gravity

51
00:02:02,569 --> 00:01:59,880
is weakest in the empty regions of space

52
00:02:04,490 --> 00:02:02,579
between galaxies dark energy has its

53
00:02:07,190 --> 00:02:04,500
most pronounced effect in deep space

54
00:02:10,449 --> 00:02:07,200
it's driving now pushing the inwards to

55
00:02:15,110 --> 00:02:13,190
the James Webb Space Telescope has

56
00:02:17,570 --> 00:02:15,120
certain capabilities that are even

57
00:02:20,390 --> 00:02:17,580
greater than Hubble's it will have

58
00:02:22,610 --> 00:02:20,400
greater resolution it can extend

59
00:02:25,070 --> 00:02:22,620
observations further to the room for red

60
00:02:28,729 --> 00:02:25,080
to even further diminish the impact of

61
00:02:32,089 --> 00:02:28,739
dust so it will both simultaneously give

62
00:02:33,890 --> 00:02:32,099
us a sharper view of these distant stars

63
00:02:35,510 --> 00:02:33,900

that are used to calibrate the expansion

64
00:02:38,030 --> 00:02:35,520
of the universe and it will also allow

65
00:02:41,089 --> 00:02:38,040
us to see through the last little wisps

66
00:02:43,250 --> 00:02:41,099
of dust in front of those our goal is to

67
00:02:46,369 --> 00:02:43,260
measure the Hubble constant to one

68
00:02:48,530 --> 00:02:46,379
percent precision and so we are using

69
00:02:50,509 --> 00:02:48,540
the Hubble Space Telescope and James

70
00:02:52,610 --> 00:02:50,519
Webb Space Telescope to refine those