1
00:00:00,000 --> 00:00:03,704
We all know what a galaxy looks like, right? It's a huge

2
00:00:03,704 --> 00:00:06,106
collection of stars and other matter that's shaped like a

3
00:00:06,106 --> 00:00:09,376
spiral or an ellipse, and if you're an astronomy fan you

4
00:00:09,376 --> 00:00:11,945
probably know that most of the mass is from invisible,

5
00:00:11,945 --> 00:00:16,250
mysterious material called dark matter. Well, NASA's Hubble

6
00:00:16,250 --> 00:00:20,020
Space Telescope just took an image of a galaxy that is none

7
00:00:20,020 --> 00:00:23,757
of those things. For the first time, astronomers have strong

8
00:00:23,757 --> 00:00:27,527
evidence for a galaxy not having a significant amount of dark

9
00:00:27,527 --> 00:00:31,031
matter. Most astronomers currently believe that dark

10
00:00:31,031 --> 00:00:34,368
matter plays a fundamental role in our universe and the

11
00:00:34,368 --> 00:00:37,204
formation of galaxies. This is
because galaxies seem to have a

12
00:00:37,204 --> 00:00:40,340
lot more mass than what we can
account for based on just the

13
00:00:40,340 --> 00:00:43,644
stars we see. How much mass is
in a system is determined by

14
00:00:43,644 --> 00:00:46,313
measuring the speed at which
galaxies rotate or individual

15
00:00:46,313 --> 00:00:50,484
stars in a galaxy move. Without
the gravity from that mass, a

16
00:00:50,484 --> 00:00:53,186
galaxy would fly apart if
everything in it is moving as

17
00:00:53,186 --> 00:00:57,157
quickly as we observe it moving.
Decades of research have led

18
00:00:57,157 --> 00:01:01,495
astronomers to the extraordinary
conclusion that 85% of the mass

19
00:01:01,495 --> 00:01:05,666
in our universe is invisible in
all wavelengths of radiation,

20
00:01:05,666 --> 00:01:08,602
and that it’s composed of matter
that does not contain protons or

21
00:01:08,602 --> 00:01:12,406
neutrons or any type of particle
we've detected before, and that

22
00:01:12,406 --> 00:01:16,043
this invisible material is all
around us, passing through us

23
00:01:16,043 --> 00:01:20,247
without interacting with regular
matter except by gravity. For

24
00:01:20,247 --> 00:01:23,050
some, that's a tough pill to
swallow, and a minority of

25
00:01:23,050 --> 00:01:25,919
astronomers wonder if maybe we
just don't completely understand

26
00:01:25,919 --> 00:01:30,190
how gravity works. If that were
the case, and it was an inherent

27
00:01:30,190 --> 00:01:32,926
property of gravity that causes
galaxies to move the way they

28
00:01:32,926 --> 00:01:36,997
do, then we could expect all
galaxies to behave the same way.

29
00:01:36,997 --> 00:01:39,599
In other words, they would all
seem to have about the same

30
00:01:39,599 --> 00:01:43,403
portion of "dark matter." But
with the galaxy in this Hubble

31
00:01:43,403 --> 00:01:46,540
image, astronomers looked at the
velocities of ten globular

32
00:01:46,540 --> 00:01:49,676
clusters in the galaxy, each a
spherical collection of hundreds

33
00:01:49,676 --> 00:01:52,679
of thousands of stars, and
calculated that their movements

34
00:01:52,679 --> 00:01:56,183
can be accounted for entirely by
the mass of the visible material

35
00:01:56,183 --> 00:02:00,153
in this system. That means this
galaxy has little to no dark

36
00:02:00,153 --> 00:02:04,257
matter. Strangely, this absence
of dark matter actually provides

37
00:02:04,257 --> 00:02:07,394
evidence that dark matter is
real. It shows that dark matter

38
00:02:07,394 --> 00:02:09,663
isn’t always coupled with
regular matter – that it’s

39
00:02:09,663 --> 00:02:13,500
something separate. You can have
regular matter without dark

40
00:02:13,500 --> 00:02:16,803
matter. This galaxy is really
weird even beyond the dark

41
00:02:16,803 --> 00:02:19,473
matter thing. You may have
noticed you can see straight

42
00:02:19,473 --> 00:02:22,609
through it. That’s because this
galaxy is what’s called an

43
00:02:22,609 --> 00:02:26,113
“ultra diffuse galaxy,” which as
the name implies, is extremely

44
00:02:26,113 --> 00:02:29,549
low density. This galaxy is
about the same volume as our own

45
00:02:29,549 --> 00:02:34,921
Milky Way galaxy, but only has
about 0.5% the amount of stars.

46
00:02:34,921 --> 00:02:37,190
Though astronomers have known
about ultra diffuse galaxies

47
00:02:37,190 --> 00:02:40,227
since the early 1980s, they can
be difficult to find since

48
00:02:40,227 --> 00:02:43,630
they’re so faint. A team of
astronomers is using an array of

49
00:02:43,630 --> 00:02:46,633
telephoto lenses called
Dragonfly to seek out these

50
00:02:46,633 --> 00:02:49,770
ghostly-looking objects. They
obtained observations from

51
00:02:49,770 --> 00:02:53,640
Dragonfly, the Sloan Digital Sky Survey, the Gemini Observatory,

52
00:02:53,640 --> 00:02:56,610
and the Keck Observatory, then requested time on the Hubble

53
00:02:56,610 --> 00:03:00,514
Space Telescope to take a closer look at this unusual galaxy.

54
00:03:00,514 --> 00:03:03,116
Having images and data from multiple sources allowed the

55
00:03:03,116 --> 00:03:05,686
team to determine that this galaxy does not have a

56
00:03:05,686 --> 00:03:08,922
significant amount of dark matter. This was definitely

57
00:03:08,922 --> 00:03:12,492
surprising to find. No other galaxies so far have appeared to

58
00:03:12,492 --> 00:03:16,396
be so lacking in dark matter. In fact, other ultra-diffuse

59
00:03:16,396 --> 00:03:19,332
galaxies seem to have an overabundance of dark matter.

60
00:03:19,332 --> 00:03:22,536
The same team who studied this galaxy discovered a different

61
00:03:22,536 --> 00:03:28,075
ultra diffuse galaxy in 2016
that they calculated was 99.9%

62
00:03:28,075 --> 00:03:32,245
dark matter. Yet another weird
thing about this galaxy – the

63
00:03:32,245 --> 00:03:35,048
globular clusters used to
measure the galaxy's rotation

64
00:03:35,048 --> 00:03:38,518
are way brighter than normal
globular clusters. The

65
00:03:38,518 --> 00:03:40,787
researchers have written a
different paper that focuses on

66
00:03:40,787 --> 00:03:44,925
just these oddball collections
of stars. So, this is a very

67
00:03:44,925 --> 00:03:48,395
strange galaxy in several ways.
Astronomers will be looking at

68
00:03:48,395 --> 00:03:51,565
Hubble observations of other
ultra diffuse galaxies to see if

69
00:03:51,565 --> 00:03:54,534
there are any other examples of
galaxies with unusually low or

70
00:03:54,534 --> 00:03:57,838
high amounts of dark matter.
With more samples, astronomers

71
00:03:57,838 --> 00:03:59,906
will be able to better
understand the nature of dark

72
00:03:59,906 --> 00:04:03,076
matter, the formation and
evolution of galaxies, and the

73
00:04:03,076 --> 00:04:05,712
overall structure of our
universe.