1
00:00:00,000 --> 00:00:07,710
[music]

2
00:00:07,730 --> 00:00:12,180
The Milky Way - home to billions of stars,

3
00:00:12,200 --> 00:00:17,310
rising and setting over billions of worlds, including our own.

4
00:00:17,330 --> 00:00:25,440
In this vast expanse, how did our Sun, the Earth, and the planets come to be?

5
00:00:25,460 --> 00:00:31,190
In recent decades, our understanding of the solar system's evolution has greatly improved,

6
00:00:31,210 --> 00:00:34,400
but deep questions remain.

7
00:00:34,420 --> 00:00:41,060
To answer those questions, astronomers are preparing to visit someplace very small.

8
00:00:41,080 --> 00:00:46,130
Asteroid Bennu. A lump of rock and organic material,

9
00:00:46,150 --> 00:00:52,930
the early building blocks of the solar system, of Earth, of us.

10
00:00:52,950 --> 00:01:01,550
Bennu is a time capsule, and its journey takes us way, way back...four and a half billion years.

11
00:01:01,570 --> 00:01:08,200
The raw ingredients of Bennu, and our solar system, originated in a stellar nursery:

12
00:01:08,220 --> 00:01:13,810
a vast cloud of hydrogen, helium, and dust.

13
00:01:13,830 --> 00:01:16,680

Our own Sun doesn't yet exist.

14
00:01:16,700 --> 00:01:21,510
Nearby are hot stars like this one, quickly burning up its fuel...

15
00:01:21,530 --> 00:01:28,430
and destroying itself in a colossal explosion called a supernova.

16
00:01:28,450 --> 00:01:35,880
The explosion destabilizes our cloud, causing it to collapse.

17
00:01:35,900 --> 00:01:40,660
In the geologic blink of an eye, a hundred thousand years,

18
00:01:40,680 --> 00:01:46,240
gravity and angular momentum flatten the cloud into a swirling disc.

19
00:01:46,260 --> 00:01:50,590
In the center, where molecules crash together tightest,

20
00:01:50,610 --> 00:01:55,600
a proto-star revs up to incredible pressures and temperatures.

21
00:01:55,620 --> 00:02:01,080
Deep within the disc, clumps of dust not much larger than a grain of wheat

22
00:02:01,100 --> 00:02:07,080
are flash heated into droplets of molten rock, called chondrules.

23
00:02:07,100 --> 00:02:10,330
The source of this heat remains a mystery.

24
00:02:10,350 --> 00:02:15,250
Chondrules are destined to become the building blocks of the solar system.

25
00:02:15,270 --> 00:02:20,230
Coaxed by gravity and turbulence, the chondrules clump.

26
00:02:20,250 --> 00:02:28,480
They grow into the first asteroids, into mountains, into planets.

27
00:02:28,500 --> 00:02:35,800
The asteroids are rubble piles of rock, metal, ice and organics.

28
00:02:35,820 --> 00:02:44,540
This large asteroid is the parent body of Bennu, a proto-planet whose size we can only guess.

29
00:02:44,560 --> 00:02:49,130
Closer to the proto-star, a planet begins to form.

30
00:02:49,150 --> 00:02:54,890
And then...dawn in the solar system.

31
00:02:54,910 --> 00:03:00,490
The proto-star undergoes fusion and ignites, revealing our Sun.

32
00:03:00,510 --> 00:03:05,080
But the solar system is far from finished.

33
00:03:05,100 --> 00:03:08,830
Jupiter most likely forms near its outer edge,

34
00:03:08,850 --> 00:03:15,820
but just 500 million years after the Sun ignites, some believe that it slowly moves inward.

35
00:03:15,840 --> 00:03:22,180
Its massive gravity ripples the asteroid belt, disrupting countless asteroids and comets,

36
00:03:22,200 --> 00:03:26,980
flinging them toward the Sun.

37
00:03:27,000 --> 00:03:33,380
They rain down on the inner planets, hammering and re-melting large portions of their crust.

38
00:03:33,400 --> 00:03:40,410

Did these impacts also deliver organics and water, key ingredients for life?

39
00:03:40,430 --> 00:03:44,600
Back in the asteroid belt, Bennu's parent body is lucky,

40
00:03:44,620 --> 00:03:48,500
it survives this period of heavy bombardment.

41
00:03:48,520 --> 00:03:56,120
The solar system cools and calms. Jupiter and its many moons assume the orbits that we see today.

42
00:03:56,140 --> 00:04:02,600
Billions of years of quiet follow...[impact] more or less.

43
00:04:02,620 --> 00:04:09,450
Then a billion years ago, one theory suggests a collision shatters the proto-planet.

44
00:04:09,470 --> 00:04:13,780
[loud explosion]

45
00:04:13,800 --> 00:04:20,580
Some of the debris loosely coalesces into a new, smaller body: Bennu.

46
00:04:20,600 --> 00:04:28,630
But Bennu will not stay in place. Dull, non-reflective, it slowly migrates toward the Sun.

47
00:04:28,650 --> 00:04:34,080
Solar heating turns its warm side into a low-intensity thruster.

48
00:04:34,100 --> 00:04:38,660
Through millions of years, Bennu's orbit gradually tightens,

49
00:04:38,680 --> 00:04:48,700
until it interacts with Saturn's gravity, altering its trajectory and hurling it into the inner solar system.

50
00:04:48,720 --> 00:04:52,730
Close encounters with Earth and Venus follow.

51
00:04:52,750 --> 00:04:57,940
Their gravitational tugs may have repeatedly stretched and reformed Bennu...

52
00:04:57,960 --> 00:05:02,880
turning it inside out and pulling off loose material.

53
00:05:02,900 --> 00:05:10,950
As a result, it has no satellites of its own...until now.

54
00:05:10,970 --> 00:05:19,190
Today, NASA is sending a spacecraft called OSIRIS-REx to explore Bennu and retrieve a sample.

55
00:05:19,210 --> 00:05:22,510
Why? Bennu has survived its long journey

56
00:05:22,530 --> 00:05:27,950
and settled into a near-Earth orbit, bringing its secrets within our reach.

57
00:05:27,970 --> 00:05:32,880
Now it is ready to teach us more about the solar system's history,

58
00:05:32,900 --> 00:05:40,980
its formation, its evolution, and our own place among the stars.