

Horsehead Nebula in Orion



Visible Light - NOAO

Courtesy: Howard McCallon

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00:00:00,000 --> 00:00:02,440

Lubna Shirazi: When most people think of astronomy,

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00:00:02,460 --> 00:00:05,700

they probably think of the planets, stars and galaxies

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00:00:05,720 --> 00:00:08,540

the way we see them when we look at them in the night sky.

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00:00:08,560 --> 00:00:10,940

It turns out that visible light only shows part

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00:00:10,960 --> 00:00:13,600

of what's happening in our universe.

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00:00:13,620 --> 00:00:18,550

Researchers use x-ray, ultraviolet, gamma ray, and infrared instruments

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00:00:18,570 --> 00:00:21,960

to peer through the dust and gas to collect and analyze radiation

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00:00:21,980 --> 00:00:24,620

emitted by objects in our universe.

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00:00:24,640 --> 00:00:27,650

Join us as we discover how the SOFIA science team

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00:00:27,670 --> 00:00:30,760

at NASA Ames Research Center is working with the world's largest

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00:00:30,780 --> 00:00:35,570

airborne telescope to see deeper into our universe than ever before.

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00:00:35,590 --> 00:00:53,680

(Music)

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00:00:53,700 --> 00:00:55,490

Lubna: To tell us more about infrared astronomy,

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00:00:55,510 --> 00:00:59,460

today we'll be meeting with SOFIA Project Scientist Pam Marcum.

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00:00:59,480 --> 00:01:03,060

So Pam, what is infrared astronomy and why is it so important?

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00:01:03,080 --> 00:01:06,940

Pam Marcum: Because of its longer wavelengths, infrared light is redder

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00:01:06,960 --> 00:01:10,340

than the reddest color that the human eye can detect.

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00:01:10,360 --> 00:01:15,050

And so astronomers must use special detectors in order to take pictures

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00:01:15,070 --> 00:01:18,360

of astronomical objects at infrared wavelengths.

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00:01:18,380 --> 00:01:21,930

The interesting, or useful, feature of infrared light

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00:01:21,950 --> 00:01:26,440

is that infrared light is able to pass readily through materials,

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00:01:26,460 --> 00:01:31,250

such as dense clouds of gas and dust, that would block

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00:01:31,270 --> 00:01:34,300

other forms of radiation, like visible light.

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00:01:34,320 --> 00:01:36,690

Lubna: So what types of things do astronomers like to look at?

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00:01:36,710 --> 00:01:41,640

Pam: Things like stars that are much less massive than our own sun;

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00:01:41,660 --> 00:01:45,960

stars that are like the sun but have progressed further along

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00:01:45,980 --> 00:01:49,820

in their evolution, they are nearing the end of their life cycle;

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00:01:49,840 --> 00:01:55,750

cooled material that has been spewed out by supernova explosions;

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00:01:55,770 --> 00:02:02,830

planets; comets; shrouds of dust that surround hot newly formed stars

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00:02:02,850 --> 00:02:06,590

inside that are actually heating up those little dust grains.

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00:02:06,610 --> 00:02:08,360

Lubna: Can you give us an example of what something

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00:02:08,380 --> 00:02:10,430

would actually look like in the infrared?

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00:02:10,450 --> 00:02:14,360

Pam: Well, let me show you some pictures of the Orion constellation,

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00:02:14,380 --> 00:02:17,630

specifically the Horsehead Nebula.

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00:02:17,650 --> 00:02:21,910

The visible picture shows some really dark areas

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00:02:21,930 --> 00:02:25,610

and those are actually dust clouds that are obscuring the visible light

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00:02:25,630 --> 00:02:29,820

that's coming from the stars that lay behind the dust.

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00:02:29,840 --> 00:02:34,540

In the near-infrared, you actually see many, many more stars, and in fact,

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00:02:34,560 --> 00:02:37,700

the Horsehead Nebula has practically disappeared.

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00:02:37,720 --> 00:02:42,130

And the reason for that is what you're seeing now is the infrared light

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00:02:42,150 --> 00:02:44,740

going right past all of the dust.

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00:02:44,760 --> 00:02:49,640

So you're actually seeing the stars behind the dust.

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00:02:49,660 --> 00:02:55,460

The mid-infrared has yet a different picture, same part of the sky,

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00:02:55,480 --> 00:03:00,120

but here you're actually seeing the dust clouds themselves glowing.

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00:03:00,140 --> 00:03:04,100

The dust is warmed at just the right temperature by those stars,

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00:03:04,120 --> 00:03:08,240

to glow at just the right wavelength that the mid-infrared detector

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00:03:08,260 --> 00:03:13,400

is actually able to see the dust.

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00:03:13,420 --> 00:03:16,340

And here we see all three images side-by-side,

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00:03:16,360 --> 00:03:19,660

and you can really see the differences just depending

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00:03:19,680 --> 00:03:22,130

on what wavelength range you look at.

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00:03:22,150 --> 00:03:26,520

And these different ways of looking at the same object really provide

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00:03:26,540 --> 00:03:29,800

a lot of insight to astronomers when they're studying

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00:03:29,820 --> 00:03:32,600

star formation processes.

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00:03:32,620 --> 00:03:35,860

Lubna: Is infrared astronomy better than studying visible light?

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00:03:35,880 --> 00:03:39,010

Pam: Well, infrared astronomy is complementary to studies

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00:03:39,030 --> 00:03:41,410

at other wavelengths, including visible light.

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00:03:41,430 --> 00:03:44,900

And each type of investigation at these different wavelengths

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00:03:44,920 --> 00:03:50,270

comes with their own advantages as well as unique scientific insights.

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00:03:50,290 --> 00:03:55,990

It turns out that water of all things, is an infrared astronomer's worst enemy.

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00:03:56,010 --> 00:04:01,130

Humidity in the earth's atmosphere absorbs infrared light,

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00:04:01,150 --> 00:04:05,350

making observations at those wavelengths not possible

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00:04:05,370 --> 00:04:08,140

even from the highest mountaintop.

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00:04:08,160 --> 00:04:11,220

You know it's kind of ironic to think that an infrared photon

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00:04:11,240 --> 00:04:16,980

may have been traveling through lots of interstellar dust and gas

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00:04:17,000 --> 00:04:20,620

for thousands of years only to get stopped dead in its tracks

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00:04:20,640 --> 00:04:23,380

once it enters the earth's atmosphere.

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00:04:23,400 --> 00:04:25,870

Lubna: To tell us more about the SOFIA program, we'll be meeting

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00:04:25,890 --> 00:04:29,900

with SOFIA Science Mission and Operations Director Erick Young.

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00:04:29,920 --> 00:04:31,940

So Erick, what is SOFIA?

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00:04:31,960 --> 00:04:35,450

ERICK YOUNG: SOFIA is the Stratospheric Observatory for Infrared Astronomy.

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00:04:35,470 --> 00:04:42,350

It's a very highly modified Boeing 747 that does observations in the infrared.

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00:04:42,370 --> 00:04:45,330

And to really understand what we have with SOFIA,

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00:04:45,350 --> 00:04:49,700

you have to think about and visualize what had to be done

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00:04:49,720 --> 00:04:52,660

to the airplane to make this observatory.

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00:04:52,680 --> 00:04:54,830

We start off with a Boeing 747,

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00:04:54,850 --> 00:04:58,400

which is one of the largest passenger airplanes in the world.

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00:04:58,420 --> 00:05:00,970

We have to cut a hole in the side of the airplane

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00:05:00,990 --> 00:05:03,030

about the size of a garage door.

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00:05:03,050 --> 00:05:07,770

Put in a telescope that's ten feet in diameter,

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00:05:07,790 --> 00:05:12,090

and then have a control system that will point this telescope

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00:05:12,110 --> 00:05:16,750

and keep it steady to the angle of a dime at a distance of a mile.

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00:05:16,770 --> 00:05:20,340

In order to accomplish that, we've had a large team

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00:05:20,360 --> 00:05:23,510

from a lot of different organizations involved.

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00:05:23,530 --> 00:05:27,340

This included NASA Dryden Flight Research Center,

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00:05:27,360 --> 00:05:29,460

NASA Ames Research Center

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00:05:29,480 --> 00:05:32,770

and the German Aerospace Center.

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00:05:32,790 --> 00:05:34,800

Lubna: What makes SOFIA different from other observatories

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00:05:34,820 --> 00:05:37,080

doing infrared astronomy?

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00:05:37,100 --> 00:05:38,810

Erick: Well, the most obvious thing, of course,

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00:05:38,830 --> 00:05:44,180

is that it's in an airplane and it's the biggest flying observatory in the world.

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00:05:44,200 --> 00:05:48,150

It is an airplane that flies well above

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00:05:48,170 --> 00:05:51,490

most of the water vapor in the earth's atmosphere.

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00:05:51,510 --> 00:05:55,260

And water vapor as Pam mentioned is the real problem

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00:05:55,280 --> 00:06:00,160

with doing infrared observations because it blocks lots of the spectrum.

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00:06:00,180 --> 00:06:05,800

With SOFIA, there is a huge chunk called the mid and far-infrared

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00:06:05,820 --> 00:06:09,560

which is only visible if you get above the earth's atmosphere,

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00:06:09,580 --> 00:06:12,120

and that makes it unique.

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00:06:12,140 --> 00:06:15,620

Another unique capability of SOFIA is the ability

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00:06:15,640 --> 00:06:20,520

to fly where the observations have to be made.

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00:06:20,540 --> 00:06:23,860

Lubna: Can you give us an example of the kind of science SOFIA is doing?

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00:06:23,880 --> 00:06:27,650
Erick: Well SOFIA does all kinds of science for astronomy.

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00:06:27,670 --> 00:06:34,700
The observations on SOFIA are open to astronomers all over the world.

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00:06:34,720 --> 00:06:40,720
The very best proposals that are judged by other astronomers to be on SOFIA

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00:06:40,740 --> 00:06:42,830
are the ones that get observed.

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00:06:42,850 --> 00:06:44,500
SOFIA Flight Crew Member: We're opening the door.

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00:06:44,520 --> 00:06:47,640
Erick: And so that means that SOFIA does observations

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00:06:47,660 --> 00:06:52,050
from looking at things within our own solar system, to nearby stars,

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00:06:52,070 --> 00:06:57,160
to stars that are being formed, all the way out to distant galaxies.

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00:06:57,180 --> 00:07:01,200
It's only limited by the innovation and really great imagination

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00:07:01,220 --> 00:07:04,130
of all the astronomers in the world.

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00:07:04,150 --> 00:07:07,090
Lubna: To tell us more about the work of the SOFIA science team,

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00:07:07,110 --> 00:07:11,760
we're meeting with NASA Ames Center Director and astronomer Pete Worden.

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00:07:11,780 --> 00:07:16,270

So Pete, as an astronomer, what do you find most exciting about SOFIA?

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00:07:16,290 --> 00:07:20,260

Pete Worden: SOFIA is a state of the art instrument.

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00:07:20,280 --> 00:07:23,920

For the first time we're going to get high resolution information

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00:07:23,940 --> 00:07:26,340

in the infrared part of the spectral region.

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00:07:26,360 --> 00:07:30,290

This will revolutionize our understanding of how stars formed,

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00:07:30,310 --> 00:07:34,280

how planets formed and how the very stuff of life forms.

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00:07:34,300 --> 00:07:36,550

Lubna: So who gets to fly on the plane?

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00:07:36,570 --> 00:07:39,600

Pete: The really cool thing about SOFIA is that,

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00:07:39,620 --> 00:07:43,900

not only researchers get to fly on it, students get to fly on it,

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00:07:43,920 --> 00:07:46,470

not only graduate students and undergraduates working on this,

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00:07:46,490 --> 00:07:48,470

but teachers get to fly on it.

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00:07:48,490 --> 00:07:51,960

The nice thing about an airplane, which is different from a spacecraft,

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00:07:51,980 --> 00:07:56,130

is that everybody gets to fly on it and gets to work with the instruments.

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00:07:56,150 --> 00:08:00,440

So it gives people not only a chance to interact with the science they're doing

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00:08:00,460 --> 00:08:04,080

in a much more direct way, but it also gives people a chance

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00:08:04,100 --> 00:08:06,850

to feel the excitement of discovery.

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00:08:06,870 --> 00:08:09,160

Lubna: SOFIA is conducting a vast amount of science,

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00:08:09,180 --> 00:08:11,520

what do you see as its ultimate goal?

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00:08:11,540 --> 00:08:17,440

Pete: I think the biggest goal is to really begin to understand

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00:08:17,460 --> 00:08:22,090

the early phases of star formation, planetary formation

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00:08:22,110 --> 00:08:26,860

and the formation of molecules out of which life emerges.

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00:08:26,880 --> 00:08:31,610

You know, the whole field of astrobiology, how life began,

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00:08:31,630 --> 00:08:34,410

where else is it in the universe, and what its future is,

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00:08:34,430 --> 00:08:38,310

is tied up in the kind of discoveries that SOFIA will make.

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00:08:38,330 --> 00:08:41,960

So it is a major step forward in understanding

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00:08:41,980 --> 00:08:44,130

who we are and where we came from.

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00:08:44,150 --> 00:08:46,920

(Sound of large airplane flying overhead)

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00:08:46,940 --> 00:08:48,100

Lubna: Thanks for joining us.

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00:08:48,120 --> 00:08:51,440

And meet us again on our next Destination Innovation.

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00:08:51,460 --> 00:08:54,790

(Music)

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00:08:54,810 --> 00:08:57,140

Lubna: For more information on NASA's SOFIA program,

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00:08:57,160 --> 00:09:02,330

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