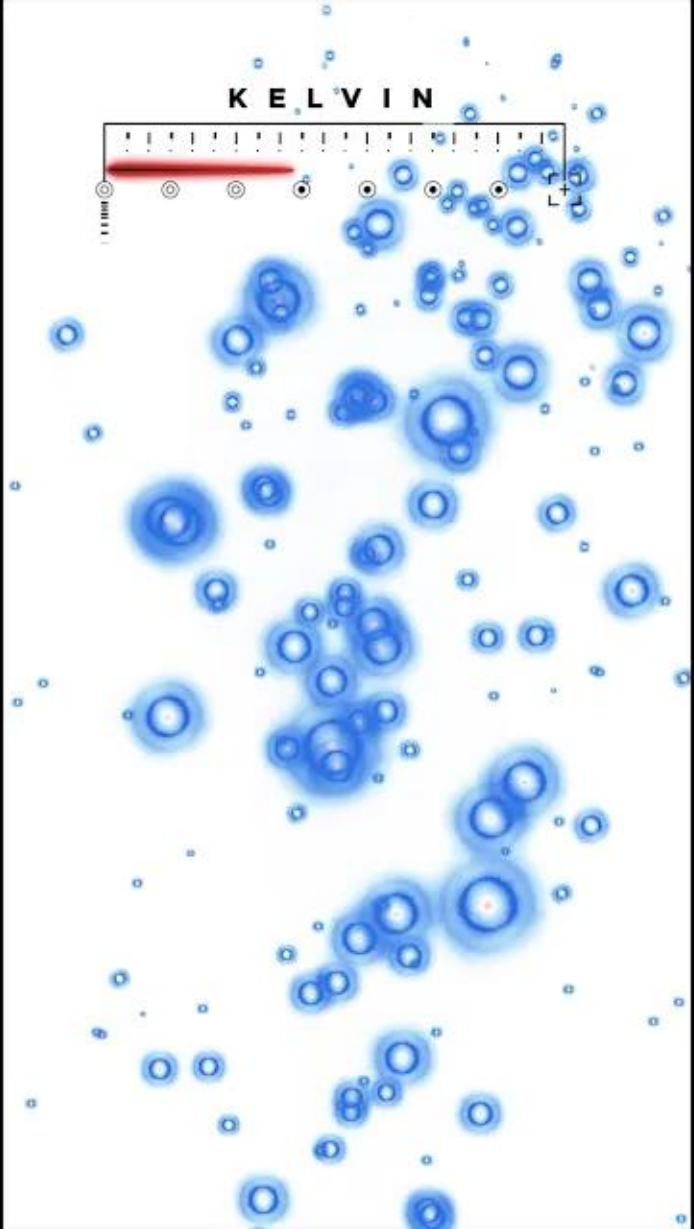
KELVIN

1
00:00:07,490 --> 00:00:04,760
that's kind of crazy

2
00:00:10,790 --> 00:00:07,500
to think that you make something cold by

3
00:00:13,249 --> 00:00:10,800
shining light on it normally we think

4
00:00:16,279 --> 00:00:13,259
about shining light on something and

5
00:00:18,260 --> 00:00:16,289
making it hot laser cooling does

6
00:00:22,580 --> 00:00:18,270
something quite counterintuitive it

7
00:00:25,759 --> 00:00:22,590
makes something cold by shining light on

8
00:00:28,800 --> 00:00:25,769
temperature is about motion the

9
00:00:31,499 --> 00:00:28,810
molecules in the air in this room are

10
00:00:34,500 --> 00:00:31,509
moving really fast about 300 meters per

11
00:00:36,000 --> 00:00:34,510
second if you cool down a gas you're

12
00:00:38,850 --> 00:00:36,010
making the atoms and molecules move more

13
00:00:42,060 --> 00:00:38,860

slowly and getting to the lowest

14
00:00:44,369 --> 00:00:42,070
possible temperatures that's the extreme

15
00:00:46,170 --> 00:00:44,379
that we're trying to go to on cow and we

16
00:00:49,079 --> 00:00:46,180
learn something new when we go to those

17
00:00:50,759 --> 00:00:49,089
extremely low temperatures we start with

18
00:00:51,930 --> 00:00:50,769
atoms that are actually room temperature

19
00:00:53,639 --> 00:00:51,940
even a little bit hotter than room

20
00:00:56,639 --> 00:00:53,649
temperature we just have a vapor of them

21
00:01:00,569 --> 00:00:56,649
in a glass cell where we use radiation

22
00:01:04,560 --> 00:01:00,579
pressure from lasers to slow down atoms

23
00:01:06,180 --> 00:01:04,570
as it turns out white pushes on stuff we

24
00:01:08,910 --> 00:01:06,190
don't feel it when we walk out in the

25
00:01:11,940 --> 00:01:08,920
sunlight but for something as light as

26
00:01:13,710 --> 00:01:11,950
an atom the push that you can exert by

27
00:01:18,240 --> 00:01:13,720
shining light on the atom in our case

28
00:01:19,320 --> 00:01:18,250
laser light can be really significant we

29
00:01:20,669 --> 00:01:19,330
don't actually use two lasers we

30
00:01:23,070 --> 00:01:20,679
actually use six and there's two this

31
00:01:24,990 --> 00:01:23,080
way - vertical - in and out and so no

32
00:01:26,790 --> 00:01:25,000
matter which way the atoms moving it's

33
00:01:29,669 --> 00:01:26,800
always moving towards one of the lasers

34
00:01:32,760 --> 00:01:29,679
and that causes low down and cools them

35
00:01:33,859 --> 00:01:32,770
down to one thousandth of the degree

36
00:01:36,059 --> 00:01:33,869
above absolute zero

37
00:01:37,650 --> 00:01:36,069
but eventually to get to the

38
00:01:39,419 --> 00:01:37,660

temperatures that we need for cow we

39
00:01:42,479 --> 00:01:39,429
actually have to turn off the lasers and

40
00:01:45,900 --> 00:01:42,489
what we do is we move the atoms so the

41
00:01:47,729 --> 00:01:45,910
held by magnetic forces and what we can

42
00:01:50,160 --> 00:01:47,739
do now is we can just adjust the

43
00:01:51,990 --> 00:01:50,170
magnetic field so that this trap that

44
00:01:53,729 --> 00:01:52,000
they're held in is not very deep so we

45
00:01:55,469 --> 00:01:53,739
can make it so that the most energetic

46
00:01:58,139 --> 00:01:55,479
atoms just have enough energy to just

47
00:01:59,999 --> 00:01:58,149
move off and escape and they fly away we

48
00:02:02,070 --> 00:02:00,009
can actually pull out just the hot atoms

49
00:02:03,690 --> 00:02:02,080
leaving the rest of them at a colles of

50
00:02:05,760 --> 00:02:03,700
temperature this is called a rapid of

51
00:02:07,710 --> 00:02:05,770
cooling it's essentially the same as

52
00:02:10,109 --> 00:02:07,720
when you blow on your coffee cup the

53
00:02:11,940 --> 00:02:10,119
hottest molecules make it out of the

54
00:02:14,970 --> 00:02:11,950
water and if you can constantly be

55
00:02:17,100 --> 00:02:14,980
blowing those away you can cool down and

56
00:02:19,470 --> 00:02:17,110
that gets us all the way down to these

57
00:02:22,170 --> 00:02:19,480
temperatures for micro Kelvin millionth

58
00:02:24,180 --> 00:02:22,180
of a degree above absolute zero but it

59
00:02:27,120 --> 00:02:24,190
turns out you can get even colder by

60
00:02:30,110 --> 00:02:27,130
using another really old trick called

61
00:02:33,780 --> 00:02:30,120
about expansion if you take any gas and

62
00:02:35,190 --> 00:02:33,790
you expand it it'll get colder so we're

63
00:02:37,050 --> 00:02:35,200

doing the same thing on a sort of small

64
00:02:40,020 --> 00:02:37,060
scale we have this little small sample

65
00:02:42,000 --> 00:02:40,030
of atoms that are confined by magnetic

66
00:02:44,190 --> 00:02:42,010
fields and what we're doing is we're

67
00:02:46,340 --> 00:02:44,200
reducing the strength of that magnetic

68
00:02:48,450 --> 00:02:46,350
field which lets the atoms expand out

69
00:02:49,950 --> 00:02:48,460
something like a factor of a thousand

70
00:02:53,340 --> 00:02:49,960
which causes them to cool off by a

71
00:02:56,190 --> 00:02:53,350
factor of a thousand this trick works so

72
00:03:00,240 --> 00:02:56,200
well we get down to temperatures below

73
00:03:03,630 --> 00:03:00,250
one nano tip one billionth of a degree

74
00:03:05,880 --> 00:03:03,640
above absolute zero and it's being done