Moon dust not as strange as hoped

02 September 2009 by **Lisa Grossman**
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EVER since a 1998 space shuttle experiment saw what appeared to be an anomalously heavy variety of matter, the hunt has been on for more of the same. Now, a search of lunar soil for so-called "strange matter" has come up short, casting doubt on whether it exists at all.

The standard model of particle physics describes six types of quark, including the up and down quarks which make up protons and neutrons, found inside ordinary atoms. Physicists have long theorised about strange matter that would also contain strange quarks. Strange matter is heavier and denser than ordinary matter, as the strange quark has roughly 10 times the mass of the up or down quark.

Some neutron stars - the dense remnants of supernovae - might actually be made of strange matter. If two such stars collided, bits of strange matter called strangelets could be spewed out. "You could get strange matter floating around in space," says Jack Sandweiss, a physicist at Yale University.

The Alpha Magnetic Spectrometer (AMS-01), which flew on the space shuttle Discovery, appears to have detected a strangelet - a nucleus like that of oxygen but with three times its mass. Delays in flying the more advanced AMS-02 instrument after the Columbia shuttle disaster have meant that this result has never been confirmed. So Sandweiss turned to an altogether different kind of detector: the moon. It has no magnetic field to deflect charged particles, so any strangelets arriving would hit its surface and stay embedded there.

> Any strangelets arriving at the moon would hit its surface and stay embedded there

Sandweiss's team took 15 grams of lunar soil from the Apollo missions and accelerated the grains past a powerful magnet. Any strangelets present would curve less in the magnetic field than normal matter - but none was observed (www.arxiv.org/abs/0903.5055). "If AMS-01 had been a real event, we would have found it," says Sandweiss.

The study was designed to find the oxygen-like strangelet seemingly seen by AMS-01. Other strangelets might have slipped by unseen. The issue could be settled when AMS-02 is flown up to the International Space Station next year. "Then we'll finally answer the question," Sandweiss says. "AMS is really the right way to do this."

Astronaut Charles Conrad Jr, commander of the Apollo 12 mission, on the surface of the moon. He has lunar soil on his spacesuit, especially around the knees and below (Image: Johnson Space Center Collection, NASA)

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There's Still Work To Be Done

Wed Sep 02 11:02:49 BST 2009 by **sciencebod**
http://www.colinb-sciencebuzz.blogspot.com

Well, it was worth a try - you win some, you lose some.

Looking at your photograph of Charles Conrad, his space suit coated with moon dust up to the knees, reminds one of a neglected aspect of the stuff. Why is it so incredibly "sticky"?

Here's my theory, for what it's worth. Ever heard of triboluminescence? Break a Polo mint inside a dark broom cupboard, and you will see flashes of light (largish crystals of sugar will do). It's due we are told to fracturing of crystals with asymmetry in their structure, which first causes electrical charge separation, followed by ionization of air - the latter generating light.

So what's that got to do with Moon dust? The Moon is being bombarded with micrometeorrites, with enough energy to fracture mineral crystals on the surface. But there's no air to be ionized, no quick way of dissipating the electrical charge

The crystals may retain their electrostatic charges for longish periods of time (minutes? months? years?) and then adhere to anything new in the vicinity. Like a spaceman on walkabout?

The first tests on Moon dust showed they were a great potting medium for plants. It was probably assumed at the time that this was due to trace elements, but there's another explanation: the particles may have bonded more firmly to root hairs, allowing more efficient dissolving and uptake of whatever useful minerals are available.

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Wed Sep 02 11:15:15 BST 2009 by **Mike from Oz**

Thank you for a fascinating comment. Almost as interesting as the article itself!

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Wed Sep 02 11:25:16 BST 2009 by **sciencebod**
http://www.colinb-sciencebuzz.blogspot.com

Thanks, Mike :-)

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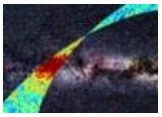

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I've just been googlin', and found this:

(long URL - click here)

It confirms my hunch that moon dust is sticky on account of electrostatics, but reckons it's solar uv and X-rays that make it so.

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Fri Sep 11 12:29:09 BST 2009 by **Lindsay**

An interesting idea but I will throw up an alternate explanation. I have not really checked up on this so it is 'shooting from the hip' so to speak. So it can probably be just as easily shot down.

The lunar dust is heavily fractured and sharp edged compared to earthly dust which is more weathered and rounded. Electrostatic charge would tend to acumulate more on the extremities of lunar dust grains as it would be there that it has the highest probability of leaking away or discharging. There would then be two effects resulting in the extra clinginess of the lunar dust. The phyisical angularity enabling a grain to securely embed itself into a spacesuit knee and a more pronounced electrostatic charge polarity of the dust grains on account of the severe grain angularity making it that bit more sticky. Which would be the more significant effect?

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Wed Sep 02 11:22:49 BST 2009 by **Jimmy D**

Yes an interesting, but perhaps somewhat complicated explanation. Couldn't it simply be that less gravity means the surface dust is kicked up a lot more than we see on earth, and so tends to cover the walkers more?

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Thu Sep 03 03:35:33 BST 2009 by **Dann**

Dust plumes here on earth only exist because of our atmosphere.

If you stamp your foot downwards onto fine dust, it's not the force of your foot that plumes the dust upwards, but rather the cushion of air your foot pushes down ahead of it.

Once dust is in the air, the very low mass of the particles and their very high surface-area-to-volume ratio means they have a very low terminal velocity, so the finer the dust, the longer it takes to settle.

On the moon, where there is no atmosphere, dust should theoretically fall back to the surface at the same rate as a hammer or a safe would. A lander coming in to land or taking off should push dust upwards with it's rocket exhaust, but I doubt that a downwards foot stomp would raise it (since the foot's not pushing a cushion of air ahead of it). However, raising the foot again would scatter any dust particles that adhered to it - but I suspect they'd quickly fall downwards.

I suspect most of the dust on the astronaut's legs got there via electrostatic attraction, rather than the astronaut kicking up plumes of it as he walked. The much lower gravity of the moon would mean that the electrostatic forces would raise the dust higher than it would here on earth - I'm guessing that the attraction pretty much equalised the moon's gravity at about knee height, hence why it didn't go any higher.

Feel free to correct me if I've erred. This was all based on logical deduction rather than a keen understanding of the physical forces involved.

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Thu Sep 03 03:40:47 BST 2009 by **Dann**

Ha! I've just realised that he's also got dust on his fingers. A more likely explanation for the dust getting on his suit is that he fell onto his knees at one point.

Electrostatic attraction might however be responsible for the dust not falling off again though - but wouldn't require enough force to raise the dust to that distance from the surface.

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Wed Sep 02 12:13:11 BST 2009 by **HMS**

To the moon gravity, the space suits will also have more gravity attraction to dust than here on earth, the dust being finer enphasises this effect.

I'll go for the gravity option... if the dust is so electromagnectic, wouldn't it bond together in clumps or in a crust?

What is observed is very fine grain of dust in very low gravity environment.

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Wed Sep 02 12:30:08 BST 2009 by **sciencebod**
http://www.colinb-sciencebuzz.blogspot.com

There's a simple way of distinguishing between a gravitational and an electrostatic force of attraction. The second one (not the first!) allows dust to stick to a vertical surface - like the leg of a space suit!

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Wed Sep 02 14:53:47 BST 2009 by **HMS**

You might be right, but it still seems to me that any electrostatic would dissipate between the at least months that go between micrometeorite impacts in one given area, in some cases and with a bit o luck you might run into a charged area but then wouldn't the suit itself discharge the particles?

Also the moon gravity is 1/6 of earth's so it makes only 1/6 of the pull on the particle so it sticks because it's so tiny and also because of the suit own gravity.

It's like the water droplets after the bath they stick to our

skin momentarily but will drop due to gravity, in the moon they would drop at 1/6 of the rate on earth.

With dust the particles build up with the ones at the botom that are suported by joints in the suit and then suporting the upper ones that seem suspended.

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Wed Sep 02 22:19:08 BST 2009 by **sciencebod**
http://www.colinb-sciencebuzz.blogspot.com

Have just this minute googled *why is moon dust sticky*. Amazed to find pages and pages of returns. This has been a hot topic for years, it would seem, without my realising it!

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Wed Sep 02 21:37:38 BST 2009 by **Troy H.**

Electromagnetic =/= Electrostatic.

Electromagnetic force is orders of magnitude stronger than gravitational force. The gravity of the astronaut would have to compete with the gravity of the planet, which it could not.

Lunar soil sticks to, well... everything because of its electrostatic charge and the sticking is made worse by its shape. Since they haven't been eroded by wind or water and are probably the result of meteorite impacts, they tend to stick together.

This is the same reason that lunar soil can hold such detailed footprints without any moisture.

Also, the outer layer of our space suits is called beta cloth and it is a woven silica fiber cloth. It can be aluminized on one or both sides to improve radiation characteristics.

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Thu Sep 03 12:28:33 BST 2009 by **HMS**

Every electric current produces a magnetic field, if you touch a charged electric wire you get glued to it because of this.

Magnetism is much stronger when the two materials are in contact and becomes weaker with distance.

The force that the electromagnectic field exert on electrically charged particles is called the electromagnetic force?

For Electrostatic to bluid up and acumulate you need a good insulator, is moon dust a good insulator?

The space suit outer layer may be a good insulator, this I don't know for sure, but it could be the suit that becomes electrostatically charged, and attract the dust. Still... I can't see what would be responsible for this charge to build up in the suit.

Maybe when it was stored in the lander it was subjected to vibration with some kind of plastic or cloth that protected it from shock... or maybe it's just low gravity and tiny dust, or maybe it's the combination of all of this causes that makes it

stick.

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Wed Sep 02 14:31:26 BST 2009 by **Gil**

I believe it is sticky because it is uneroded by weathering, so it has more fine spiky elements on it.

I'm not sure where I heard that from, however, so it could've been some made up stuff from an old sci-fi novel.

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Wed Sep 02 14:47:04 BST 2009 by **sciencebod**
http://www.colinb-sciencebuzz.blogspot.com

Well, that should be easy enough to prove or disprove - by microscopy, Gil.

But please reassure me on one thing - that you are not thinking in comfortable earthbound terms, ie you and dog go for an autumnal ramble on Sunday, each pick up-a few burrs.

A spikey particle may attach easily to a weaved fabric. But is the outermost layer of a space suit weaved? It's more likely to be a smooth non-textured synthetic polymer surely- as a base for reflective silvering?

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Wed Sep 02 18:32:11 BST 2009 by **Charlie**
http://www.ilcdover.com/

All the spacesuits I have handled (admittedly only a few) had a woven outer covering.

That outer cover was primarily intended to prevent the Soviets from examining the suits, but secondarily to reflect light.

Space suits are extremely complex machines, incorporating heating, cooling, and armor as well as pressure isolation.

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Wed Sep 02 15:50:26 BST 2009 by **MrHappy**

The thermoluminescence (which can also be seen in a wintergreen lifesaver) is not the cause of the stickiness. The stickiness comes from the particles being electrolytically charged. Or less wordy they stick because fo static electricity. If you need to envision it, think of a cellophane wrapper that you can't get off your hands. It sticks to one hand, then when you pull it off it sticks to the other until you have to stick it to a garbage bag or other object.

The reason why the particles don't clump is because they all have the same charge. Same charge repulses.

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Thu Sep 10 08:06:59 BST 2009 by **Phil**

This also shows how the decline in popularity of polo mints will inhibit further scientific inspiration. Spend as long as you like in a dark broom cupboard with a werthers original and you'll never come up with an insight like that.

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Insufficient Sample Size?

Wed Sep 02 14:19:36 BST 2009 by **EchoGnome**

Has anyone considered the following:

would the 'strangelets' be present in sufficient quantities for a random 15g sample of dust to contain a detectable amount? The text above suggests that the AMS found 1 nucleus floating in space, this seems to me to be such a small amount that a HUGE amount of luck would have to be involved in order to find a stranglet in one random sample of lunar dust, maybe equivalent to finding a diamond in a random sample of beach sand?

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Insufficient Sample Size?

Wed Sep 02 16:01:10 BST 2009 by **Uh Huh**

Exactly! They were looking for a very particular oxygen-like strangelet in 15 grams of lunar soil. Is a negative result really so surprising? And, more importantly, does it really rule out presence of strangelets of any type anywhere in the Solar system?

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Insufficient Sample Size?

Wed Sep 02 16:38:59 BST 2009 by **Barak**

The lunar soil has been acting as a strangelet trap or filter (should they exist) and thus has been accumulating and concentrating strangelets for the last 4 billion years or so. Far more likely to find them there than free-floating.

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