1
00:00:05,300 --> 00:00:03,590
as a laboratory in space ISS provides a

2
00:00:07,610 --> 00:00:05,310
place to investigate how things work

3
00:00:09,589 --> 00:00:07,620
when there's no gravity and necessary

4
00:00:11,690 --> 00:00:09,599
step on the road to humankind's future

5
00:00:15,140 --> 00:00:11,700
exploration of space beyond low-earth

6
00:00:17,900 --> 00:00:15,150
orbit the capillary flow experiment is a

7
00:00:19,880 --> 00:00:17,910
physical science experiment that's been

8
00:00:23,840 --> 00:00:19,890
underway onboard the station for a few

9
00:00:25,490 --> 00:00:23,850
years now since expedition 9 this

10
00:00:27,890 --> 00:00:25,500
morning we're going to learn about that

11
00:00:30,020 --> 00:00:27,900
work joining me now from Portland State

12
00:00:32,510 --> 00:00:30,030
University in Portland Oregon is Andrew

13
00:00:34,880 --> 00:00:32,520

Wallman a research assistant on the

14
00:00:37,310 --> 00:00:34,890
capillary flow experiment team good

15
00:00:40,309 --> 00:00:37,320
morning - good morning Rico glad to talk

16
00:00:43,069 --> 00:00:40,319
with you we're happy to have you here so

17
00:00:45,319 --> 00:00:43,079
the name of the experiment indicates

18
00:00:47,799 --> 00:00:45,329
you're looking at capillary flow what is

19
00:00:51,559 --> 00:00:47,809
capillary flow or the capillary force

20
00:00:53,750 --> 00:00:51,569
capillary flow is refer to fluid flow

21
00:00:55,849 --> 00:00:53,760
that's powered by a capillary pressure

22
00:00:57,979 --> 00:00:55,859
and that pressure comes from three

23
00:00:59,809 --> 00:00:57,989
different things first is surface

24
00:01:02,989 --> 00:00:59,819
tension which is the fluid property that

25
00:01:04,729 --> 00:01:02,999
wants to keep the fluid together second

26
00:01:08,200 --> 00:01:04,739
is the wedding condition which is best

27
00:01:10,580 --> 00:01:08,210
described or illustrated by dropping

28
00:01:13,220 --> 00:01:10,590
raindrop on a windshield and watching it

29
00:01:15,650 --> 00:01:13,230
beat up or putting some oil in a hot pan

30
00:01:17,870 --> 00:01:15,660
and watching it spread out and the third

31
00:01:19,640 --> 00:01:17,880
thing is the shape or the geometry of

32
00:01:23,060 --> 00:01:19,650
the container itself so those three

33
00:01:26,270 --> 00:01:23,070
things can create a pressure in the

34
00:01:29,240 --> 00:01:26,280
fluid that spontaneously pump it without

35
00:01:31,130 --> 00:01:29,250
a moving part can you explain to me in

36
00:01:33,260 --> 00:01:31,140
the context of future space exploration

37
00:01:35,060 --> 00:01:33,270
why is it important to know how these

38
00:01:37,640 --> 00:01:35,070

fluids flow in the absence of gravity

39
00:01:40,240 --> 00:01:37,650
and how those flows can be controlled in

40
00:01:43,670 --> 00:01:40,250
the absence of gravity so capillary

41
00:01:46,820 --> 00:01:43,680
flows are normally dominated here on

42
00:01:48,710 --> 00:01:46,830
earth by gravity so we don't notice them

43
00:01:52,940 --> 00:01:48,720
but when you go up into orbit these

44
00:01:55,820 --> 00:01:52,950
flows are all over the place and we like

45
00:01:58,850 --> 00:01:55,830
to study them for example bubbles in

46
00:02:02,240 --> 00:01:58,860
your soda on earth will rise to the top

47
00:02:05,390 --> 00:02:02,250
and come out about bubbles in space stay

48
00:02:08,600 --> 00:02:05,400
suspended in the fluid and they cause

49
00:02:12,950 --> 00:02:08,610
problems but some of the equipment also

50
00:02:13,730 --> 00:02:12,960
we would like to move fluids around with

51
00:02:17,330 --> 00:02:13,740
out

52
00:02:19,730 --> 00:02:17,340
a pump or a moving moving part and so we

53
00:02:22,880 --> 00:02:19,740
can do that by changing the geometry of

54
00:02:24,980 --> 00:02:22,890
the piping okay and so what are the

55
00:02:27,860 --> 00:02:24,990
benefits of this information that we are

56
00:02:31,010 --> 00:02:27,870
getting from this study well the largest

57
00:02:35,240 --> 00:02:31,020
benefit that we're getting is high

58
00:02:37,510 --> 00:02:35,250
reliability so most of the fluid

59
00:02:41,120 --> 00:02:37,520
management systems onboard station today

60
00:02:43,730 --> 00:02:41,130
have been designed without knowledge of

61
00:02:46,700 --> 00:02:43,740
how capillary forces behave in orbit and

62
00:02:49,250 --> 00:02:46,710
so there's problems and so we want to

63
00:02:50,630 --> 00:02:49,260

mitigate these problems by putting into

64
00:02:53,210 --> 00:02:50,640
play some of the things that we've

65
00:02:55,220 --> 00:02:53,220
learned can't you use computers to

66
00:02:58,310 --> 00:02:55,230
simulate how these fluids behave in

67
00:03:00,740 --> 00:02:58,320
space yeah we can use computers to

68
00:03:03,020 --> 00:03:00,750
simulate the flows but they're just that

69
00:03:05,240 --> 00:03:03,030
the simulations are models to help

70
00:03:10,040 --> 00:03:05,250
verify our simulations and our models we

71
00:03:12,500 --> 00:03:10,050
need to have actual experiments and view

72
00:03:16,700 --> 00:03:12,510
view what's actually happening so that

73
00:03:19,070 --> 00:03:16,710
we get a higher fidelity solution okay

74
00:03:22,370 --> 00:03:19,080
well I know the ISS and the microgravity

75
00:03:23,960 --> 00:03:22,380
environment is very essential to not

76
00:03:26,980 --> 00:03:23,970
only this experiment but many

77
00:03:29,780 --> 00:03:26,990
experiments and and so it is a perfect

78
00:03:31,940 --> 00:03:29,790
place to conduct us this type of

79
00:03:33,860 --> 00:03:31,950
experiment I know the experiment is

80
00:03:36,110 --> 00:03:33,870
investigating fluid flows within like

81
00:03:37,340 --> 00:03:36,120
containers of different shapes can you

82
00:03:39,500 --> 00:03:37,350
tell me about some of the different

83
00:03:41,960 --> 00:03:39,510
tests that you use to gather the data on

84
00:03:44,360 --> 00:03:41,970
how the liquids are behaving in

85
00:03:46,400 --> 00:03:44,370
weightlessness so depending on the test

86
00:03:49,640 --> 00:03:46,410
cell we have 15 different test cells up

87
00:03:53,870 --> 00:03:49,650
there right now and each one is a unique

88
00:03:56,630 --> 00:03:53,880

shape for a solution to a math problem

89
00:03:58,820 --> 00:03:56,640
and the astronaut will pump the fluid

90
00:04:01,100 --> 00:03:58,830
into the test chamber and we'll watch

91
00:04:04,550 --> 00:04:01,110
the fluid migrate from one end of the

92
00:04:07,100 --> 00:04:04,560
chamber to the next all on its own or we

93
00:04:08,990 --> 00:04:07,110
can drain the container and watch how

94
00:04:10,850 --> 00:04:09,000
the draining process is affected by the

95
00:04:13,280 --> 00:04:10,860
shape of the container we also can

96
00:04:15,740 --> 00:04:13,290
produce some bubbles on purpose and put

97
00:04:18,410 --> 00:04:15,750
those bubbly froth inside the test

98
00:04:21,199 --> 00:04:18,420
chamber and then we can study how we can

99
00:04:22,680 --> 00:04:21,209
separate the bubbles from the liquid so

100
00:04:24,030 --> 00:04:22,690
how do the efforts

101
00:04:26,160 --> 00:04:24,040
drops on the station how are they

102
00:04:28,380 --> 00:04:26,170
participating in this capillary flow

103
00:04:30,810 --> 00:04:28,390
experiment what are they doing how the

104
00:04:33,510 --> 00:04:30,820
astronauts are essential they are our

105
00:04:36,300 --> 00:04:33,520
lab partners up in orbit so the

106
00:04:38,490 --> 00:04:36,310
astronaut actually is the individual

107
00:04:40,560 --> 00:04:38,500
that's turning the knobs opening the

108
00:04:44,340 --> 00:04:40,570
valves pushing the plungers it's very

109
00:04:47,070 --> 00:04:44,350
interactive and I saw here on the ground

110
00:04:49,320 --> 00:04:47,080
are communicating with the astronaut in

111
00:04:51,480 --> 00:04:49,330
a control center talking to them telling

112
00:04:53,730 --> 00:04:51,490
them okay we'd like to open valve one

113
00:04:55,290 --> 00:04:53,740

see what happens so in addition to just

114
00:04:56,760 --> 00:04:55,300
following the crew procedures the

115
00:04:59,340 --> 00:04:56,770
astronauts also have a unique

116
00:05:02,940 --> 00:04:59,350
perspective and so they're able to tell

117
00:05:05,970 --> 00:05:02,950
us things that are happening that we may

118
00:05:08,850 --> 00:05:05,980
not necessarily be able to see from our

119
00:05:11,070 --> 00:05:08,860
downlinked video I know that as I

120
00:05:12,420 --> 00:05:11,080
mentioned before the this experiment the

121
00:05:14,280 --> 00:05:12,430
capillary flow experiment has been

122
00:05:17,850 --> 00:05:14,290
gathering data for a few years now as I

123
00:05:19,530 --> 00:05:17,860
mentioned earlier since expedition 9 can

124
00:05:21,060 --> 00:05:19,540
you tell us what you learned so far and

125
00:05:23,790 --> 00:05:21,070
and then what's the next step in this

126
00:05:26,220 --> 00:05:23,800
process yeah we've learned quite a bit

127
00:05:29,610 --> 00:05:26,230
and most of it is pretty boring it's all

128
00:05:33,240 --> 00:05:29,620
math most of it is math but that's

129
00:05:35,970 --> 00:05:33,250
important for design tools for engineers

130
00:05:37,890 --> 00:05:35,980
here on earth to better improve their

131
00:05:41,190 --> 00:05:37,900
designs for future spaceflight

132
00:05:42,900 --> 00:05:41,200
as a result of the CFE experiments we've

133
00:05:45,570 --> 00:05:42,910
been able to publish more than 20 papers

134
00:05:49,020 --> 00:05:45,580
we have six terrestrial applications

135
00:05:51,630 --> 00:05:49,030
come out of it we've had three patents

136
00:05:54,240 --> 00:05:51,640
including an astronaut coffee cup which

137
00:05:55,350 --> 00:05:54,250
we are hoping to put onboard station on

138
00:05:58,170 --> 00:05:55,360

139
00:05:59,610 --> 00:05:58,180
it's even got a handle and as you

140
00:06:02,159 --> 00:05:59,620
mentioned some of the results are

141
00:06:05,370 --> 00:06:02,169
mapping and I would just say I wouldn't

142
00:06:07,260 --> 00:06:05,380
qualify it as boring a necessarily to to

143
00:06:09,750 --> 00:06:07,270
a lot of folks and including yourself it

144
00:06:11,970 --> 00:06:09,760
seems that you really seem to enjoy the

145
00:06:14,400 --> 00:06:11,980
work that you're doing oh yeah

146
00:06:17,909 --> 00:06:14,410
absolutely yeah that is super exciting

147
00:06:20,490 --> 00:06:17,919
for our group we really get get off on

148
00:06:23,460 --> 00:06:20,500
it it's it's super exciting that's great

149
00:06:25,170 --> 00:06:23,470
well I really appreciate your being with

150
00:06:27,210 --> 00:06:25,180
taking the time to talk with me today

151
00:06:29,550 --> 00:06:27,220
about that experiment and best of luck