South Downs Mercury

The monthly circular of South Downs Astronomical Society
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- Next meeting Friday 5th September Lecture room of the South Downs Planetarium, Chichester, at 7.30pm. Please support a raffle we are organizing this month to raise money to buy a Solar Telescope

- "**What's up" - Guide to the month ahead by SDAS member John Whittington**

- **Club Evening use of Telescopes**

- **India vs America in race to MARS**

India and America are locked into a race to Mars - but it looks as if the US will get there first. On Sunday 20 September, NASA's Mars Atmosphere and Volatile Evolution (MAVEN) spacecraft completed its 10 month journey and go into orbit around the Red Planet. Its 442 million mile trip will conclude with a tricky manoeuvre which should see the craft ease into an elliptical orbit. Six thrusters will ignite to perform "settling burn" which will help the craft to point in the right direction. The six engines will then fire in pairs to slow the craft down and steer it into position. The MAVEN mission has been going on for 11 years, with the craft itself launched in November 2013. But for the scientists in charge of it, the fun has just begun. Once in orbit, MAVEN will begin observing the upper atmosphere of Mars, focusing on how it is effected by interactions with the sun and the solar wind. It is hoped these tests might explain why Mars lost the water which was thought to once gush over its surface. "These observations will help scientists determine how much gas from Mars' atmosphere has been lost to space throughout the planet's history and which processes have driven that loss," said Bruce Jakosky, principal investigator for MAVEN at the University of Colorado. "Every day at Mars is gold," added David Mitchell, MAVEN's project manager at NASA's Goddard Space Flight Centre in Greenbelt, Maryland. However, the Americans aren't alone up there. On Thursday next week, a craft launched by the Indian Space Research Organisation (ISRO) will also segue into orbit, if all goes to plan. "India will be the first country in the world to insert a spacecraft into the Martian orbit in a maiden attempt if the operation succeeds," said ISRO scientific secretary V. Koteswara Rao. "And also the first Asian country to reach the Red Planet's sphere." The Indian probe will test for methane in the atmosphere. If present, this could indicate the presence of life.

- **Stray positrons caught on ISS hint at DARK MATTER source**

Data gathered by the International Space Station's (ISS') Alpha Magnetic Spectrometer (AMS) is being cautiously suggested as useful evidence for the existence of dark matter. The AMS is a particle detector on the ISS and keeps its eyes on cosmic rays, in order to observe the high-energy particles they carry. As explained in a new piece in Physical Review Letters titled Electron and Positron Fluxes in Primary Cosmic Rays Measured with the Alpha Magnetic Spectrometer on the International Space Station, since May 2011 it has detected and analysed 41 billion items of interest. Of those, 580,000 were positrons and 9.2

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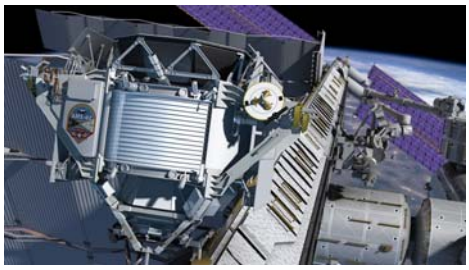
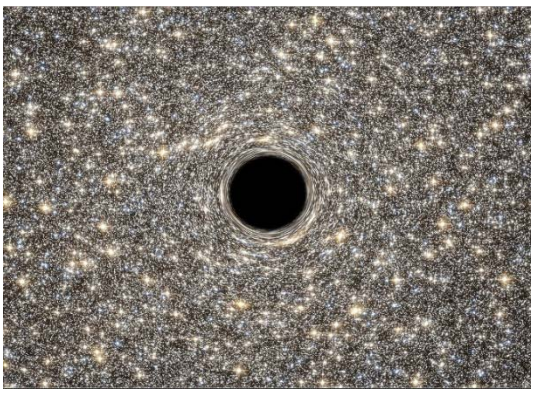
million were electrons. When the scientists involved calculated “the positron fraction” — the ratio of the number of positrons to the combined number of positrons and electrons they found a higher fraction at lower energy levels. That's not been observed before, leading Paolo Zuccon, an assistant professor of physics at MIT, to comment the results “show unambiguously that a new source of positrons is active in the galaxy.” Positrons are anti-electrons and it is assumed they are created when dark matter particles collide and annihilate each other. A new source of positrons therefore suggests that somewhere out there dark matter particles are enduring such collisions. That's a long way short of a positive identification of dark matter, but clearly enough for the scientists concerned, and reputable journals, to suggest it is a useful step towards such a proclamation



A computer generated image showing AMS-02 mounted to the ISS S3 Upper Inboard Payload Attach Site

- **Supermassive black hole dominates titchy star formation**

Astronomers have spied a supermassive black hole - of the type theorised by some physicists to be portals out of our universe to elsewhere - in an itsy-bitsy ultra-compact dwarf galaxy, the smallest ever known to contain such a gigantic light-sucking feature. "It is the smallest and lightest object that we know of that has a supermassive black hole," says Anil Seth, astrophysicist at the University of Utah. "It's also one of the most black hole-dominated galaxies known."

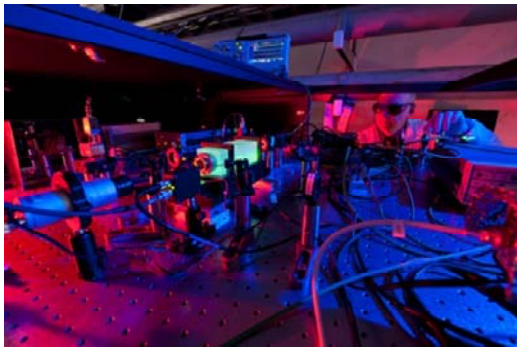


The astronomers used the Gemini North 8m telescope on Hawaii’s Mauna Kea and photos from the Hubble Space Telescope to spot that the little galaxy called M60-UCD1 has a black hole with a mass equivalent to 21 million suns. Our own Milky Way has a central supermassive black hole with the mass of four million suns, which is just a fraction of the galaxy’s entire mass of around 50 billion solar masses. However, M60-UCD1’s black hole is five times larger and takes up a huge 15 per cent of the small galaxy’s total mass of 140 million suns. If M60-UCD1 can contain this huge event horizon, it’s likely that other ultra-compact dwarf galaxies can too – in fact, they may even be the stripped down remains of larger galaxies torn apart in collisions with other galaxies. "That is pretty amazing, given that the Milky Way is 500 times larger and more than 1,000 times heavier than the dwarf galaxy M60-UCD1," Seth said. "We believe this once was a very big galaxy with maybe ten billion stars in it, but then it passed very close to the centre of an even larger galaxy, M60, and in that process all the stars and dark matter in the outer part of the galaxy got torn away and became part of M60," he says. "That was maybe as much as ten billion years ago. We don't know." The ultimate fate of the tiny galaxy is likely to be obliteration, as it merges inexorably with the M60, among the largest galaxies in the local universe. "Eventually, this thing may merge with the centre of M60, which has a monster black hole in it, with 4.5 billion solar masses – more than 1,000 times bigger than the supermassive

black hole in our galaxy. When that happens, the black hole we found in M60-UCD1 will merge with that monster black hole," Seth explained. Ultra compact dwarf galaxies are among the densest star systems in the Universe and M60-UCD1 is the most massive of these now known. It lies around 54 million light years from Earth, but only 22,000 light years from the centre of the galaxy M60. Astronomers reckon that this type of galaxy is either the stripped centre of larger galaxies that were involved in collisions or globular clusters of hundreds of thousands of stars, all born together.

- **Is this the real life? Is this just fantasy?**

How can we tell from the inside of our Universe if it's actually real or just a hologram? Scientists at Fermilab have set out to answer this thorny question with a new experiment in the National Accelerator Lab called the Holometer.

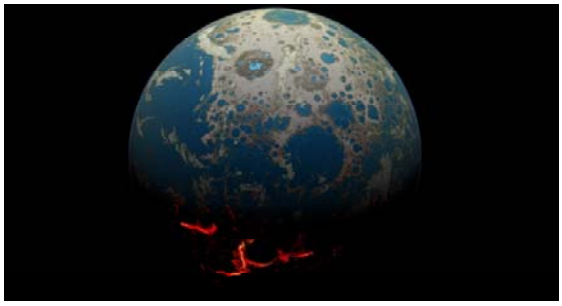


Lasers are SO COOL

If people inside our television could think about it, they wouldn't be able to tell that they were nothing more than a 2D projection, because their world looks 3D to them. In the same way, there's no simple way to tell if the world we see around us is an illusion, a collective hallucination or the real 3D deal. Scientists reckon it's possible that, just like the pixels that make up the 3D image on your TV, all the information about the Universe could actually be encoded in tiny packets in just two dimensions. These natural pixels would be ten trillion trillion times smaller than an atom – a unit known as the Planck length. Things get heavily quantum from this assumption on… "We want to find out whether space-time is a quantum system just like matter is," said Craig Hogan, director of Fermilab's Centre for Particle Astrophysics and the developer of the holographic noise theory. "If we see something, it will completely change ideas about space we've used for thousands of years." In quantum theory, you can't know both the exact location and the exact speed of subatomic particles at one time. If space comes in 2D pieces that have limited information about precise locations, then it would be subject to same theory of uncertainty. To figure out if they're right, scientists need to look for the jiggle in the hologram. Matter continues to move as quantum waves even when it's cooled to absolute zero, so digitised space bits should also have built-in vibrations even in their lowest energy state. The Fermilab's Holometer will attempt to measure the quantum jitter of space itself using a pair of interferometers placed close together. Each instrument will send a one-kilowatt laser beam at a beam splitter and down two perpendicular 40m arms. The light will then be reflected back to the splitter when the two beams recombine, creating fluctuations in the brightness if these vibrations exist. The tricky part will be separating out any "holographic noise" from extraneous background sources, like radio waves from nearby electronics. The Holometer, which is the most sensitive device ever created to measure quantum jitter, is testing on such a high frequency that the motions of normal matter shouldn't be a problem. "If we find a noise we can't get rid of, we might be detecting something fundamental about nature – a noise that is intrinsic to space-time," said Fermilab physicist Aaron Chou, lead scientist and project manager for the Holometer. "It's an exciting moment for physics. A positive result will open a whole new avenue of questioning about how space works."

- **Meteorites likely wiped out Earth's earliest life**

The biggest smash-ups would have boiled off oceans and obliterated life



Mega-meteorites pelted early Earth. They would likely have created magma-gushing gashes (red lines in this artists' rendition) and killed off any emerging life — until 4.3 billion years ago.

Repeatedly during its early history, Earth was bombarded by space rocks larger in diameter than the state of Utah. Such collisions likely killed off any emerging life on the planet's surface — probably again and again. The last of these death rocks struck around 4.3 billion years ago. At least that's the estimate that scientists propose in the July 31 *Nature*. This date offers an upper limit to how long our planet may have continuously sustained life. Earth appears to be around 4.6 billion years old. For its first 800,000 years, the planet was a hellish place. That's why geologists call this the Hadean eon — after Hades, the Greek god of the underworld. Debris left over from the solar system's creation regularly slammed into Earth. This would have boiled away the early ocean and coated the planet with molten rock. But scientists think that it was during this chaotic time that life began. "If life on Earth emerged before [a] final sterilizing impact, it may have been completely erased," says Simone Marchi. That's right: Rendered extinct. "Life would have had to start all over again," concludes this planetary scientist at the Southwest Research Institute in Boulder, Colo. She led the new study. So much material struck Earth during the Hadean that it would have built up the planet's surface by a height equal to that of Mount Everest. These impacts shaped the emergence of tectonic plates. Those relatively thin, migrating slabs of rock make up Earth's surface, floating over a layer of molten rock below. Over time, those slabs continually rise out of the molten rock and submerge again. Their activity, which renews Earth's surface, plays out over billions of years. It also means that few surface rocks remain that are older than around 3.8 billion years old. So our planet holds no obvious record of events earlier than that. In search of records for even earlier collisions, Marchi and her colleagues looked to the moon. Why? Its surface lacks the recycling action of plate tectonics, so the moon still shows scars from early asteroid impacts. Scientists can determine the ages of those very ancient impacts by *crater counting*. As a crater ages, newer meteorites pock its surface at each new impact site. During Apollo missions to the moon, astronauts retrieved moon rocks. Back on Earth, geologists dated rocks collected from lunar craters. Scientists can estimate the age of the moon's large and old craters by counting the number of smaller, fresher ones within the older ones. Marchi's team used this information to estimate the number, frequency and size of asteroids that likely impacted early Earth. Of course this works only if they assume both had a similar impact history. The team then created a computer program to simulate Earth's early asteroid bombardment. And the moon data suggest that asteroid impacts became smaller and less frequent with time. The computer also suggested that every bit of Earth's surface had at some point been covered in a magma-oozing crater created by an impact. Three to seven asteroids larger than 500 kilometres (roughly 310 miles) across probably struck Earth during this early time. At least, that's what the computer program indicates. Any of these could have vaporized all of the planet's surface water. This hot, sizzling rock and lava would likely have destroyed any life then living on the surface. The last of these life-sterilizing impacts took place 4.27 billion years ago, the researchers estimate. Fossils preserve evidence of life on Earth going back only 3.8 billion years (although some scientists dispute that earliest evidence). Geochemist Jeffrey Bada works at the Scripps Institution of Oceanography in La Jolla, Calif. He believes that a better understanding of early asteroid bombardment will help researchers probing the origins of life. Earth's really big asteroid smash-ups would have obliterated any cells that had evolved, he says. "Life could not have started prior to that and survived."