



Flowing Solar Wind

Electron
Cloud

1
00:00:00,010 --> 00:00:04,030
[music fades up]

2
00:00:06,070 --> 00:00:10,070
[narrator] Polar lunar craters are of interest for future space exploration because

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00:00:10,090 --> 00:00:14,130
potential resources, including water ice, have been found to exist

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00:00:14,150 --> 00:00:18,160
there. However intriguing recent calculation from

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00:00:18,180 --> 00:00:22,210
NASA's Lunar Science Institute team indicate a possible

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00:00:22,230 --> 00:00:26,260
new obstacle to reaching those resources, and the implications are

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00:00:26,280 --> 00:00:27,320
a bit shocking.

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00:00:27,340 --> 00:00:31,340
[Bill Farrell] Well in a nutshell, what we're finding, is that the polar

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00:00:31,360 --> 00:00:35,350
craters are very unusual electrical environments.

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00:00:35,370 --> 00:00:39,410
And in particular there can be large surface charging

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00:00:39,430 --> 00:00:41,430
at the bottom of these polar craters.

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00:00:42,510 --> 00:00:46,510
[narrator] Because the Moon is only slightly tilted to the Sun, landscapes at the

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00:00:46,530 --> 00:00:50,530

lunar poles have several unique characteristics. With sunlight

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00:00:50,550 --> 00:00:54,600

coming in sideways, tall polar peaks reach out and receive almost

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00:00:54,620 --> 00:00:58,640

constant sunlight, while deep polar craters hide surfaces that

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00:00:58,660 --> 00:01:02,680

may not have seen light for millions of years. The orientation

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00:01:02,700 --> 00:01:06,720

of these dark craters to the Sun may allow them to trap water ice

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00:01:06,740 --> 00:01:10,740

but it may also be charging them to hundreds of volts.

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00:01:10,760 --> 00:01:14,810

[Farrell] Well the solar wind is actually a relatively tenuous gas.

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00:01:14,830 --> 00:01:18,870

that's emitted from the Sun, but it's not a neutral gas, like the gas

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00:01:18,890 --> 00:01:22,910

in this room, it's actually a gas that's really, for the most part, free

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00:01:22,930 --> 00:01:26,940

ions and free electrons, it's really two components. And so you have this electrical

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00:01:26,960 --> 00:01:30,970

gas if you will. And then as it passes by the Moon,

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00:01:30,990 --> 00:01:35,040

the electrons behave slightly differently than the ions, of course the

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00:01:35,060 --> 00:01:39,080

electrons are very low mass, the ions are more mass, again we don't think

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00:01:39,100 --> 00:01:43,120

of an ion as being something real heavy, but compared to these little, flimsy electrons

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00:01:43,140 --> 00:01:47,150

they really are. So as you pass by, for example, a polar crater

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00:01:47,170 --> 00:01:51,170

the electrons will actually fill into the crater, ahead of the

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00:01:51,190 --> 00:01:55,180

ions. Now as it turns out, as it does that, you create an

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00:01:55,200 --> 00:01:59,220

electric field, it's called an ambipolar electric field, and that electric field then

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00:01:59,240 --> 00:02:01,240

drives in the ions.

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00:02:01,260 --> 00:02:05,240

[narrator] So while it is already known that human or robotic explorers searching

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00:02:05,260 --> 00:02:09,310

within these dark craters would face temperatures that plunge below minus

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00:02:09,330 --> 00:02:13,350

400 degrees fahrenheit, this new computer model suggests

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00:02:13,370 --> 00:02:17,390

they may have to contend with a dangerous electrical environment as well.

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00:02:17,410 --> 00:02:21,420

Static discharge could short out sensitive electronics,

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00:02:21,440 --> 00:02:25,440

while the static cling of sticky and extremely abrasive lunar dust

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00:02:25,460 --> 00:02:28,500

could wear out spacesuits and other equipment.

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00:02:28,520 --> 00:02:32,550

Astronauts and instruments within these craters would need to be

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00:02:32,570 --> 00:02:35,580

electrically grounded to avoid such hazards.

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00:02:35,600 --> 00:02:39,650

[Farrell] Well that is actually the crux of the whole problem, what is

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00:02:39,670 --> 00:02:43,720

the electrical ground on the Moon? You actually have a surface on the Moon

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00:02:43,740 --> 00:02:47,790

that has the conductivity, it's almost like candle wax, you know, you're not going to get

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00:02:47,810 --> 00:02:51,830

a charge out of the ground. So you're really grounded to the plasma.

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00:02:51,850 --> 00:02:55,850

And when you're out in the solar wind, you know, on the surface of the Moon,

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00:02:55,870 --> 00:02:59,920

not in these craters and not in these mountains, okay you're grounded. But when you start heading into

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00:02:59,940 --> 00:03:03,990

these craters, you've now lost touch with your electrical ground, so that means you take a step

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00:03:04,010 --> 00:03:08,030

and you might have to wait a hundred seconds before that charge that you just

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00:03:08,050 --> 00:03:12,060

accumulated disappates away. That's a long time to be stepping around.

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00:03:12,080 --> 00:03:15,140

So you really do have to worry about human systems going into these craters.

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00:03:15,160 --> 00:03:19,200

[narrator] The next steps for the Lunar Science Institute team include more complex

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00:03:19,220 --> 00:03:23,260

computer models. There are still many questions to answer about where the

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00:03:23,280 --> 00:03:27,300

Moon's key polar resources lie, how they got there, and whether

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00:03:27,320 --> 00:03:29,370

or not future explorers will be able to reach them.