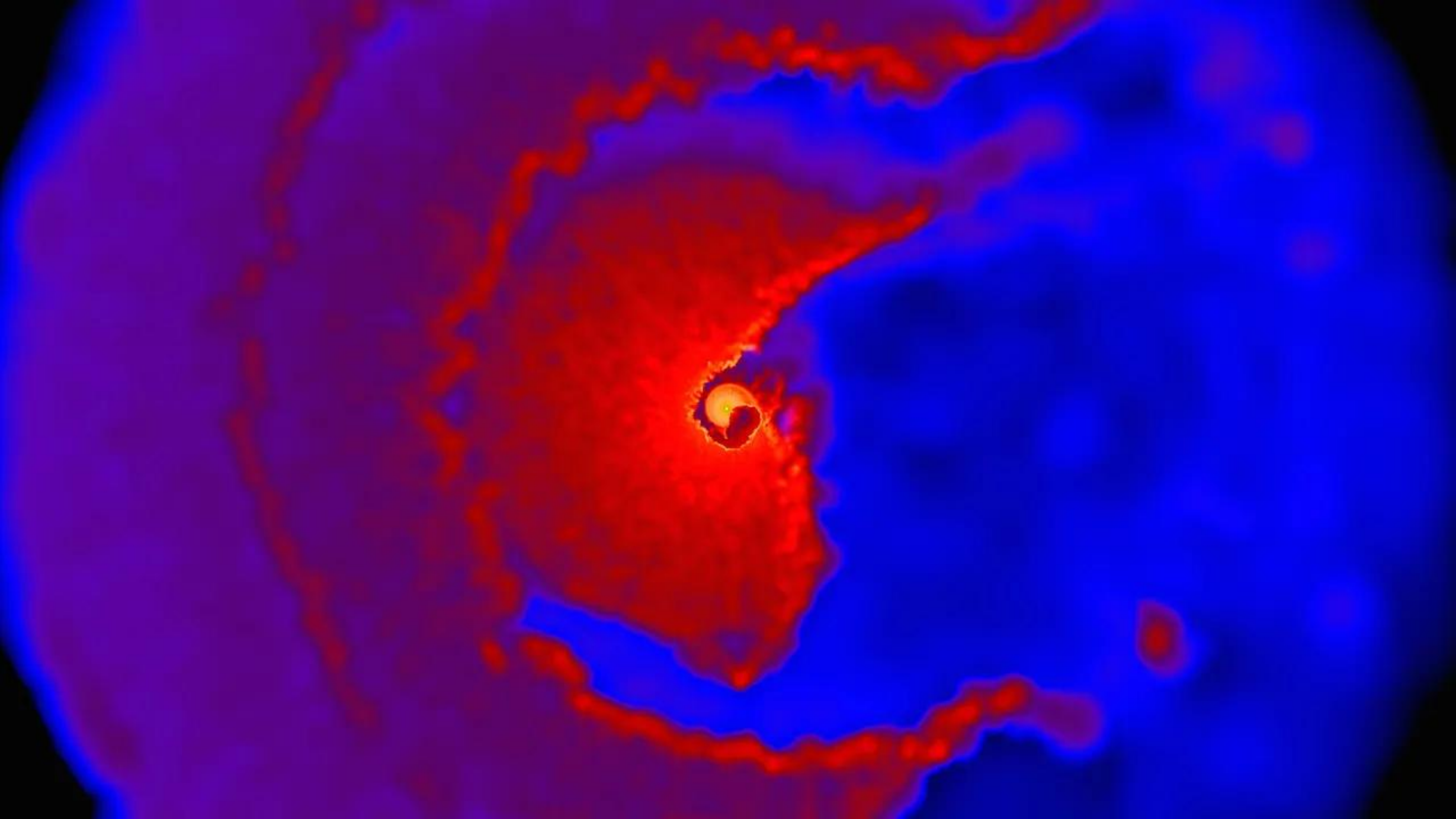

1
00:00:12,050 --> 00:00:04,010
[Music]

2
00:00:12,070 --> 00:00:16,080
is the most massive star within 10,000 light-years.

3
00:00:16,100 --> 00:00:20,130
In the mid-nineteenth century, a tremendous eruption hurled

4
00:00:20,150 --> 00:00:24,150
enough gas into space to make at least 10 copies of the sun, creating

5
00:00:24,170 --> 00:00:28,180
an expanding nebula still visible today. New results from

6
00:00:28,200 --> 00:00:32,250
NASA satellites, ground-based telescopes, and theoretical models are

7
00:00:32,270 --> 00:00:36,260
providing astronomers with an improved understanding of the system.

8
00:00:36,280 --> 00:00:40,280
At the nebula's heart lie two giant stars. The smaller of the two

9
00:00:40,300 --> 00:00:44,340
is 30 times the mass of the sun and a million times brighter.

10
00:00:44,360 --> 00:00:48,360
The primary weighs 90 suns and shines 5 times brighter than

11
00:00:48,380 --> 00:00:52,400
its companion. Both stars produce powerful outflows called

12
00:00:52,420 --> 00:00:56,470
stellar winds, but the primary's is so dense it prevents astronomers

13
00:00:56,490 --> 00:01:00,500

from directly observing the star. The secondary's orbit

14
00:01:00,520 --> 00:01:04,520
is among the most eccentric known. Every five and a half years, when the

15
00:01:04,540 --> 00:01:08,530
two stars swing toward closest approach, or periastron, the come about

16
00:01:08,550 --> 00:01:12,550
as close to each other as Mars is from the sun.

17
00:01:12,570 --> 00:01:16,560
Eta Carinae's most recent periastron occurred in August 2014,

18
00:01:16,580 --> 00:01:20,590
and many of NASA's space-based telescopes, as well as ground-based

19
00:01:20,610 --> 00:01:24,620
observatories, looked on. Where the stellar winds collide,

20
00:01:24,640 --> 00:01:28,640
temperatures reach hundreds of degrees - hot enough to emit

21
00:01:28,660 --> 00:01:32,680
X-rays. But the X-ray emission shuts down near periastron,

22
00:01:32,700 --> 00:01:36,720
when the smaller star is swallowed up by the dense wind of its larger companion.

23
00:01:36,740 --> 00:01:40,730
The X-rays gradually recover after periastron,

24
00:01:40,750 --> 00:01:44,760
but they do so a bit differently each time, suggesting structural

25
00:01:44,780 --> 00:01:48,790
changes in the dueling winds. Recent observations have

26
00:01:48,810 --> 00:01:52,840
helped theorists refine computer models of this interaction. Here,

27
00:01:52,860 --> 00:01:56,860
darker colors indicate lower gas densities around the stars,

28
00:01:56,880 --> 00:02:00,880
while the stars themselves appear as black circles. When the stars are

29
00:02:00,900 --> 00:02:04,940
far apart, the winds collide head-on, creating a huge cavity

30
00:02:04,960 --> 00:02:08,950
surrounded by 50-million-degree gas. But near periastron,

31
00:02:08,970 --> 00:02:12,990
the secondary whips around the larger star, carving a tunnel though the primary's

32
00:02:13,010 --> 00:02:17,050
dense wind. The secondary star's rapid motion changes the

33
00:02:17,070 --> 00:02:21,070
collision zone from head...to tail. The smaller star's

34
00:02:21,090 --> 00:02:25,100
faster wind flows out along the cavity it created and then crashes into the

35
00:02:25,120 --> 00:02:29,150
outward-moving wind of its companion. From out perspective on Earth,

36
00:02:29,170 --> 00:02:33,170
the X-rays fade, then recover, as the stars move apart.

37
00:02:33,190 --> 00:02:37,210
New 3-D models of these simulations reveal the formation

38
00:02:37,230 --> 00:02:41,320

of finger-like protrusions along the cavity near periastron,

39
00:02:41,340 --> 00:02:45,370
features never before identified. Theorists now investigating

40
00:02:45,390 --> 00:02:49,430
the phenomenon suggest they may arise from instabilities developing in gas as

41
00:02:49,450 --> 00:02:53,510
it flows along the cavity wall. Astronomers also

42
00:02:53,530 --> 00:02:57,530
keep an eye on Eta Carinae with the Hubble Space Telescope.

43
00:02:57,550 --> 00:03:01,560
These images show a structure resembling a crab, formed by gas

44
00:03:01,580 --> 00:03:05,590
excited by the secondary star's intense UV light.

45
00:03:05,610 --> 00:03:09,610
This light dims near periastron, when the secondary passes through the thickest part of

46
00:03:09,630 --> 00:03:13,640
the primary's wind. The gas relaxes, settling into a lower-energy state.

47
00:03:13,660 --> 00:03:17,680
As a result, the crab appears in a different

48
00:03:17,700 --> 00:03:21,720
spectral line until the stars move apart and the UV light is restored.

49
00:03:21,740 --> 00:03:25,750
Eta Carinae is one of the closest and most

50
00:03:25,770 --> 00:03:29,790
massive colliding-wind binaries, and serves as a natural laboratory for

51
00:03:29,810 --> 00:03:33,860
studying these rare and important objects. While its past

52
00:03:33,880 --> 00:03:37,870
eruptions remain unexplained, astronomers think they have a handle on its current

53
00:03:37,890 --> 00:03:41,910
state--a claim to be tested at the next periastron in February

54
00:03:41,930 --> 00:03:45,960
2020. [Music]