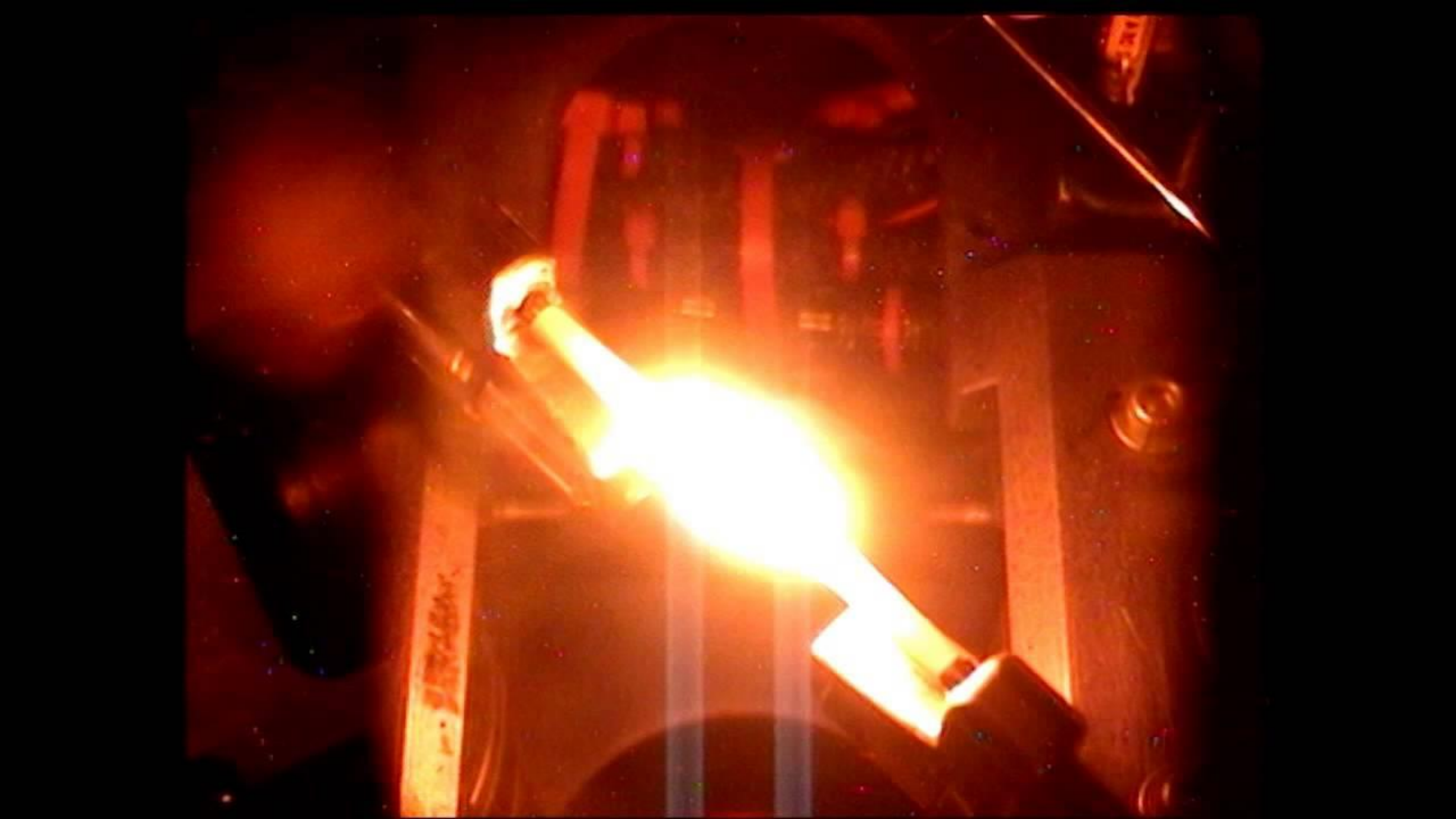

1
00:00:00,696 --> 00:00:02,906
>> You never want to hear
about a fire in space,

2
00:00:03,196 --> 00:00:05,676
but that's exactly what had
to happen for this experiment.

3
00:00:06,036 --> 00:00:08,696
The FLEX-2 experiment
burned fuel droplets

4
00:00:08,926 --> 00:00:10,946
to see how they react
without gravity.

5
00:00:11,256 --> 00:00:12,976
Now this information
could lead to better ways

6
00:00:12,976 --> 00:00:15,566
of extinguishing flames
in space as well as lead

7
00:00:15,566 --> 00:00:18,216
to environmentally friendly
fuels here on Earth.

8
00:00:18,916 --> 00:00:22,006
>> My experiment is a
droplet combustion experiment.

9
00:00:22,446 --> 00:00:24,866
We burned fuel droplets
in microgravity

10
00:00:25,666 --> 00:00:28,806
to understand how
liquid fuels burn;

11
00:00:29,506 --> 00:00:33,386
so that we can use them
efficiently and also cleanly

12
00:00:33,936 --> 00:00:35,896
by understanding how
the chemistry works.

13
00:00:36,586 --> 00:00:38,366
And it has got another
application,

14
00:00:38,426 --> 00:00:40,166
which is fire safety in space.

15
00:00:40,816 --> 00:00:43,226
If you burn these things
in different environments,

16
00:00:43,696 --> 00:00:45,856
reducing the oxygen
concentration slowly,

17
00:00:45,856 --> 00:00:49,306
and then finding out what is the
minimum oxygen concentrations

18
00:00:49,676 --> 00:00:51,906
below which is cannot
burn anymore,

19
00:00:52,356 --> 00:00:55,386
so that enhances the fire safety
in microgravity environment.

20
00:00:55,986 --> 00:00:59,336
Also we used different
diluents in the ambient.

21

00:00:59,896 --> 00:01:03,266
So, for example, on Earth
you have oxygen and nitrogen.

22
00:01:03,926 --> 00:01:05,756
But we can change it into oxygen

23
00:01:06,106 --> 00:01:09,106
and carbon dioxide,
oxygen and helium.

24
00:01:09,826 --> 00:01:16,116
These inert diluents,
they change the behavior

25
00:01:16,456 --> 00:01:17,676
of how these things burn.

26
00:01:18,336 --> 00:01:21,776
For example, in space station
now they use carbon dioxide

27
00:01:21,776 --> 00:01:22,836
as a fire extinguisher.

28
00:01:23,636 --> 00:01:27,156
So is it the most efficient
inert that we can use?

29
00:01:27,536 --> 00:01:31,626
So if we try different inerts
like helium, carbon dioxide,

30
00:01:31,926 --> 00:01:33,786
and sometimes also xenon.

31
00:01:34,426 --> 00:01:37,286
So this tells us what is the
effective fire suppressant

32
00:01:37,286 --> 00:01:37,776
in space.

33
00:01:38,366 --> 00:01:42,656
So this experiment has got both
practical applications looking

34
00:01:42,836 --> 00:01:47,126
at how liquid fuels burn, also
fire safety in microgravity.

35
00:01:47,836 --> 00:01:52,896
So these are the main
applications of my experiments.

36
00:01:52,896 --> 00:01:56,116
It has benefits, you
know, if you use a lot

37
00:01:56,366 --> 00:01:59,086
of liquid fuels in, you
know, transportation

38
00:01:59,346 --> 00:02:01,096
and power generations
and so forth.

39
00:02:01,776 --> 00:02:06,886
So the objective here is how
to use it more efficiently.

40
00:02:07,256 --> 00:02:09,906
So these liquid fuels,
they have a very complex

41
00:02:09,906 --> 00:02:10,836
chemical kinetics.

42
00:02:11,386 --> 00:02:14,956

So by looking at
spherically symmetric burning

43
00:02:14,956 --> 00:02:15,846
in microgravity,

44
00:02:16,176 --> 00:02:18,106
we can understand the
chemistry much better.

45
00:02:18,516 --> 00:02:22,476
That means we can use
fuels like gas, diesel,

46
00:02:23,166 --> 00:02:25,276
aviation fuel more efficiently

47
00:02:25,456 --> 00:02:28,076
at the same time reducing
the pollution formation.

48
00:02:28,696 --> 00:02:31,306
For example, one of the
things that we discovered

49
00:02:31,306 --> 00:02:35,546
in the FLEX experiments is the
so-called cool flame combustion.

50
00:02:35,996 --> 00:02:38,536
What happens there is
the hot flame goes out,

51
00:02:39,096 --> 00:02:42,346
under the drop it continues to
burn at a very vigorous rate,

52
00:02:42,716 --> 00:02:44,166
but without any visible flame?

53
00:02:44,806 --> 00:02:48,246
And it just partially
oxidizes the liquid fuel

54
00:02:48,446 --> 00:02:49,986
and it extinguishes
at some point.

55
00:02:50,366 --> 00:02:53,416
This is called low
temperature combustion

56
00:02:53,576 --> 00:02:55,396
or cool flame combustion
as we call it.

57
00:02:55,806 --> 00:02:59,426
And this has got a lot
of important implications

58
00:02:59,806 --> 00:03:00,806
for Earth applications.

59
00:03:00,876 --> 00:03:03,396
For example, the new
internal combustion engines

60
00:03:03,756 --> 00:03:05,686
that are coming up
are being developed.

61
00:03:06,206 --> 00:03:08,826
One, for example,
its CCI engine,

62
00:03:09,116 --> 00:03:12,556
this homogeneous charge
compression ignition engine,

63

00:03:12,806 --> 00:03:14,796
which involves low
temperature chemistry.

64
00:03:15,616 --> 00:03:20,066
So the FLEX results will
have important applications

65
00:03:20,066 --> 00:03:22,926
in that area for example.

66
00:03:23,056 --> 00:03:25,376
And also low temperature
chemistry it reduces knocks

67
00:03:25,376 --> 00:03:27,576
formation and soot
formation and so forth.

68
00:03:28,006 --> 00:03:30,846
So this has got practical
applications in the form

69
00:03:30,846 --> 00:03:34,936
of using the good fuels in
the efficient and clean way.

70
00:03:35,346 --> 00:03:38,236
And the space applications
for this is also very critical

71
00:03:38,606 --> 00:03:41,056
because from the
point of fire safety.

72
00:03:41,426 --> 00:03:43,086
So if you have a fire
fighting strategy

73
00:03:43,146 --> 00:03:45,836

in a microgravity environment
or the spacecraft environment,

74
00:03:46,126 --> 00:03:48,716
so if you think once
the hot flame is gone,

75
00:03:49,096 --> 00:03:52,296
then you can't think that
the fire is extinguished.

76
00:03:52,646 --> 00:03:55,036
What is happening it's almost
like smoldering combustion

77
00:03:55,426 --> 00:03:59,746
on Earth like if you put a
piece of log in the fireplace

78
00:04:00,156 --> 00:04:03,176
and the flame goes out,
but it can still smolder

79
00:04:03,366 --> 00:04:05,966
and product toxic
gases just like that.

80
00:04:05,966 --> 00:04:08,236
This is the first time
anybody has observed this.

81
00:04:08,516 --> 00:04:11,666
The hot flame goes out, and
there's no visible flame,

82
00:04:11,806 --> 00:04:13,796
and still the liquid
fuel continues

83
00:04:13,796 --> 00:04:17,216

to burn partially
oxidizing this fuels spewing

84
00:04:17,216 --> 00:04:19,316
out combustible mixtures.

85
00:04:20,276 --> 00:04:26,606
So it is very important to
know that so that in principle,

86
00:04:26,606 --> 00:04:29,386
at least we have demonstrated
that, after hot flame,

87
00:04:29,656 --> 00:04:33,086
the cool flame can be a fire
hazard because it can reignite

88
00:04:33,286 --> 00:04:34,776
and then bring back
the hot flame.

89
00:04:35,336 --> 00:04:37,856
So that is a very
important space application.

90
00:04:38,306 --> 00:04:42,236
And also we have looked at
the suppressant effectiveness.

91
00:04:42,446 --> 00:04:43,916
Is it CO2 is better?

92
00:04:43,916 --> 00:04:44,976
Or helium is better?

93
00:04:44,976 --> 00:04:46,246
Or some other inert is better?

94

00:04:46,596 --> 00:04:49,696
So it has got both Earth
applications as well

95
00:04:49,696 --> 00:04:51,556
as fire safety applications
in space.

96
00:04:52,036 --> 00:04:53,166
>> And that will
do it for us here

97
00:04:53,166 --> 00:04:54,986
at the Payload Operations
Integration Center

98
00:04:54,986 --> 00:04:55,516
in Huntsville.