
SOFIA
HERIC OB
ARED AST

1
00:00:00,000 --> 00:00:03,899
When most people think of astronomy they
probably think of the planets,

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00:00:03,900 --> 00:00:08,380
stars and galaxies the way we see them
when we look at them in the night sky.

3
00:00:08,380 --> 00:00:12,860
It turns out that visible light only shows
part of what's happening in our universe.

4
00:00:12,860 --> 00:00:18,660
Researchers use x-ray, ultraviolet, gamma
ray and infrared instruments to peer

5
00:00:18,660 --> 00:00:22,859
through dust and gas, to collect and
analyze radiation emitted by objects in

6
00:00:22,859 --> 00:00:28,019
our universe. Join us as we discover how
the SOFIA science team at NASA Ames

7
00:00:28,019 --> 00:00:32,070
Research Center is working with the
world's largest airborne telescope to

8
00:00:32,070 --> 00:00:34,720
see deeper into our universe than ever
before.

9
00:00:53,080 --> 00:00:57,020
To tell us more about infrared astronomy
today will be meeting with SOFIA project

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00:00:57,030 --> 00:01:01,830
scientists Pam Marcum. So Pam, what is
infrared astronomy and why is it so

11
00:01:01,830 --> 00:01:06,600
important? Because with longer
wavelengths infrared light is redder

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00:01:06,600 --> 00:01:11,220
than the reddest color that the human
eye can detect and so astronomers must

13
00:01:11,220 --> 00:01:16,350
use special detectors in order to take
pictures of astronomical objects at

14
00:01:16,350 --> 00:01:21,900
infrared wavelengths. The interesting or
useful feature of infrared light is that

15
00:01:21,900 --> 00:01:28,050
infrared light is able to pass readily
through materials such as dense clouds

16
00:01:28,050 --> 00:01:33,460
of gas and dust that would block other
forms of radiation like visible light.

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00:01:33,880 --> 00:01:38,300
So what types of things do astronomers
like to look at? Things like stars that

18
00:01:38,300 --> 00:01:44,280
are much less masses that our own Sun.
Stars that are like the Sun but, have

19
00:01:44,280 --> 00:01:47,550
progressed further along in their
evolution they're nearing the end of

20
00:01:47,550 --> 00:01:53,700
their life cycle. Cooled material that
has been spewed out by supernova explosions.

21
00:01:55,680 --> 00:02:02,120
Planets, comets, shrouds of
dust that surround hot newly formed

22
00:02:02,120 --> 00:02:05,860
stars inside that are actually heating
up those little dust grains.

23
00:02:06,240 --> 00:02:09,640
Can you giveus an example of what something that you
look like in the infrared?

24
00:02:09,880 --> 00:02:13,920
Well, let me show you some pictures of the Orion constellation,

25
00:02:14,140 --> 00:02:16,220
Specifically, the Horsehead Nebula.

26
00:02:16,960 --> 00:02:22,740
The visible picture shows some really
dark areas and those are actually dust

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00:02:23,020 --> 00:02:27,120
clouds that are obscuring the visible
light that's coming from the stars that

28
00:02:27,130 --> 00:02:33,430
lay behind the dust. In the near-infrared,
you actually see many, many more stars

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00:02:33,430 --> 00:02:38,110
and in fact the Horsehead Nebula has
practically disappeared and the reason

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00:02:38,110 --> 00:02:43,510
for that is what you're seeing now is
the infrared light going right past all

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00:02:43,510 --> 00:02:51,340

of the dust so you're actually seeing
the stars behind the dust. The mid infrared has

32
00:02:51,340 --> 00:02:56,830
yet a different picture. Same part of the
sky but here you're actually seeing the

33
00:02:56,830 --> 00:03:02,110
dust clouds themselves glowing. The dust
is warmed at just the right temperature

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00:03:02,110 --> 00:03:06,920
by those stars to glow at just the right
wavelength that the mid infrared

35
00:03:06,920 --> 00:03:11,620
detector is actually able to see the
dust.

36
00:03:13,080 --> 00:03:17,200
And here we see all three images side to
side and you can really see the

37
00:03:17,210 --> 00:03:22,130
differences, just depending on what
wavelength range you look at and these

38
00:03:22,130 --> 00:03:26,990
different ways of looking at the same
object really provide a lot of insight

39
00:03:26,990 --> 00:03:31,380
to astronomers when they're studying star
formation processes.

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00:03:32,220 --> 00:03:36,880
Is Infrared astronomy better than studying visible
light? Well, infrared astronomy is

41
00:03:36,880 --> 00:03:40,840

complementary to studies at other
wavelengths including visible light and

42
00:03:40,850 --> 00:03:45,500
each type of investigation at these
different wavelengths comes with their

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00:03:45,500 --> 00:03:49,260
own advantages as well as unique
scientific insights.

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00:03:50,140 --> 00:03:55,220
Turns out that water, of all things is an infrared astronomers
worst enemy.

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00:03:55,220 --> 00:03:59,580
Humidity in the Earth's atmosphere
absorbs infrared light.

46
00:04:00,840 --> 00:04:06,200
Making observations at those wavelengths not
possible even from the highest

47
00:04:06,200 --> 00:04:11,210
mountaintop. You know it's kind of ironic
to think that an infrared photon may

48
00:04:11,210 --> 00:04:17,360
have been traveling through lots of
interstellar dust and gas for thousands

49
00:04:17,360 --> 00:04:21,200
of years only to get stopped dead in its
tracks once it enters the Earth's

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00:04:21,200 --> 00:04:26,030
atmosphere. To tell us more about this
SOFIA program we'll be meeting with Sofia

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00:04:26,030 --> 00:04:31,300

science missioning operations director
Eric Young. So, Eric what is SOFIA?

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00:04:31,520 --> 00:04:35,860
SOFIA is the Stratospheric Observatory for
Infrared Astronomy. It's a very highly

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00:04:35,870 --> 00:04:42,310
modified Boeing 747 that does
observations in the infrared and to

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00:04:42,310 --> 00:04:46,680
really understand what we have with
SOFIA you have to think about and

55
00:04:46,680 --> 00:04:51,920
visualize what had to be done to the
airplane to make this observatory.

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00:04:52,330 --> 00:04:56,580
We start off with a Boeing 747 which is
one of the largest passenger airplanes

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00:04:56,590 --> 00:05:01,270
in the world. You have to cut a hole in
the side of the airplane about the size

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00:05:01,270 --> 00:05:08,110
of a garage door, put in a telescope that's
ten feet in diameter and then have a

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00:05:08,110 --> 00:05:13,539
control system that will point this
telescope and keep it steady to the angle

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00:05:13,539 --> 00:05:18,419
of a dime at a distance of a mile. In
order to accomplish that we've had a

61
00:05:18,420 --> 00:05:22,260

large team from a lot of different
organizations involved.

62
00:05:22,880 --> 00:05:26,640
This included NASA Dryden Flight Research Center,

63
00:05:26,780 --> 00:05:28,860
NASA Ames Research Center,

64
00:05:29,360 --> 00:05:31,340
and the German Aerospace Center.

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00:05:32,240 --> 00:05:35,860
What makes SOFIA different
from other observatories doing infrared astronomy?

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00:05:36,660 --> 00:05:40,200
Well, the most obvious thing of
course, is that it's in an airplane and

67
00:05:40,210 --> 00:05:46,570
it's the biggest flying observatory in
the world. It is an airplane that flies

68
00:05:46,570 --> 00:05:51,940
well above most of the water vapor in
the Earth's atmosphere and water vapor

69
00:05:51,940 --> 00:05:56,440
as Pam mentioned is the real problem
with doing the infrared observations

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00:05:56,440 --> 00:05:58,860
because it blocks lots of the spectrum.

71
00:05:59,660 --> 00:06:03,100
With SOFIA there's a huge chunk called

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00:06:03,220 --> 00:06:08,019

the mid and far infrared which is only
visible if you get above the Earth's

73
00:06:08,020 --> 00:06:10,960
atmosphere and that makes it unique.

74
00:06:11,860 --> 00:06:14,600
Another unique capability of SOFIA is

75
00:06:14,680 --> 00:06:19,180
the ability to fly to where the
observations have to be made.

76
00:06:19,960 --> 00:06:23,320
Can you give us an example of the kind of
science SOFIA is doing?

77
00:06:24,060 --> 00:06:26,700
Well SOFIA does all kinds of science. for astronomy.

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00:06:26,700 --> 00:06:30,340
The observations on SOFIA are open to

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00:06:30,520 --> 00:06:32,580
astronomers all over the world.

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00:06:34,200 --> 00:06:37,040
The very best proposals that are judged

81
00:06:37,140 --> 00:06:40,160
by other astronomers that to be on SOFIA

82
00:06:40,320 --> 00:06:42,040
are the ones that get observed.

83
00:06:44,100 --> 00:06:46,600
So, that means if SOFIA does observations,

84

00:06:47,460 --> 00:06:50,080
from looking at things within our own solar system

85
00:06:50,500 --> 00:06:53,020
to nearby stars, stars that are
being formed,

86
00:06:53,680 --> 00:06:56,220
all the way out to distant galaxies.

87
00:06:56,660 --> 00:07:00,780
It's only limited by the
innovation and really great imagination

88
00:07:00,780 --> 00:07:02,500
of all the astronomers in the world.

89
00:07:03,800 --> 00:07:05,620
To tell us more about the work of the SOFIA

90
00:07:05,760 --> 00:07:08,159
science team we're meeting with NASA Ames Center

91
00:07:08,160 --> 00:07:10,440
Director and astronomer Pete Worden.

92
00:07:11,840 --> 00:07:13,460
So Pete, as an astronomer what do you find

93
00:07:13,580 --> 00:07:15,420
most exciting about SOFIA?

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00:07:16,020 --> 00:07:19,040
SOFIA is state-of-the-art instrument.

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00:07:19,860 --> 00:07:21,920
For the first time we're going to be able to get

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00:07:21,940 --> 00:07:24,180
high-resolution information in the infrared

97
00:07:24,180 --> 00:07:25,580
part of the spectrum region.

98
00:07:26,080 --> 00:07:29,120
This will revolutionize our understanding of, of how

99
00:07:29,220 --> 00:07:33,260
stars form, how planets form and how the
very stuff of life forms.

100
00:07:33,940 --> 00:07:35,700
So, who gets to fly on the plane?

101
00:07:35,700 --> 00:07:38,160
The really cool thing about SOFIA

102
00:07:38,340 --> 00:07:40,160
is that not only researchers

103
00:07:40,280 --> 00:07:41,060
get to fly on it,

104
00:07:41,060 --> 00:07:43,060
students get to fly on it.

105
00:07:43,220 --> 00:07:44,700
Not only graduate students and

106
00:07:44,700 --> 00:07:46,140
undergraduates working on this but,

107
00:07:46,140 --> 00:07:47,460
teachers get to fly on it.

108
00:07:48,140 --> 00:07:49,200

The nice thing about an airplane,

109
00:07:50,100 --> 00:07:51,560
which is different from a spacecraft

110
00:07:51,720 --> 00:07:53,640
is that everybody gets to fly on it

111
00:07:53,640 --> 00:07:55,200
and gets to work with the instruments

112
00:07:55,200 --> 00:07:57,200
so it gives people not only

113
00:07:57,420 --> 00:07:59,440
a chance to interact with the science

114
00:07:59,440 --> 00:08:01,400
they're doing in a much more direct way.

115
00:08:01,860 --> 00:08:03,640
But, it also gives people a chance

116
00:08:03,640 --> 00:08:05,640
to feel the excitement of discovery.

117
00:08:06,520 --> 00:08:08,540
SOFIA is connecting a vast amount of science.

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00:08:08,540 --> 00:08:10,200
What do you see as its ultimate goal?

119
00:08:11,360 --> 00:08:13,700
I think the biggest goal is to

120
00:08:14,920 --> 00:08:17,680
really begin to understand the early

121
00:08:17,840 --> 00:08:19,860
phases of star formation,

122
00:08:19,960 --> 00:08:22,860
planetary formation and the formation of molecules

123
00:08:22,980 --> 00:08:25,840
out of which life emerges.

124
00:08:26,340 --> 00:08:29,140
You know, there the whole field of astrobiology,

125
00:08:29,920 --> 00:08:32,340
That how life began, where else isit in the universe

126
00:08:32,340 --> 00:08:35,020
and what its future is, is tied up in the

127
00:08:35,080 --> 00:08:37,640
kind of discoveries that SOFIA will make.

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00:08:37,980 --> 00:08:40,300
So it is a major step forward in

129
00:08:40,300 --> 00:08:42,060
understanding who we are

130
00:08:42,060 --> 00:08:44,060
and where we came from.

131
00:08:46,620 --> 00:08:48,080
Thanks for joining us and meet us

132
00:08:48,120 --> 00:08:50,780
again on our next Destination Innovation.

133
00:08:54,540 --> 00:08:56,840

For more information on NASA's SOFIA program