



1  
00:00:10,390 --> 00:00:05,749  
why won't the supernova explode

2  
00:00:16,150 --> 00:00:12,549  
somewhere in the milky way a massive

3  
00:00:18,630 --> 00:00:16,160  
star is about to die a spectacular death

4  
00:00:20,230 --> 00:00:18,640  
as its nuclear fuel runs out the star

5  
00:00:22,390 --> 00:00:20,240  
begins to collapse under its own

6  
00:00:24,390 --> 00:00:22,400  
tremendous weight

7  
00:00:25,509 --> 00:00:24,400  
crushing pressure triggers new nuclear

8  
00:00:28,070 --> 00:00:25,519  
reactions

9  
00:00:29,349 --> 00:00:28,080  
setting the stage for a terrifying blast

10  
00:00:31,750 --> 00:00:29,359  
and then

11  
00:00:33,350 --> 00:00:31,760  
nothing happens

12  
00:00:36,229 --> 00:00:33,360  
at least that's what supercomputers have

13  
00:00:37,750 --> 00:00:36,239

been telling astrophysicists for decades

14

00:00:41,590 --> 00:00:37,760

many of the best computer models of

15

00:00:43,670 --> 00:00:41,600

supernovas fail to produce an explosion

16

00:00:45,830 --> 00:00:43,680

at the end of the simulation gravity

17

00:00:47,350 --> 00:00:45,840

wins the day and the star simply

18

00:00:50,790 --> 00:00:47,360

collapses

19

00:00:52,790 --> 00:00:50,800

clearly physicists are missing something

20

00:00:55,189 --> 00:00:52,800

we don't fully understand how supernovas

21

00:00:57,350 --> 00:00:55,199

of massive stars work yet says fiona

22

00:01:00,950 --> 00:00:57,360

harrison an astrophysicist at the

23

00:01:02,869 --> 00:01:00,960

california institute of technology

24

00:01:04,950 --> 00:01:02,879

to figure out what's going on

25

00:01:07,990 --> 00:01:04,960

scientists need to examine the inside of

26

00:01:10,950 --> 00:01:08,000

a real supernova while it's exploding

27

00:01:13,670 --> 00:01:10,960

not a particularly easy thing to do

28

00:01:15,910 --> 00:01:13,680

so instead they examine the remnant of

29

00:01:17,590 --> 00:01:15,920

the exploded star as soon after the

30

00:01:19,190 --> 00:01:17,600

explosion as possible

31

00:01:21,270 --> 00:01:19,200

harrison and colleagues have figured out

32

00:01:23,030 --> 00:01:21,280

how to do this using a new space

33

00:01:25,350 --> 00:01:23,040

telescope called the nuclear

34

00:01:27,749 --> 00:01:25,360

spectroscopic telescope array

35

00:01:30,390 --> 00:01:27,759

nustar for short

36

00:01:32,310 --> 00:01:30,400

launched on june 13th 2012 onboard a

37

00:01:34,950 --> 00:01:32,320

pegasus xl rocket dropped from an

38

00:01:37,429 --> 00:01:34,960

airplane high above the pacific ocean

39

00:01:39,429 --> 00:01:37,439

nustar is a small explorer satellite

40

00:01:42,469 --> 00:01:39,439

that carries the first space telescope

41

00:01:44,789 --> 00:01:42,479

that can focus very high energy x-rays

42

00:01:46,789 --> 00:01:44,799

nustar will produce images roughly 100

43

00:01:49,990 --> 00:01:46,799

times sharper than those possible with

44

00:01:52,149 --> 00:01:50,000

previous high-energy x-ray telescopes

45

00:01:54,630 --> 00:01:52,159

when nustar finishes its checkout and

46

00:01:56,469 --> 00:01:54,640

becomes fully operational scientists

47

00:01:58,389 --> 00:01:56,479

will use it to scan supernova remnants

48

00:01:59,670 --> 00:01:58,399

for clues etched into the pattern of

49

00:02:01,749 --> 00:01:59,680

elements spread throughout the

50

00:02:03,429 --> 00:02:01,759

explosion's debris

51  
00:02:05,590 --> 00:02:03,439  
the distribution of the material in a

52  
00:02:08,630 --> 00:02:05,600  
supernova remnant tells you a lot about

53  
00:02:10,710 --> 00:02:08,640  
the original explosion says harrison

54  
00:02:13,030 --> 00:02:10,720  
an element of particular interest is

55  
00:02:14,869 --> 00:02:13,040  
titanium 44.

56  
00:02:16,869 --> 00:02:14,879  
creating this isotope of titanium

57  
00:02:19,430 --> 00:02:16,879  
through nuclear fusion requires a

58  
00:02:21,430 --> 00:02:19,440  
certain combination of energy pressure

59  
00:02:23,430 --> 00:02:21,440  
and raw materials

60  
00:02:25,270 --> 00:02:23,440  
inside the collapsing star that

61  
00:02:27,030 --> 00:02:25,280  
combination occurs at a depth that's

62  
00:02:29,110 --> 00:02:27,040  
very special

63  
00:02:31,270 --> 00:02:29,120

everything below that depth succumbs to

64

00:02:32,949 --> 00:02:31,280

gravity and collapses inward to form a

65

00:02:34,550 --> 00:02:32,959

black hole

66

00:02:37,030 --> 00:02:34,560

everything above that depth will be

67

00:02:39,589 --> 00:02:37,040

blown outward in the explosion

68

00:02:42,390 --> 00:02:39,599

titanium 44 is created just above the

69

00:02:44,309 --> 00:02:42,400

cusps so the pattern of how titanium 44

70

00:02:46,229 --> 00:02:44,319

is spread throughout a supernova remnant

71

00:02:47,750 --> 00:02:46,239

can reveal a lot about what happened at

72

00:02:50,390 --> 00:02:47,760

that crucial threshold during the

73

00:02:52,070 --> 00:02:50,400

explosion and with that information

74

00:02:53,350 --> 00:02:52,080

scientists might be able to figure out

75

00:02:55,830 --> 00:02:53,360

what's wrong with their computer

76

00:02:58,229 --> 00:02:55,840

simulations

77

00:03:00,390 --> 00:02:58,239

to detect titanium 44

78

00:03:02,470 --> 00:03:00,400

nustar needs to be able to focus very

79

00:03:05,190 --> 00:03:02,480

high energy x-rays

80

00:03:07,509 --> 00:03:05,200

titanium 44 is radioactive

81

00:03:11,910 --> 00:03:07,519

and when it decays it releases photons

82

00:03:14,470 --> 00:03:11,920

with an energy of 68 000 electron volts

83

00:03:16,949 --> 00:03:14,480

existing x-ray space telescopes such as

84

00:03:19,750 --> 00:03:16,959

nasa's chandra x-ray observatory can

85

00:03:22,149 --> 00:03:19,760

focus x-rays only up to about 15 000

86

00:03:25,270 --> 00:03:22,159

electron volts

87

00:03:27,509 --> 00:03:25,280

normal lenses can't focus x-rays at all

88

00:03:31,190 --> 00:03:27,519

glass bends x-rays only a minuscule

89

00:03:33,030 --> 00:03:31,200

amount not enough to form an image

90

00:03:34,710 --> 00:03:33,040

x-ray telescopes are an entirely

91

00:03:37,670 --> 00:03:34,720

different kind of telescope consisting

92

00:03:39,190 --> 00:03:37,680

of many concentric shells

93

00:03:41,110 --> 00:03:39,200

they look a bit like the layers of a

94

00:03:43,030 --> 00:03:41,120

cylindrical onion

95

00:03:45,270 --> 00:03:43,040

incoming x-rays pass between these

96

00:03:47,030 --> 00:03:45,280

layers which guide the x-rays to the

97

00:03:49,910 --> 00:03:47,040

focus by reflecting them off the

98

00:03:51,670 --> 00:03:49,920

surfaces of the shells

99

00:03:53,429 --> 00:03:51,680

the new star team has spent years

100

00:03:55,270 --> 00:03:53,439

perfecting delicate manufacturing

101

00:03:57,589 --> 00:03:55,280

techniques required to make

102

00:04:00,550 --> 00:03:57,599

high-precision x-ray optics for nustar

103

00:04:02,390 --> 00:04:00,560

that work at energies as high as 79 000

104

00:04:04,309 --> 00:04:02,400

electron volts

105

00:04:07,509 --> 00:04:04,319

their efforts could crack the mystery of

106

00:04:09,910 --> 00:04:07,519

the supernova that wouldn't explode

107

00:04:12,309 --> 00:04:09,920

and that's just for starters

108

00:04:15,750 --> 00:04:12,319

nustar will also study black holes

109

00:04:17,189 --> 00:04:15,760

blazars pulsars and many more exotic

110

00:04:18,949 --> 00:04:17,199

objects

111

00:04:20,870 --> 00:04:18,959

the high energy universe is about to

112

00:04:23,030 --> 00:04:20,880

come into sharper focus

113

00:04:24,629 --> 00:04:23,040

and no one can say what surprises may be

114

00:04:26,469 --> 00:04:24,639

in store