



1

00:00:16,279 --> 00:00:20,689

One of the earliest recorded observations of an astronomical phenomenon refers to the

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00:00:20,689 --> 00:00:28,349

zodiacal light, which was described in the Quran, depicted by the ancient Aztecs, and

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00:00:28,349 --> 00:00:29,349

mentioned by Aristotle.

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00:00:29,349 --> 00:00:35,140

It is a faint glow in the sky night caused by sunlight reflected off small dust particles

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00:00:35,140 --> 00:00:38,269

in orbit around the Sun.

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00:00:38,269 --> 00:00:43,320

I'm Jerry Weinberg from the Dudley Observatory in Albany, New York.

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00:00:43,320 --> 00:00:47,800

I have one of the three Skylab experiments at Dudley Observatory.

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00:00:47,800 --> 00:00:51,329

My experiment is designed to measure the zodiacal light.

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00:00:51,329 --> 00:00:55,649

The zodiacal light is shown in this painting here, depicted as this faint glow rising up

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00:00:55,649 --> 00:00:56,649

from the lunar surface.

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00:00:56,649 --> 00:01:01,390

This is the way it would appear to an astronaut

in the command module.

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00:01:01,390 --> 00:01:04,720

The lunar excursion module is shown here descending to the lunar surface.

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00:01:04,720 --> 00:01:10,920

The Earth is shown here with Venus here and the Sun several degrees beneath the horizon.

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00:01:10,920 --> 00:01:16,060

The word zodiacal derives from zodiac, which is a band along the sky positioned approximately

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00:01:16,060 --> 00:01:21,000

here, along which the Sun, the Moon, and the planets move across the sky as seen from the

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00:01:21,000 --> 00:01:22,000

Earth.

17

00:01:22,000 --> 00:01:26,520

The zodiacal light is concentrated along this band and it is brightest toward it and toward

18

00:01:26,520 --> 00:01:27,840

the Sun.

19

00:01:27,840 --> 00:01:34,400

In our experiment on Skylab, which is called Gegenschein/Zodiacal Light, which has the

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00:01:34,400 --> 00:01:35,400

number S073.

21

00:01:35,400 --> 00:01:43,420

We are going to be making measurements with a small telescope and camera of the brightness

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00:01:43,420 --> 00:01:48,189
of this faint glow on the sky through all
three Skylab missions.

23
00:01:48,189 --> 00:01:55,430
If one looks down on the solar system from
above, and this is the Earth, the Sun here,

24
00:01:55,430 --> 00:01:59,609
and the Earth in orbit about the Sun.

25
00:01:59,609 --> 00:02:04,890
If you look in any direction from the Earth,
through the whole solar system, you'll see

26
00:02:04,890 --> 00:02:09,070
sunlight reflected back off any particles
that are along this direction.

27
00:02:09,070 --> 00:02:15,230
For example, if I put a particle here, the
sunlight strikes this particle and is reflected

28
00:02:15,230 --> 00:02:16,761
back toward the Earth.

29
00:02:16,761 --> 00:02:20,110
The same happens for all those particles along
a particular direction.

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00:02:20,110 --> 00:02:25,400
This light that is reflected back is what
is called zodiacal light and is what we will

31
00:02:25,400 --> 00:02:26,700
measure in this experiment.

32
00:02:26,700 --> 00:02:31,400
The Gegenschein is another manifestation of
the zodiacal light and is derived from the

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00:02:31,400 --> 00:02:36,560

German word which means against glow or brightness.

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00:02:36,560 --> 00:02:43,659

It is a brightening in the sky opposite the Sun from the Earth so that if one looked in

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00:02:43,659 --> 00:02:50,099

this direction, away from the Sun from the Earth, one would see that the sky would get

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00:02:50,099 --> 00:02:53,349

darker here and then start to get brighter in this region.

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00:02:53,349 --> 00:03:01,040

This brightening opposite the Sun from the Earth is the phenomenon called the Gegenschein.

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00:03:01,040 --> 00:03:05,220

Our experiment will utilize the scientific airlock, or opening in the spacecraft, and

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00:03:05,220 --> 00:03:10,299

the astronaut will extend the instrument eighteen feet out through the scientific airlock to

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00:03:10,299 --> 00:03:15,280

where it is beyond these large solar panels, which are always directed toward the Sun.

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00:03:15,280 --> 00:03:20,700

During part of the mission, we will also operate out another scientific airlock, which is just

42

00:03:20,700 --> 00:03:22,569

opposite the one toward the Sun.

43

00:03:22,569 --> 00:03:25,370

It will be facing out in this direction.

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00:03:25,370 --> 00:03:31,459

Since the zodiacal light is not distributed uniformly over the sky, it is brighter near

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00:03:31,459 --> 00:03:38,159

the Sun and other regions, we have to scan our telescope over the sky to make these measurements.

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00:03:38,159 --> 00:03:43,080

We have control equipment within the spacecraft that the astronaut uses to program the instrument

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00:03:43,080 --> 00:03:52,189

to be able to scan in different directions, in different ways, or to look in and one direction.

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00:03:52,189 --> 00:03:56,250

This is engineering unit of that experiment hardware that is now aboard the Skylab.

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00:03:56,250 --> 00:04:01,360

It was developed by the NASA Marshall Space Flight Center, Martin Marietta Corporation,

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00:04:01,360 --> 00:04:04,910

Denver, and the Dudley Observatory.

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00:04:04,910 --> 00:04:11,060

Packed within this canister when the instrument is not extended, is all the experiment equipment,

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00:04:11,060 --> 00:04:12,349

including the extension mechanism.

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00:04:12,349 --> 00:04:18,050

This end of the canister butts up against the scientific airlock and on the front of

54
00:04:18,050 --> 00:04:23,560
it are several of the control panels, which
the astronaut uses to control the equipment.

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00:04:23,560 --> 00:04:27,690
These three control panels are used by the
astronaut to set up the various switches which

56
00:04:27,690 --> 00:04:33,080
operate the instrument to perform the various
observing scans on the sky that we need.

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00:04:33,080 --> 00:04:38,630
In particular, this box here is an automatic
program which permits the astronaut to set

58
00:04:38,630 --> 00:04:45,050
up the switches and perform a program unattended
after he has initiated a program start.

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00:04:45,050 --> 00:04:49,030
The instrument in shown here extended its
full eighteen feet.

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00:04:49,030 --> 00:04:55,139
It's supported by guide rails because in
the lab we don't have a zero g condition

61
00:04:55,139 --> 00:04:57,300
weightlessness like we have in space.

62
00:04:57,300 --> 00:05:03,080
Similarly, this end, which contains the telescope
and camera system, has a counterweight on

63
00:05:03,080 --> 00:05:06,560
it to balance it for operations that we do
in the laboratory.

64
00:05:06,560 --> 00:05:11,340
When the instrument is expended form the scientific airlock, it points directly toward the Sun.

65
00:05:11,340 --> 00:05:15,840
This instrument is designed to look at very faint light that is a million, million times

66
00:05:15,840 --> 00:05:16,840
fainter than the Sun.

67
00:05:16,840 --> 00:05:21,550
We have to point the instrument away from that direction by at least fifteen degrees

68
00:05:21,550 --> 00:05:24,210
before we can start to make these measurements.

69
00:05:24,210 --> 00:05:31,310
To make these move, we can move it around the direction of extension and/or away from

70
00:05:31,310 --> 00:05:34,700
the direction to the Sun, such as it's now doing.

71
00:05:34,700 --> 00:05:40,460
The head, which is everything beyond this point, consists of two major systems, a telescope

72
00:05:40,460 --> 00:05:44,620
photometer system, which is shown here, and a camera system here.

73
00:05:44,620 --> 00:05:50,740
The telescope measures the light coming in from the sky from stars, zodiacal light, and

74
00:05:50,740 --> 00:05:54,940

anything else and converts it to an electrical signal back here, which is then sent back

75
00:05:54,940 --> 00:05:57,660
to the ground through the spacecraft telemetry system.

76
00:05:57,660 --> 00:06:03,410
The camera periodically takes photographs as the telescope is making regular scan measurements

77
00:06:03,410 --> 00:06:04,410
around the sky.

78
00:06:04,410 --> 00:06:10,030
The two cylinders at the end are sun shields, which block the direct light of the Sun from

79
00:06:10,030 --> 00:06:14,960
falling on the objective and allows both instruments to observe to within approximately fifteen

80
00:06:14,960 --> 00:06:17,340
degrees of the Sun.

81
00:06:17,340 --> 00:06:22,669
The measurements that are made with the telescope are made at ten different colors and measure

82
00:06:22,669 --> 00:06:27,060
the brightness and polarization characteristics of the zodiacal light and star light.

83
00:06:27,060 --> 00:06:31,720
These are then separated in the analysis on the ground after the data is telemetered to

84
00:06:31,720 --> 00:06:35,420
Houston.

85

00:06:35,420 --> 00:06:41,080

This telescope photometer on the top here is an outgrowth and a follow-up to studies

86

00:06:41,080 --> 00:06:44,949

we conducted in Hawaii between 1961 and 68.

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00:06:44,949 --> 00:06:49,919

The system itself is essentially equivalent to an instrument we used all those years in

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00:06:49,919 --> 00:06:52,380

Hawaii and to an instrument we're using there now.

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00:06:52,380 --> 00:06:57,580

During the Skylab missions, we are coordinating observations from the ground with observations

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00:06:57,580 --> 00:07:02,330

from the spacecraft together with observations using a different instrument on the first

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00:07:02,330 --> 00:07:07,389

Pioneer probe, which is now in route to Jupiter and will encounter Jupiter in December of

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00:07:07,389 --> 00:07:08,389

this year.

93

00:07:08,389 --> 00:07:14,289

One of the things we're hoping to do, which can't be done from the ground, is to look

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00:07:14,289 --> 00:07:15,900

within fifteen degrees of the Sun.

95

00:07:15,900 --> 00:07:21,229

This isn't possible to do from the Earth's

surface because of the competition from other

96
00:07:21,229 --> 00:07:25,780
sources of light in the Earth's atmosphere
and because the atmosphere absorbs some of

97
00:07:25,780 --> 00:07:27,009
this light.

98
00:07:27,009 --> 00:07:31,070
By looking to within fifteen degrees and also
looking at a number of colors, we're able

99
00:07:31,070 --> 00:07:33,910
to get information that is not otherwise attainable.

100
00:07:33,910 --> 00:07:40,039
From the data we get back , we hope to analyze
the detailed nature of the particles that

101
00:07:40,039 --> 00:07:41,470
give rise to the zodiacal light.

102
00:07:41,470 --> 00:07:47,599
For example, we want to know are the dust
particles which give rise to it coming from

103
00:07:47,599 --> 00:07:48,800
the asteroid belt?

104
00:07:48,800 --> 00:07:53,259
Are they a result of grinding up of collisions
of different particles?

105
00:07:53,259 --> 00:07:57,389
Are they a remnant of the original cloud of
gas and dust out of which the solar system

106
00:07:57,389 --> 00:07:58,389

evolved?

107

00:07:58,389 --> 00:08:04,370

Is it also associated with comet tails or
is it associated with all of these?

108

00:08:04,370 --> 00:08:07,960

Analysis of these observations will tell us
something about the current state of the dust

109

00:08:07,960 --> 00:08:12,539

in the solar system, which in turn will enable
us to say something about the origin of it

110

00:08:12,539 --> 00:08:15,200

and something about the evolution of it.

111

00:08:15,200 --> 00:08:18,930

What will it be like thousands of years from
now?

112

00:08:18,930 --> 00:08:25,770

One of the principal things it will also tell
us what are the effects of light scattered

113

00:08:25,770 --> 00:08:29,419

off particles that are suspended in a large
region of space.

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00:08:29,419 --> 00:08:35,500

All of our knowledge about the atmospheres
of planets, much of the Milky Way, the solar

115

00:08:35,500 --> 00:08:43,130

system dust, comets, asteroids is derived
from information obtained from light scattered

116

00:08:43,130 --> 00:08:45,560

off bodies such as this.

117

00:08:45,560 --> 00:08:51,090

We are able here to observe these things from outer space without the complications of the

118

00:08:51,090 --> 00:08:54,660

Earth's atmosphere and to derive a lot of information we could not otherwise get.

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00:08:54,660 --> 00:08:59,470

It is directly applicable to problems like pollution in the Earth's atmosphere, which

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00:08:59,470 --> 00:09:04,420

is also caused by light sources being reflected off different particles.

121

00:09:04,420 --> 00:09:09,100

For example, sunlight reflected off different gas and dust particles.

122

00:09:09,100 --> 00:09:14,730

The information that we get from this experiment has a direct relationship to any things that

123

00:09:14,730 --> 00:09:19,150

have to do with light scattered off particles, whether it is in urban areas, whether it is