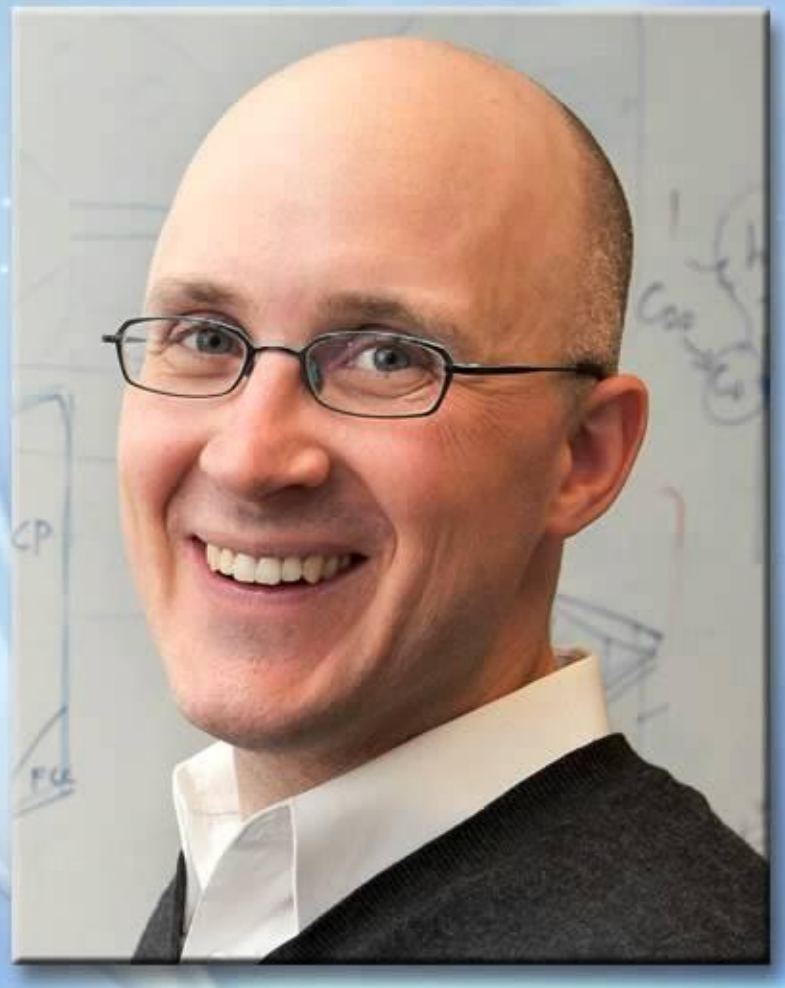

DR. ERIC FURST

PRINCIPAL INVESTIGATOR, INSPACE
UNIVERSITY OF DELAWARE

1
00:00:01,400 --> 00:00:02,768
>> The science research
that is underway

2
00:00:02,768 --> 00:00:06,238
on board the International Space
Station covers a wide range

3
00:00:06,238 --> 00:00:07,440
of disciplines.

4
00:00:07,440 --> 00:00:10,376
We talk most days about
the work that's being done

5
00:00:10,376 --> 00:00:12,344
to protect the astronauts.

6
00:00:12,344 --> 00:00:14,814
There is also a variety
of other sciences.

7
00:00:14,814 --> 00:00:18,084
Things like astronomy
and biology and physics.

8
00:00:18,084 --> 00:00:20,019
There've been a series
of experiments

9
00:00:20,019 --> 00:00:22,855
that have taken advantage of
the weightlessness of space

10
00:00:22,855 --> 00:00:25,858
to investigate the
behavior of colloids.

11
00:00:25,858 --> 00:00:27,493

One of those experiments
is known

12
00:00:27,493 --> 00:00:31,130
as the InSPACE experiment,
and it was recently featured

13
00:00:31,130 --> 00:00:34,867
in a Science@NASA article
about the development not

14
00:00:34,867 --> 00:00:39,472
of smart materials, but in
fact of genius materials.

15
00:00:39,472 --> 00:00:42,675
The principle investigator on
InSPACE is Dr. Eric Furst.

16
00:00:42,675 --> 00:00:44,710
He joins us this
morning from his office

17
00:00:44,710 --> 00:00:46,612
at the University of Delaware.

18
00:00:46,612 --> 00:00:47,780
Dr. Furst good morning.

19
00:00:47,780 --> 00:00:49,882
Would you start by giving
us the short version

20
00:00:49,882 --> 00:00:53,152
of what a colloid is and
how you got interested

21
00:00:53,152 --> 00:00:55,020
in researching them
in the first place?

22
00:00:55,020 --> 00:00:56,922
>> Sure, good morning Pat.

23
00:00:56,922 --> 00:00:58,157
Colloids basically refer

24
00:00:58,157 --> 00:01:01,293
to small particles
disbursed in a fluid.

25
00:01:01,293 --> 00:01:04,530
These particles are on the
order of maybe tens to hundreds

26
00:01:04,530 --> 00:01:07,299
of nanometers to
micrometers in scale.

27
00:01:07,299 --> 00:01:11,070
It's a unique, basically it
refers to a unique length scale

28
00:01:11,070 --> 00:01:16,208
of matter where the material
is many billions of atoms still

29
00:01:16,208 --> 00:01:18,344
in size, and yet small enough.

30
00:01:18,344 --> 00:01:20,980
So small that you'd have to
use a microscope to see it

31
00:01:20,980 --> 00:01:24,950
or even more exotic
techniques to see the particles.

32
00:01:24,950 --> 00:01:28,087

But what that does is it
confers certain properties

33
00:01:28,087 --> 00:01:29,288
on those particles.

34
00:01:29,288 --> 00:01:32,057
And one of the special
properties is they exhibit

35
00:01:32,057 --> 00:01:34,593
Brownian in motion,
random thermal motion.

36
00:01:34,593 --> 00:01:37,630
And that gives them all sorts
of really neat things that use

37
00:01:37,630 --> 00:01:41,100
and technologies and we
like to study in some

38
00:01:41,100 --> 00:01:43,335
of our scientific work.

39
00:01:43,335 --> 00:01:45,404
Why I'm interested
in colloids is

40
00:01:45,404 --> 00:01:47,506
because they're really
interesting building blocks

41
00:01:47,506 --> 00:01:50,242
as matter to assemble
other structures from

42
00:01:50,242 --> 00:01:53,012
or other useful functional
types of materials.

43
00:01:53,012 --> 00:01:57,216
Genius materials as some
people have called them.

44
00:01:57,216 --> 00:02:00,186
And you know, there's
actually been a wide variety

45
00:02:00,186 --> 00:02:03,022
of thing we can imagine we would
want to use technologically

46
00:02:03,022 --> 00:02:05,024
in the future, as
well as lots of things

47
00:02:05,024 --> 00:02:06,759
that surround us today.

48
00:02:06,759 --> 00:02:08,394
Many of the customer
care products

49
00:02:08,394 --> 00:02:11,597
that we use are actually
structured on this length scale.

50
00:02:11,597 --> 00:02:13,332
They're actually
colloidal materials.

51
00:02:13,332 --> 00:02:16,769
The shampoos that we have,
detergents, fabric softeners,

52
00:02:16,769 --> 00:02:19,872
paints, these are all
colloidal materials.

53
00:02:19,872 --> 00:02:24,276
>> And you've been investigating
with the InSPACE experiment

54
00:02:24,276 --> 00:02:27,246
on this space station as
far back as Expedition 6.

55
00:02:27,246 --> 00:02:29,715
Have you been doing,
looking at the same thing

56
00:02:29,715 --> 00:02:31,584
in each iteration of this?

57
00:02:31,584 --> 00:02:32,685
>> Well not quite.

58
00:02:32,685 --> 00:02:36,055
It has been awhile since
we kicked these off.

59
00:02:36,055 --> 00:02:38,757
And actually some of these, the
experimental ideas stretch back

60
00:02:38,757 --> 00:02:40,092
to even when I was doing my PhD

61
00:02:40,092 --> 00:02:43,529
with my advisor a
number of years ago.

62
00:02:43,529 --> 00:02:47,499
You know, it's part of the
iterate of aspects of science

63
00:02:47,499 --> 00:02:50,069
that every time you ask

a question and you start

64
00:02:50,069 --> 00:02:52,504
to answer that, ten more
questions, you know,

65
00:02:52,504 --> 00:02:56,976
come up as you peer into
this sort of frontier

66
00:02:56,976 --> 00:02:59,378
between what we know
and what we don't know.

67
00:02:59,378 --> 00:03:02,014
And you know, that
can really lead

68
00:03:02,014 --> 00:03:04,316
to some exciting markets
what's happened here

69
00:03:04,316 --> 00:03:05,651
in the InSPACE experiments.

70
00:03:05,651 --> 00:03:09,221
When we first started off,
we were looking at, you know,

71
00:03:09,221 --> 00:03:12,658
just a structure of these
materials under magnetic fields.

72
00:03:12,658 --> 00:03:15,894
And we got some ideas about
how we might be able to change

73
00:03:15,894 --> 00:03:18,030
or tailor those structures
that would give us insight

74
00:03:18,030 --> 00:03:20,966
into how we can make new
materials here on earth.

75
00:03:20,966 --> 00:03:23,369
And that's what led
to InSPACE 2.

76
00:03:23,369 --> 00:03:28,540
And from that, that's grown
into an InSPACE 3 project.

77
00:03:28,540 --> 00:03:30,843
>> What did you think
was going to happen

78
00:03:30,843 --> 00:03:33,912
when you applied a
magnetic force to colloids?

79
00:03:33,912 --> 00:03:37,483
>> Yes, these specific
experiments look

80
00:03:37,483 --> 00:03:39,451
at some special particles
basically.

81
00:03:39,451 --> 00:03:42,855
These are colloids that are
magnetically responsive.

82
00:03:42,855 --> 00:03:46,525
And first they're mainly
model materials for work

83
00:03:46,525 --> 00:03:49,495
that we do here on the ground
where we use electric fields

84
00:03:49,495 --> 00:03:51,497
to guide the assembly
of particles

85
00:03:51,497 --> 00:03:54,066
in directed self-assembly.

86
00:03:54,066 --> 00:03:57,469
Anyway, these magnetic particles
respond in a magnetic field,

87
00:03:57,469 --> 00:04:01,106
and we know a lot about that
from ground basic experiments.

88
00:04:01,106 --> 00:04:03,042
If you place a magnetic
field on one of these.

89
00:04:03,042 --> 00:04:06,211
They're fluids initially,
just like a dilute paint.

90
00:04:06,211 --> 00:04:09,181
If you took a latex paint,
it would flow llike that.

91
00:04:09,181 --> 00:04:11,583
But when you put them
in a magnetic field

92
00:04:11,583 --> 00:04:13,552
of sufficient strength,
they freeze up.

93
00:04:13,552 --> 00:04:15,020
They become a solid.

94

00:04:15,020 --> 00:04:16,922
And so on earth there's
technology based

95
00:04:16,922 --> 00:04:19,391
on that called
magnetorheological dampers

96
00:04:19,391 --> 00:04:21,960
and that transition
from a liquid

97
00:04:21,960 --> 00:04:25,030
to a solid is called
magnetorheological effect.

98
00:04:25,030 --> 00:04:28,000
So we were pretty sure
that we would see data fact

99
00:04:28,000 --> 00:04:30,703
that we could form these
sort of solids in space.

100
00:04:30,703 --> 00:04:32,071
But what we were
really interested

101
00:04:32,071 --> 00:04:34,973
in in the experiments were well
what would happen if we turn

102
00:04:34,973 --> 00:04:38,544
that field on and off,
toggle that field on and off,

103
00:04:38,544 --> 00:04:41,046
with the suspension
structure change?

104

00:04:41,046 --> 00:04:42,314
And in fact, it does.

105
00:04:42,314 --> 00:04:45,050
That's the study that we
initiated, and we were looking

106
00:04:45,050 --> 00:04:49,121
at how these structures
coarsen with time.

107
00:04:49,121 --> 00:04:52,124
That give us insight into
how all those materials are

108
00:04:52,124 --> 00:04:53,826
assembling and forming,

109
00:04:53,826 --> 00:04:56,395
essentially in equilibrium
structure that's dictated

110
00:04:56,395 --> 00:04:58,297
by their shapes and
their interactions.

111
00:04:58,297 --> 00:05:02,735
And that's really the basis
of these sort of materials

112
00:05:02,735 --> 00:05:06,105
that form themselves, what
we call self-assembly.

113
00:05:06,105 --> 00:05:09,141
>> Are there, what
are our applications

114
00:05:09,141 --> 00:05:13,345
that we might understand

for how that could be used

115
00:05:13,345 --> 00:05:16,715
to our advantage, either
in space and on the ground?

116
00:05:16,715 --> 00:05:20,185
>> Yeah, I mean, in my
laboratory we've used this sort

117
00:05:20,185 --> 00:05:22,221
of self-assembly
principle to make materials

118
00:05:22,221 --> 00:05:25,290
with interesting optical
properties that might be useful

119
00:05:25,290 --> 00:05:28,827
with color displays for
instance, like electronic inks.

120
00:05:28,827 --> 00:05:32,931
We've made materials that have
ultralow thermal connectivity

121
00:05:32,931 --> 00:05:35,033
so that they are nice
thermal barriers.

122
00:05:35,033 --> 00:05:37,469
That would certainly have
applications in turbines,

123
00:05:37,469 --> 00:05:38,637
for instance, here on earth.

124
00:05:38,637 --> 00:05:40,406
Gas-based turbines.

125
00:05:40,406 --> 00:05:44,009
Aircraft turbines, as well as
potential space applications.

126
00:05:44,009 --> 00:05:48,380
You know, the ability
to structure matter

127
00:05:48,380 --> 00:05:53,018
and actually get that structure
to form on its on spontaneously,

128
00:05:53,018 --> 00:05:56,822
gives us new manufacturing
methods for nanotechnologies.

129
00:05:56,822 --> 00:05:58,056
So that's one of the things

130
00:05:58,056 --> 00:06:00,192
that we're really interested
in and excited about.

131
00:06:00,192 --> 00:06:04,096
And, getting that
structure to form, you know,

132
00:06:04,096 --> 00:06:07,866
it confers the properties with
how that material is going

133
00:06:07,866 --> 00:06:09,067
to interact with energy.

134
00:06:09,067 --> 00:06:11,637
How it's going to interact
with chemical species.

135
00:06:11,637 --> 00:06:14,807

And so there's many
facets that that, you know,

136
00:06:14,807 --> 00:06:17,342
that that can have an impact.

137
00:06:17,342 --> 00:06:20,112
And you know, again,
sort of, we use materials

138
00:06:20,112 --> 00:06:22,614
like this on an everyday basis.

139
00:06:22,614 --> 00:06:25,150
So you know, it just
throws the sort of breadth

140
00:06:25,150 --> 00:06:28,387
of what can be impacted by that.

141
00:06:28,387 --> 00:06:32,291
>> I suspect that there might be
more worthwhile research to do.

142
00:06:32,291 --> 00:06:34,126
Is there going to
be an InSPACE 4?

143
00:06:34,126 --> 00:06:35,627
>> I hope so.

144
00:06:35,627 --> 00:06:39,064
We have, you know, like I said,
every time you ask a question,

145
00:06:39,064 --> 00:06:41,600
you get at least ten more back.

146
00:06:41,600 --> 00:06:43,402

We've discovered some
really interesting things

147
00:06:43,402 --> 00:06:46,572
in these last experiments based
on how we can change the shape

148
00:06:46,572 --> 00:06:51,810
of a particle to guide
different structures to form.

149
00:06:51,810 --> 00:06:54,880
And we've been doing
corresponding experiments here

150
00:06:54,880 --> 00:06:56,215
on the ground.

151
00:06:56,215 --> 00:06:59,418
There's a lot of things
that we would like to try.

152
00:06:59,418 --> 00:07:03,188
And with some of the facilities
that have been sent up

153
00:07:03,188 --> 00:07:05,123
and have been developed
on the space station,

154
00:07:05,123 --> 00:07:08,093
it's really such a
unique laboratory

155
00:07:08,093 --> 00:07:10,596
to us to access and to use.

156
00:07:10,596 --> 00:07:14,566
It's a phenomenal
research activity.

157
00:07:14,566 --> 00:07:17,069
And having, you know one

158
00:07:17,069 --> 00:07:18,904
of the really key things
is taking advantage

159
00:07:18,904 --> 00:07:20,939
of the microgravity for us.

160
00:07:20,939 --> 00:07:25,244
But also having the hands of the
astronauts on those experiments,

161
00:07:25,244 --> 00:07:28,514
the feedback that we get from
them allows us to take advantage

162
00:07:28,514 --> 00:07:30,883
of that really unique
environment in space.

163
00:07:30,883 --> 00:07:34,786
But in a much deeper and richer
way than I think if we could,

164
00:07:34,786 --> 00:07:36,822
you know, just send an
automated experiment up.

165
00:07:36,822 --> 00:07:38,857
It gives us that feedback loop.

166
00:07:38,857 --> 00:07:42,194
And, you know, that
observation and that control

167
00:07:42,194 --> 00:07:44,596

that humans have
in the laboratory.

168
00:07:44,596 --> 00:07:48,467
So, you know, I hope we can take
advantage of that some more.

169
00:07:48,467 --> 00:07:49,902
>> We look forward to seeing it.

170
00:07:49,902 --> 00:07:51,370
Dr. Furst, thank you very much.

171
00:07:51,370 --> 00:07:53,171
I appreciate talking
to you this morning.

172
00:07:53,171 --> 00:07:53,805
>> Thank you.

173
00:07:53,805 --> 00:07:55,107
Have a great day.

174
00:07:55,107 --> 00:07:58,277
>> Dr. Eric Furst is the, is
the principal investigator

175
00:07:58,277 --> 00:08:02,447
of the InSPACE experiment,
which has been underway