



1
00:00:07,030 --> 00:00:04,309
how can astronomers determine distances

2
00:00:09,990 --> 00:00:07,040
in the far reaches of the universe

3
00:00:12,629 --> 00:00:10,000
a small galaxy close in looks similar to

4
00:00:14,150 --> 00:00:12,639
a large galaxy farther out

5
00:00:16,230 --> 00:00:14,160
this is a real challenge that

6
00:00:17,670 --> 00:00:16,240
researchers have found several solutions

7
00:00:19,750 --> 00:00:17,680
for

8
00:00:21,349 --> 00:00:19,760
one method uses something called a

9
00:00:26,470 --> 00:00:21,359
standard candle

10
00:00:29,429 --> 00:00:26,480
event that emits a specific known amount

11
00:00:32,549 --> 00:00:29,439
of light allowing scientists to find its

12
00:00:34,389 --> 00:00:32,559
distance with a straightforward formula

13
00:00:36,470 --> 00:00:34,399

this works because light sources

14

00:00:38,549 --> 00:00:36,480

appeared predictably dimmer the farther

15

00:00:40,549 --> 00:00:38,559

they are from an observer

16

00:00:42,470 --> 00:00:40,559

since astronomers know how much light a

17

00:00:44,389 --> 00:00:42,480

standard candle gives off

18

00:00:48,069 --> 00:00:44,399

they can determine its distance by

19

00:00:50,790 --> 00:00:48,079

measuring how dim it appears from earth

20

00:00:52,709 --> 00:00:50,800

since only very bright objects or events

21

00:00:54,630 --> 00:00:52,719

are visible in the far reaches of the

22

00:00:57,270 --> 00:00:54,640

universe the options for standard

23

00:01:00,069 --> 00:00:57,280

candles are limited some of the best and

24

00:01:01,510 --> 00:01:00,079

most reliable are exploding stars called

25

00:01:02,950 --> 00:01:01,520

supernovae

26

00:01:04,950 --> 00:01:02,960

there are a few different kinds of

27

00:01:07,109 --> 00:01:04,960

supernovae but the best for standard

28

00:01:09,350 --> 00:01:07,119

candles are type 1a

29

00:01:12,230 --> 00:01:09,360

these supernovae involve a white dwarf

30

00:01:15,109 --> 00:01:12,240

the leftover core of a dead star and one

31

00:01:17,429 --> 00:01:15,119

other star in a binary system

32

00:01:19,590 --> 00:01:17,439

some of the time it may be a white dwarf

33

00:01:21,350 --> 00:01:19,600

and a larger host star

34

00:01:23,670 --> 00:01:21,360

scientists think the white dwarf

35

00:01:25,910 --> 00:01:23,680

steadily accumulates material shed by

36

00:01:27,510 --> 00:01:25,920

the host star gaining mass in the

37

00:01:29,990 --> 00:01:27,520

process

38

00:01:32,390 --> 00:01:30,000

when it reaches a specific tipping point

39

00:01:34,630 --> 00:01:32,400

the white dwarf has gained enough mass

40

00:01:35,590 --> 00:01:34,640

to trigger a runaway reaction at its

41

00:01:38,230 --> 00:01:35,600

core

42

00:01:40,630 --> 00:01:38,240

and it explodes spectacularly sending

43

00:01:42,710 --> 00:01:40,640

out an expanding sphere of super hot

44

00:01:45,830 --> 00:01:42,720

material that glows from the energy of

45

00:01:51,510 --> 00:01:48,389

in other cases scientists think two

46

00:01:53,350 --> 00:01:51,520

white dwarf stars may form the binary

47

00:01:55,749 --> 00:01:53,360

either the stars finally merging

48

00:01:58,389 --> 00:01:55,759

together triggers the supernova

49

00:02:00,630 --> 00:01:58,399

or it happens as they spiral in closer

50

00:02:03,429 --> 00:02:00,640

and closer while the more massive of the

51
00:02:06,870 --> 00:02:03,439
two pulls material off its companion in

52
00:02:11,830 --> 00:02:09,270
before they merge it reaches the same

53
00:02:13,990 --> 00:02:11,840
mass tipping point in goes supernova

54
00:02:16,949 --> 00:02:14,000
always releasing a similar amount of

55
00:02:21,670 --> 00:02:19,030
because white dwarf explosions are all

56
00:02:23,990 --> 00:02:21,680
so similar the energy and light output

57
00:02:25,430 --> 00:02:24,000
of type 1a supernovae are easy to

58
00:02:27,910 --> 00:02:25,440
standardize

59
00:02:29,030 --> 00:02:27,920
type 1a supernovae are rare in any one

60
00:02:31,190 --> 00:02:29,040
galaxy

61
00:02:33,509 --> 00:02:31,200
occurring only once every 500 years or

62
00:02:36,229 --> 00:02:33,519
so in the milky way but because there

63
00:02:38,390 --> 00:02:36,239

are so many galaxies astronomers using

64

00:02:41,509 --> 00:02:38,400

current telescopes observe type 1a

65

00:02:43,509 --> 00:02:41,519

supernovae about 100 times a year

66

00:02:45,270 --> 00:02:43,519

by comparing the observed brightness

67

00:02:46,790 --> 00:02:45,280

with the intrinsic brightness

68

00:02:50,710 --> 00:02:46,800

astronomers can determine their

69

00:02:53,430 --> 00:02:50,720

distances within 6 percent

70

00:02:56,070 --> 00:02:53,440

the nancy grace roman space telescope

71

00:02:59,190 --> 00:02:56,080

set to launch in the mid-2020s will

72

00:03:01,350 --> 00:02:59,200

observe large patches of sky repeatedly

73

00:03:03,270 --> 00:03:01,360

increasing the opportunities to spot

74

00:03:05,430 --> 00:03:03,280

these supernovae

75

00:03:08,149 --> 00:03:05,440

scientists predict roman will see as

76
00:03:11,589 --> 00:03:08,159
many supernovae in one month as they've

77
00:03:13,110 --> 00:03:11,599
found in the last 20 years

78
00:03:15,910 --> 00:03:13,120
finding more of them will help

79
00:03:18,630 --> 00:03:15,920
astronomers refine the accuracy of this

80
00:03:21,350 --> 00:03:18,640
method contribute to an improved

81
00:03:23,430 --> 00:03:21,360
three-dimensional map of the universe

82
00:03:26,229 --> 00:03:23,440
and better understand

83
00:03:27,430 --> 00:03:26,239
how the universe has expanded and