Europa glows at night

It could tell us what there is on the surface of Jupiter's moon

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The first satellites of planets in the Solar System to be seen were the four moons of Jupiter, which Galileo spotted through his telescope in 1610. And the smallest of the four, slightly smaller than Earth's Moon, is Europa.

Europa displays a surface which is the smoothest of the known solid objects in the Solar System. The smoothness suggests that below the surface, there is an ocean of liquid water, kept liquid by internal heat and tidal flexing. This, and the high oxygen content of the thin atmosphere, makes Europa a strong candidate as a host of extra-terrestrial life.

The surface of Europa, however, is battered by intense radiation, which was thought to prevent the survival of any life-form till deep below the surface. While there are studies to say that life could exist at a depth of just a centimetre, there is now a paper in the journal, *Nature Astronomy*, that puts a different slant on the onslaught of radiation. Murthy S Gudipati, Bryana L Henderson?and Fred B Bateman, from Nasa's Jet Propulsion Laboratory, Pasadena and the National Institute of Standards and Technology, Gaithersburg, Maryland, write that the radiation would affect the salt and ice on the surface to give off a greenish glow, which could help sensitive analysis of its composition. Bombardment of pieces of material with radiation, for analysis, is standard laboratory technique. It would appear that we could carry out these studies of the material on Europa without the need to go there and fetch samples.

The reason for the radiation that strikes Europa is the strong magnetic field of the parent planet, Jupiter. Jupiter's magnetic field is 14 times stronger than Earth's and the planet has a rotation period of nine hours. The strong and rapidly changing magnetic field reacts with the *solar wind* – charged particles, mainly electrons, protons and alpha particles, that stream forth from the Sun. These, along with the rich outpouring of charged particles from Io, Jupiter's volcanic moon, create a rotating ring. The influence of the radiation, which is called the magnetosphere of Jupiter, extends seven million kilometres towards the Sun and another seven million kilometres, almost to the orbit of Saturn in the opposite direction. This is the largest magnetosphere in the Solar System and its existence was first inferred from strong radio signals that come from Jupiter, as a rotating radio beacon.

The result is that the moons of Jupiter (there are 79 in all) are blasted with radiation. In fact, even spacecraft that were sent near Jupiter and to fly past Europa needed special shielding and could remain in the radiation only for short periods.

The paper in *Nature Astronomy* observes that the radiation that strikes the surface of Europa, which is essentially made of silicate rock and covered by a crust of water-ice, could create energy-rich chemicals at the surface. These, if transported down to the ocean below the surface, could promote chemical reactions, which, in turn, could support life processes. In this context, the paper says, it is important to understand the chemical constituents of Europa's surface, particularly, sodium and magnesium, and chloride, carbonate and sulphate ions, which would help assess the salinity of the water ocean and the nature of the interaction between the ocean and the surface.

The major moons of Jupiter, including Europa, have been extensively studied with the help of several conventional tools. These include telescopic observation from Earth and orbiting stations like the Hubble Space Telescope and observations by the *Pioneer* and *Voyager* fly-by spacecraft, the *Galileo* orbiter (to Jupiter) that mapped near infrared emission from Europa over eight years, and *New Horizons*, which flew past on its way to Pluto. And there are more missions planned, including *Europa-Clipper*, to orbit Europa. However, "many salts of interest are relatively featureless in the near infrared spectral region that is typically used for compositional analysis," the paper says. The near IR spectra seen can thus be correlated to many combinations of chemical components. Even observations of the visible and UV spectra, using the Keck Observatory and the Hubble Space Telescope have not given significant results. "For definitive salt identification, complementary methods are needed," the paper says.

Laboratory studies conducted by the group shows that the *radiation induced ice-glow* can provide this complementary information. The laboratory studies used a piece of equipment built at the Jet Propulsion Laboratory, called the Ice Chamber for Europa High-Energy Electron and Radiation-Environment Testing (*ICE-HEART*). Ice cores held in an aluminium tube were cooled down to the temperature of Europa's surface. They were then bombarded with controlled electron beams from the Medical and Industrial Radiation facility at Gaithersburg, in Maryland, US. Electron beams of different energies were used with a large number of ice-core compositions. Any emission from the ice-cores was recorded with all other lighting switched off, to simulate the night-time conditions of the water-ice on Europa.

The trials, building on earlier studies, showed that electron bombardment of water-ice and salts produced a glow with spectral characteristics that changed according to the salt component. The radiation that bathes the surface of Europa would then produce similar emission. Imaging the glow, from short range, as from the proposed *Europa-Clipper* orbiter, could then provide information about the distribution of salinity, patches with fresh water-ice, and other characteristics.

The *Europa Instrument Set* aboard the proposed orbiter includes a wide-angle camera and a narrow angle camera, for selective, high resolution imaging. Night-time imaging of the radiation-induced glow could then produce a map of the chemical composition of the Europa surface. The night-time data could be combined with the daytime observations for better identification of the chemical composition and geological features, now of Europa and later of Io, Ganymede and Callisto, the other moons of Jupiter, the paper says.

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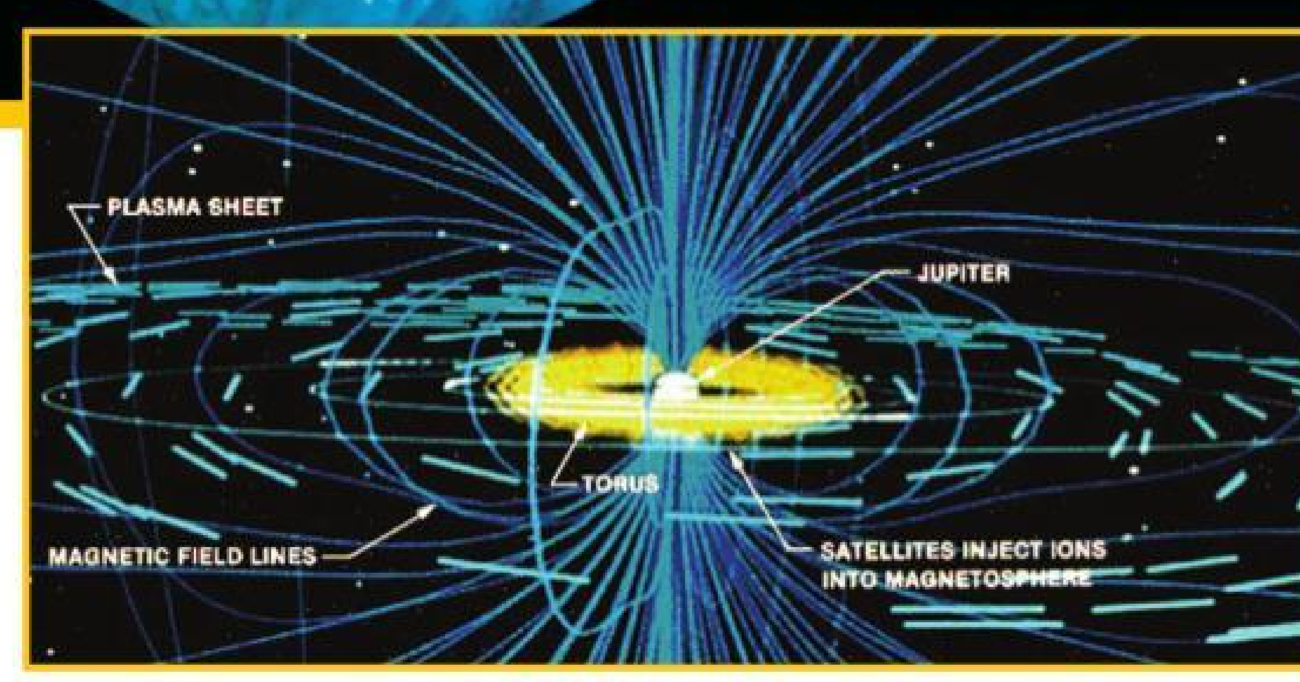
IT IS NOT REFLECTED LIGHT

It is not unusual to analyse reflected light, for instance the light that comes to us from the planets, to identify the elements in the planet's atmosphere, through which the light has passed. This is even done with starlight which passes through the atmosphere of a heavenly body that is just about to block the star from view.

In the case of Europa, the glow that we see is not reflected light. What shines on Europa is not light, but high energy radiation of charged particles – electrons, protons and alpha particles. These cause the elements on the surface of Europa to emit light, which could help us understand what these elements are. As for the atmosphere, there is none to speak of on Europa. And not a bad thing, as the glow at the surface can be viewed with less scattering.



PLUS POINTS

Puzzle-solvers

Otters are naturally playful and inquisitive animals, but a new study reveals that Asian short-clawed otters actively learn from one another when solving puzzles to get food.

A research team at the University of Exeter in the UK gave groups of otters a variety of different transparent containers, each containing meatballs as bait. These plastic puzzles could be opened by twisting or pulling a particular lid or handle.

The researchers found evidence of "social learning" – as when one otter cracked the puzzle, its closest "friends" quickly figured it out too. The otters saw each puzzle twice, several months apart, and when they came back to it, the researchers found the otters could solve the puzzle 69 per cent faster on average the second time round. They said this suggests the animals have a capacity for long-term memory.

"Asian short-clawed otters are declining in the wild, partly due to overfishing and pollution affecting the crustaceans and small fish they feed on," said lead author Alex Saliveros, of the Centre for Ecology and Conservation on Exeter's Penryn Campus in Cornwall, "With that in mind, we wanted to understand more about how they learn and remember information about new food sources. Being able to catch new prey in new ways, and to pass on that knowledge, could be important in terms of conservation.

"Our study is the first to show evidence of social learning and long-term memory in Asian short-clawed otters –which may be good news in terms of their adaptability and future survival."

By building up a picture of the otters' "social networks" – done by examining which otters spent most time together – before presenting them with the puzzles, the researchers were able to see how problem-solving techniques passed through the otter groups.

Senior author Dr Neeltje Boogert said, "We previously found that smooth-coated otters learn from each other. Now that we know Asian short-clawed otters do so as well, we can start investigating how we might transmit critical survival information regarding new foods and predators through wild otter groups more generally."

The Asian small-clawed otter is the world's smallest otter species, and mainly lives in mangrove swamps and freshwater wetlands in South and South-east Asia. The species faces ongoing habitat loss, pollution, and is hunted in some areas. it is listed as "vulnerable" on the IUCN Red List.

The research is published in the journal *Royal Society Open Science*.

–THE INDEPENDENT

Zoologist no more

In a career spanning about 40 years, National University of Singapore professor Dennis Hugh Murphy created some of the earliest maps of Bukit Timah Nature Reserve and the Mandai mangroves. He also had a hand in the development of the Singapore Zoo's Fragile Forest bio-dome, where visitors to this day can get up close with insects and other animals in a rainforest setting.

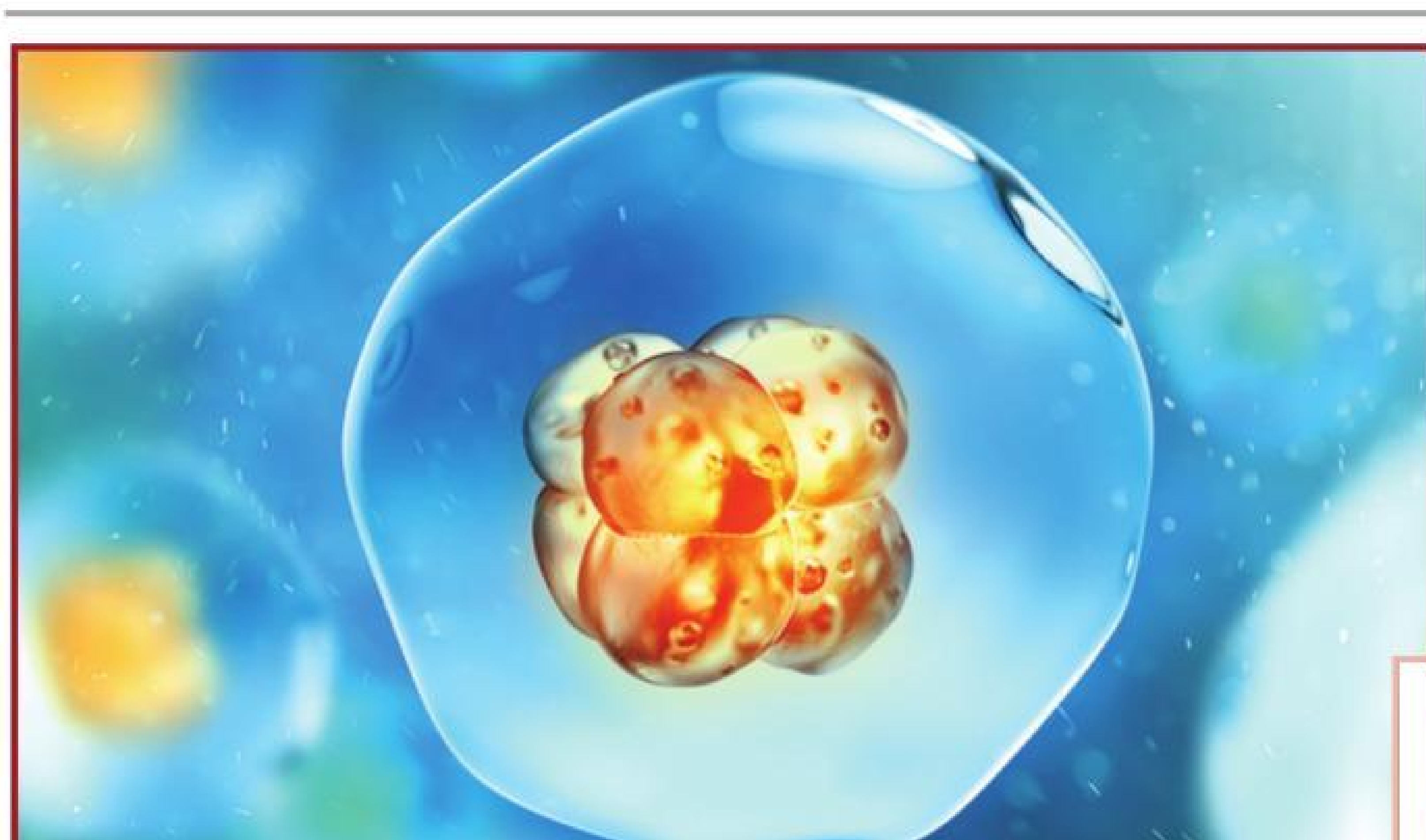
On 7 November, the celebrated British zoologist who mentored a generation of biologists in Singapore died peacefully in a nursing home in Singapore. He was 89.

Murphy, affectionately known as Paddy, first moved to Singapore in 1960 and joined the then Singapore campus of the University of Malaya as a lecturer in its zoology department.

Speaking to The Straits Times, his former students said they have fond memories of a jovial man who was practical yet generous with his time, spontaneous and unorthodox in his perspectives, and humble despite his towering contributions to science.

Murphy's key achievements include pioneering work on Singapore's mangrove biodiversity in the 1970s and 80s. Even after his retirement in 1990, he continued to be a fixture at the NUS labs for nearly a decade more. He later served as a consultant to government agencies and various firms in insect identification.

–THE STRAITS TIMES/ANN



HOPE ON THE HORIZON

With it being World Pancreatic Cancer Day tomorrow, a new drug could improve life expectancy and quality for pancreatic cancer patients

TIM SKERRY

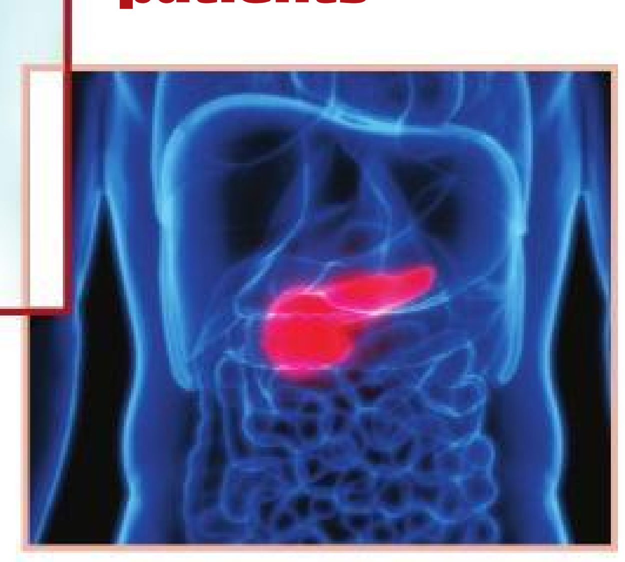
Pancreatic cancer is a devastating disease, and most patients die within a few months of diagnosis. This is partly because the early signs of the disease are non-specific, so that intermittent back or abdominal pain, digestive disturbances and weight loss are often seen by patients as too trivial to bother their doctor. The location of the pancreas also makes it challenging to detect. Its position at the back of the abdomen behind other organs makes it hard for doctors to feel during routine examinations. This means that often the disease is advanced and even terminal when it is diagnosed. In addition, pancreatic cancer is also a major cause of cancer deaths because the tumours are difficult to treat.

Many of the new therapies that have made such dramatic improvements in the treatment for other cancer types, such as immunotherapies, have been disappointingly unsuccessful in pancreatic cancer. The result is that pancreatic cancer is rising in the causes of cancer deaths and is expected to become the second highest cause within five years. Current treatments for pancreatic cancer include surgery or cytotoxic drug cocktails, but neither are without problems.

As many pancreatic cancer patients are over 60, they are often too frail to be considered for the extensive surgery needed to remove affected tissues if the tumour has spread. The cytotoxic drug cocktails are very aggressive, and few patients experience valuable extension of good quality life. There is a pressing need, therefore, for novel treatments for pancreatic cancer.

A group of scientists in the University of Sheffield have made discoveries that suggest new ways to treat pancreatic and other cancers, based on a drug they have invented which blocks one of two types of receptors for the hormone adrenomedullin. AM is important because it controls blood pressure by dilating blood vessels all over the body. If its actions are blocked, blood pressure rises rapidly, and this would be dangerous to patients. However, most tumours secrete AM and it has powerful effects which help tumours to grow and survive.

First, AM signals between tumour cells to increase their growth rate and lifespan. The AM released from tumours also affects cells in the patient, increasing blood vessel growth to supply oxygen and nutrients to the tumour and helping it to evade host defence mechanisms. This happens because AM alters immune cell responses to tumours so that tumour cells are not killed. Finally, it stimulates the formation of a tough fibrous matrix around tumour cells which makes it hard for drug molecules to get to and kill them.



Together with my colleagues, professor Joe Harrity and Dr Gareth Richards from the University of Sheffield, I have been working on AM for several years. There are two different receptors for the hormone on cells and the AM1 adrenomedullin receptor controls its normal functions in regulating blood pressure, while the AM2 receptor is responsible for functions in cancer. We worked with experts in medicinal chemistry and molecular modelling from industry to develop "first in class" drugs that block the functions of the AM2 receptor, without altering AM1 receptor function. With £5 million of support from the Wellcome Trust's Seeding Drug Discovery committee, our team designed and made more than 1,000 different molecules in order to identify compounds that are suitable for use as drugs.

The results are very encouraging. Studies of human pancreatic cancer growth in mice suggest that the drugs slow tumour growth dramatically and alter the nature of the tumour mass to make it more susceptible to host defences and other drug treatments. Unlike cytotoxic drugs, these molecules are very specific and appear to have a low likelihood of causing side effects at even high doses.

The University of Sheffield has now formed a spinout company Modulus Oncology, with partners from the Edinburgh-based oncology drug incubator company Cumulus Oncology to take the new compounds forward. Dr Alan Wise and Dr Clare Waring, scientist entrepreneurs from Cumulus have a long experience of successful drug development. Together with Sheffield scientists and internationally recognised medical experts in cancer treatment and drug development, professors Glen Clack and Andrew Biankin, they lead Modulus Oncology.

Modulus Oncology is seeking investment in order to make enough drugs for legally required safety testing (CTA/IND approval) before embarking on clinical trials in humans. Pancreatic cancer is one of a small number of cancers being considered for the first trials, and in addition to the regulatory approval studies, the company will perform further research to identify specific groups of pancreatic cancer patients who would be most likely to benefit from the AM2 receptor antagonist drugs.

As a "first in class" drug, AM2 receptor antagonists offer a new and potentially important way to treat cancers and extend the lives of patients with pancreatic cancer.

As cases of pancreatic cancer continue to increase worldwide there has never been a more appropriate time for a new treatment. The invention of a new drug molecule is just the first step in a long process, from bench to bedside. However, this new development could lead the way for a treatment for pancreatic cancer patients worldwide.

The writer is professor, department of oncology and metabolism, University of Sheffield, UK, and co-founder and chief scientific officer, Modulus Oncology