
NASA
SPACESTATION
LIVE

1
00:00:08,549 --> 00:00:06,630
the international space station isn't

2
00:00:11,350 --> 00:00:08,559
just a laboratory for experiments about

3
00:00:12,950 --> 00:00:11,360
how the human body responds in being in

4
00:00:14,390 --> 00:00:12,960
a weightlessness

5
00:00:16,470 --> 00:00:14,400
it's a place where scientists are

6
00:00:18,470 --> 00:00:16,480
studying how many things behave when

7
00:00:20,630 --> 00:00:18,480
there is no gravity present in one

8
00:00:23,830 --> 00:00:20,640
experiment researchers are examining the

9
00:00:26,390 --> 00:00:23,840
behavior of liquids inside containers

10
00:00:28,790 --> 00:00:26,400
it's called the spheres slosh experiment

11
00:00:30,230 --> 00:00:28,800
and flight engineers kimia yui and chao

12
00:00:32,549 --> 00:00:30,240
lingren will be conducting another

13
00:00:34,069 --> 00:00:32,559

experiment run later this week this

14
00:00:36,549 --> 00:00:34,079
morning we're going to learn more about

15
00:00:38,549 --> 00:00:36,559
that experiment from jacob roth the

16
00:00:40,229 --> 00:00:38,559
co-principal investigator who joins us

17
00:00:42,229 --> 00:00:40,239
from his office at the kennedy space

18
00:00:44,790 --> 00:00:42,239
center in florida good morning jacob

19
00:00:47,430 --> 00:00:44,800
good morning amiko thank you uh for

20
00:00:49,590 --> 00:00:47,440
joining us here spheres slash so can you

21
00:00:51,350 --> 00:00:49,600
tell me start start by just explaining

22
00:00:52,229 --> 00:00:51,360
in this fierce loss what are we looking

23
00:00:55,189 --> 00:00:52,239
at

24
00:00:57,270 --> 00:00:55,199
or the behavior of all fluids or are we

25
00:00:58,869 --> 00:00:57,280
looking at some some only some in

26
00:01:00,869 --> 00:00:58,879
particular

27
00:01:03,510 --> 00:01:00,879
so here at the launch services program

28
00:01:05,670 --> 00:01:03,520
we're particularly concerned uh with

29
00:01:08,390 --> 00:01:05,680
launch vehicle upper stage propellants

30
00:01:10,230 --> 00:01:08,400
and how they behave during coasts or

31
00:01:12,149 --> 00:01:10,240
before separation events

32
00:01:14,469 --> 00:01:12,159
but the experiment was really designed

33
00:01:16,070 --> 00:01:14,479
as a more of a broad study of general

34
00:01:17,749 --> 00:01:16,080
fluid behavior

35
00:01:19,030 --> 00:01:17,759
briefly explain why are we wanting to

36
00:01:21,350 --> 00:01:19,040
understand this

37
00:01:24,070 --> 00:01:21,360
so um particularly for upper stage

38
00:01:26,230 --> 00:01:24,080

propellants uh we get concerned about

39
00:01:28,469 --> 00:01:26,240
what the fluids are doing um you know

40
00:01:30,390 --> 00:01:28,479
you fire your engines and you're under a

41
00:01:33,270 --> 00:01:30,400
gravity environment and then you go into

42
00:01:36,230 --> 00:01:33,280
a coast and the fluids move around and

43
00:01:38,390 --> 00:01:36,240
predicting where they are um what kind

44
00:01:40,230 --> 00:01:38,400
of walls will get wetted

45
00:01:42,630 --> 00:01:40,240
what kind of moments that might generate

46
00:01:44,310 --> 00:01:42,640
on the rocket itself what that might do

47
00:01:46,789 --> 00:01:44,320
to your separation attitude for a

48
00:01:48,789 --> 00:01:46,799
spacecraft all of those things come are

49
00:01:51,350 --> 00:01:48,799
very difficult to predict and can have a

50
00:01:53,990 --> 00:01:51,360
big effect on the mission success

51
00:01:56,870 --> 00:01:54,000
okay so talk to me about the sphere

52
00:01:59,350 --> 00:01:56,880
satellites how are those being used

53
00:02:01,030 --> 00:01:59,360
to contribute to this research

54
00:02:03,190 --> 00:02:01,040
so the spheres uh really had two

55
00:02:05,190 --> 00:02:03,200
advantages the first advantage was that

56
00:02:06,870 --> 00:02:05,200
they have a kind of a reproducible

57
00:02:08,389 --> 00:02:06,880
consistent thrust

58
00:02:10,070 --> 00:02:08,399
turns out that that thrust is a little

59
00:02:11,350 --> 00:02:10,080
low so we can only use it in certain

60
00:02:12,869 --> 00:02:11,360
situations

61
00:02:14,470 --> 00:02:12,879
but that was kind of the big thing but

62
00:02:15,990 --> 00:02:14,480
the biggest reason we use them more than

63
00:02:17,350 --> 00:02:16,000

anything else was that they were already

64
00:02:19,830 --> 00:02:17,360
on station

65
00:02:21,270 --> 00:02:19,840
so we took advantage of their power

66
00:02:23,110 --> 00:02:21,280
they had a lot of capabilities the

67
00:02:25,270 --> 00:02:23,120
computers you know and all this stuff

68
00:02:27,589 --> 00:02:25,280
was already there saved us from having

69
00:02:29,350 --> 00:02:27,599
to build it ourselves and made it a lot

70
00:02:30,710 --> 00:02:29,360
quicker and a lot easier to get on the

71
00:02:32,309 --> 00:02:30,720
station

72
00:02:34,630 --> 00:02:32,319
describe what happens during one of

73
00:02:37,030 --> 00:02:34,640
those experiment sessions yeah so after

74
00:02:39,509 --> 00:02:37,040
uh after setup after they get everything

75
00:02:41,589 --> 00:02:39,519
buttoned up and everything put together

76
00:02:44,150 --> 00:02:41,599
we have a series of test maneuvers we

77
00:02:46,790 --> 00:02:44,160
found out in our first checkout session

78
00:02:48,309 --> 00:02:46,800
that there's a lot of bubbles that form

79
00:02:49,750 --> 00:02:48,319
inside the liquid

80
00:02:52,229 --> 00:02:49,760
and that makes it really hard for us to

81
00:02:53,910 --> 00:02:52,239
get a good initial condition so before

82
00:02:55,830 --> 00:02:53,920
every maneuver they perform what we call

83
00:02:57,830 --> 00:02:55,840
a settling maneuver where they spin it

84
00:03:00,309 --> 00:02:57,840
either around one sphere or around the

85
00:03:02,470 --> 00:03:00,319
center to try and get the bubbles out

86
00:03:03,750 --> 00:03:02,480
and then they slowly slow it down so

87
00:03:04,949 --> 00:03:03,760
that they've got a good initial

88
00:03:07,430 --> 00:03:04,959

condition

89
00:03:10,229 --> 00:03:07,440
after that we'll perform a maneuver

90
00:03:12,070 --> 00:03:10,239
where we start data collection and then

91
00:03:13,990 --> 00:03:12,080
a given maneuver will happen either the

92
00:03:16,070 --> 00:03:14,000
spheres will fire and move it around a

93
00:03:17,830 --> 00:03:16,080
certain trajectory to try and see what

94
00:03:19,990 --> 00:03:17,840
the fluid is going to do or we'll have

95
00:03:21,670 --> 00:03:20,000
the astronaut push it or pull it or

96
00:03:23,110 --> 00:03:21,680
rotate it or push it and let it float

97
00:03:24,470 --> 00:03:23,120
across the room

98
00:03:26,789 --> 00:03:24,480
and during that whole time we're taking

99
00:03:28,789 --> 00:03:26,799
accelerometer and gyro data as well as

100
00:03:30,630 --> 00:03:28,799
images to get an idea of what the fluid

101
00:03:32,949 --> 00:03:30,640
is doing and we'll perform a series of

102
00:03:34,390 --> 00:03:32,959
those maneuvers until we run out of time

103
00:03:36,149 --> 00:03:34,400
and we'll tear everything down and

104
00:03:38,229 --> 00:03:36,159
download the data

105
00:03:40,149 --> 00:03:38,239
okay so well with all the sophisticated

106
00:03:43,190 --> 00:03:40,159
computer programs to model all sorts of

107
00:03:45,430 --> 00:03:43,200
phenomena why would we need to use this

108
00:03:46,630 --> 00:03:45,440
type of demonstration what makes this uh

109
00:03:48,309 --> 00:03:46,640
practical

110
00:03:50,550 --> 00:03:48,319
so that's a very good question and it's

111
00:03:52,309 --> 00:03:50,560
really the point of this practical

112
00:03:54,550 --> 00:03:52,319
demonstration this type of experiment

113
00:03:56,710 --> 00:03:54,560

was to improve those models

114
00:03:58,470 --> 00:03:56,720
computer programs and models have been

115
00:04:00,470 --> 00:03:58,480
written we have the computational fluid

116
00:04:03,670 --> 00:04:00,480
dynamics as well as pendulum swash

117
00:04:06,309 --> 00:04:03,680
models but they've all been validated in

118
00:04:07,910 --> 00:04:06,319
1g cases they've all been validated

119
00:04:09,830 --> 00:04:07,920
against you know experiments that have

120
00:04:13,750 --> 00:04:09,840
occurred on the ground and so we really

121
00:04:16,069 --> 00:04:13,760
don't know how well they predict low g

122
00:04:17,990 --> 00:04:16,079
environments so this experiment was

123
00:04:20,469 --> 00:04:18,000
really designed to make those computer

124
00:04:22,950 --> 00:04:20,479
models better or to make us

125
00:04:24,390 --> 00:04:22,960
have less uncertainty about how well

126
00:04:25,830 --> 00:04:24,400
they're predicting

127
00:04:27,990 --> 00:04:25,840
now your experiment arrived on the

128
00:04:29,350 --> 00:04:28,000
station about two years ago i can't

129
00:04:30,870 --> 00:04:29,360
believe it's already been two years so

130
00:04:32,790 --> 00:04:30,880
how many more sessions are you planning

131
00:04:34,390 --> 00:04:32,800
and what can you say about what we've

132
00:04:35,830 --> 00:04:34,400
learned so far as a result of the

133
00:04:38,230 --> 00:04:35,840
sessions we've had

134
00:04:39,990 --> 00:04:38,240
okay so um we have this session this

135
00:04:42,790 --> 00:04:40,000
this week um we have one additional

136
00:04:45,030 --> 00:04:42,800
session left after that um in addition

137
00:04:47,670 --> 00:04:45,040
we're also planning possibly in the next

138
00:04:49,430 --> 00:04:47,680

year to send up a pair of at least one

139
00:04:51,670 --> 00:04:49,440
if not two tanks

140
00:04:53,030 --> 00:04:51,680
um we're hoping to to do a little bit

141
00:04:55,030 --> 00:04:53,040
more now that we've studied how they

142
00:04:57,110 --> 00:04:55,040
behave we're going to be putting some

143
00:04:58,790 --> 00:04:57,120
internals inside the tanks and trying to

144
00:05:01,350 --> 00:04:58,800
understand a little bit about how we can

145
00:05:03,510 --> 00:05:01,360
contain or control the fluid so it stays

146
00:05:05,430 --> 00:05:03,520
where we want

147
00:05:06,790 --> 00:05:05,440
as for what we've learned we've really

148
00:05:10,390 --> 00:05:06,800
learned a great deal about how

149
00:05:13,350 --> 00:05:10,400
unintuitive low g fluid behavior is

150
00:05:15,350 --> 00:05:13,360
we do know from some initial looks that

151
00:05:17,749 --> 00:05:15,360
our models have proven to be fairly

152
00:05:20,070 --> 00:05:17,759
accurate at bulk fluid motion

153
00:05:22,390 --> 00:05:20,080
but we've also found some good areas for

154
00:05:23,189 --> 00:05:22,400
improvement particularly we struggle

155
00:05:26,070 --> 00:05:23,199
with

156
00:05:28,469 --> 00:05:26,080
bubbles and droplet behavior and how

157
00:05:30,070 --> 00:05:28,479
whether or not they recollect into the

158
00:05:32,310 --> 00:05:30,080
bulk fluid or not that's been very

159
00:05:33,510 --> 00:05:32,320
difficult for us to predict

160
00:05:34,950 --> 00:05:33,520
i will mention

161
00:05:37,110 --> 00:05:34,960
that some of this data we've already

162
00:05:39,909 --> 00:05:37,120
used to improve our models and to reduce

163
00:05:42,310 --> 00:05:39,919

our uncertainty particularly for the mms

164
00:05:44,629 --> 00:05:42,320
the magnetospheric multiscale mission

165
00:05:47,029 --> 00:05:44,639
that launched in march they were very

166
00:05:48,710 --> 00:05:47,039
concerned about fluid behavior during

167
00:05:50,070 --> 00:05:48,720
their multi-spacecraft separation

168
00:05:51,909 --> 00:05:50,080
sequence because they had four

169
00:05:54,230 --> 00:05:51,919
spacecraft that had to be separated in a

170
00:05:55,670 --> 00:05:54,240
particular interval with particular

171
00:05:57,430 --> 00:05:55,680
attitudes and they were very concerned

172
00:05:59,830 --> 00:05:57,440
about what the fluid would do and so

173
00:06:02,230 --> 00:05:59,840
this data was helpful in easing their

174
00:06:03,909 --> 00:06:02,240
worry a little bit

175
00:06:05,749 --> 00:06:03,919
well this is certainly interesting and

176
00:06:07,830 --> 00:06:05,759
really great that you guys are able to

177
00:06:09,189 --> 00:06:07,840
make use of the sphere satellites that

178
00:06:11,350 --> 00:06:09,199
are already in place onboard the

179
00:06:14,070 --> 00:06:11,360
international space station

180
00:06:16,550 --> 00:06:14,080
also i understand that there's some an

181
00:06:17,909 --> 00:06:16,560
education outreach component can you

182
00:06:19,189 --> 00:06:17,919
share with me some of your results with

183
00:06:20,950 --> 00:06:19,199
the middle and high school students that

184
00:06:22,870 --> 00:06:20,960
you guys have worked with

185
00:06:24,950 --> 00:06:22,880
yeah so we've worked with a wide range

186
00:06:27,029 --> 00:06:24,960
of students um in you know starting at

187
00:06:29,110 --> 00:06:27,039
the college level we've had florida tech

188
00:06:32,950 --> 00:06:29,120

built this apparatus and we continue to

189
00:06:36,469 --> 00:06:34,469
the younger individuals you know given

190
00:06:38,230 --> 00:06:36,479
how visual our results are how great the

191
00:06:40,390 --> 00:06:38,240
pictures and videos are we use that

192
00:06:42,070 --> 00:06:40,400
really well to get them engaged um they

193
00:06:44,629 --> 00:06:42,080
particularly find

194
00:06:46,790 --> 00:06:44,639
the fluid images and uh and videos

195
00:06:49,110 --> 00:06:46,800
fascinating we've also particularly

196
00:06:51,430 --> 00:06:49,120
engaged with first robotics

197
00:06:53,189 --> 00:06:51,440
as a robotics competition and we've

198
00:06:55,909 --> 00:06:53,199
given a number of presentations to them

199
00:06:58,550 --> 00:06:55,919
on on how using that type of robotics

200
00:07:00,150 --> 00:06:58,560
can be done for uh for real science

201
00:07:01,990 --> 00:07:00,160
and then we've also been working here at

202
00:07:03,670 --> 00:07:02,000
the kennedy space center visitor center

203
00:07:05,110 --> 00:07:03,680
to provide presentations to visiting

204
00:07:06,469 --> 00:07:05,120
student groups

205
00:07:08,070 --> 00:07:06,479
great well thank you jacob i think

206
00:07:09,510 --> 00:07:08,080
that's all the time we have thank you so

207
00:07:10,790 --> 00:07:09,520
much for joining us and answering some

208
00:07:13,430 --> 00:07:10,800
of these questions good luck to you and

209
00:07:14,390 --> 00:07:13,440
your team as you continue to uh research

210
00:07:16,309 --> 00:07:14,400
this