



Shadow that brightens

THE SEARCH FOR PLANETS OUTSIDE THE SOLAR SYSTEM IS SET TO FOLLOW A NEW PATH, WRITES S ANANTHANARAYANAN

he methods used to detect planets around distant stars were effective mainly with those that were fairly close to the parent stars and this was not a disadvantage because it was felt that it was the "earth-like" planets that would be in closer orbits that we were interested in. But being confined to inner orbits left us "in the dark" about a swarm of planets at greater distances and, hence, a great part of the population of the near cosmos.

The instrumentation on board Kepler, the exoplanet-detecting satellite that has been following the earth in orbit around the sun since 2009, and also earth-based stations have notched up a score of more than 5,000 candidate planets using a technique of measuring a slight *drop* in intensity when a near-orbit planet moves across the face of a star. The same facility has now been readied to do the reverse — detect a *spurt* in the intensity when a distant-orbit, or free-floating planet moves past!

The difficulty in detecting planets, especially outside the Solar System, is that they have no light of their own and only reflect the light of their sun. We can detect this reflected light from nearby planets when it is nighttime and the sun is behind our backs. But with planets of distant stars, the dim reflected light is lost in the glare of the star and distant planets cannot be seen in telescopes.

The way distant planets, known as exoplanets, were first detected is by the slight movement of the parent star, which is caused by the orbiting of a planet. This movement of the star, for the same reason that the whistle of a train engine that rushes past is shrill at first and then falls to lower pitch, causes a slight rise and fall of the frequency of light emitted by the star. The change in frequency can be detected on the earth and this helps work out what kind of planet it is that has caused the motion of the star. One can imagine that the movement and, hence, the change in frequency would be greater with planets that are in near orbits and moved fast and it is planets of this kind that were mostly detected by this method. But with advances in sensitivity of detection of the intensity of light coming from stars, another method was developed, based on the very small but definite blocking of light when a planet crossed the path of light coming to us from a



And along with the telescope, there is an arrangement to send images back to earth by wireless, gyro-wheels to make small adjustments of orientation and solar panels to provide power. The craft is launched to orbit the sun, like the

Kepler's brightness-sensing capacity in a new mission known as K2, or "second life", and Kepler continued on its exoplanet detecting spree. It is now set to join with other earth-based observatories in a three-month intense hunt for exoplanets that are in outer orbits of host stars and also a category of "free floating" planets wandering in the central region of the Milky Way. These are also important components of the universe and there is some evidence to suggest that there are more of such bodies than stars in our galaxy!

Gravitational lensing

Planets that are at a distance from a parent star block less of the light emitted by the star than planets that are in near-orbits. Distant planets thus cause very little "dimming" of starlight, which cannot be detected by the Kepler photometers. But stars at a distance bring about another effect that makes them detectable, not because of "dimming" but because they act like a magnifying glass and result in a "brightening" of starlight.

Objects like planets that have mass, exert the force of gravity that has been interpreted as being, in fact, an effect on the structure of space itself. It is this distortion of space by an object that other objects with mass sense as the force of gravity of the first object, and so on. Distortion of space also leads to bending of the path of light. This effect was a major prediction of the General Theory of Relativity and was verified during a total solar eclipse, when stars that should have been hidden by the sun's disc came into view as a result of light being bent while passing the sun.

In the same way, a massive planet in the path of light from a star would have the effect of bending the rays of light, so that light could be concentrated and, hence, more intense at a point further away. The effect would be more discernable in the case of planets at greater distances from stars, as the bending is slight; in fact, it is known as "micro-lensing" and the effect is more marked if the cone of light passing the planet is narrow.

As Kepler has sensitive photometers that con-

PLUS POINTS

Green energy drop

Developing countries that already have a high share of renewable energy in their



unlikely to increase the flow due to the skyrocketing demand for cheap

electricity, according to a study by the International Renewable Energy Agency (Irena). It says many developing countries made huge strides towards deploying renewable technologies over the past decade, but this rise is now levelling off. Instead, these countries are turning towards fossil fuels to meet their energy demands.

Nicholas Wagner, an Iirena programme officer who helped prepare the report, says countries like Brazil, Ethiopia, Kenya and Nigeria "have a high share of renewable biomass as part of their energy portfolios, which is fine", but instead of focusing on increasing this, these countries have turned to fossil fuels to power greater demand for heating, cooling and transport.

Renewables formed nearly 50 per cent of Indonesia's energy mix in 2000, but this dropped to under 40 per cent by 2013, the report found. China, India and Mexico have also seen their renewable share fall over this period. Globally, the share of renewables in the energy mix has slightly risen over the past decade, the report, published last month, found. In 2015, a total of 150 gigawatts of additional renewable energy was installed around the world, the largest annual amount yet.

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Pet scans

star. This kind of detection is many times more sensitive when carried out from outside the scattering effects of the earth's atmosphere, and this is what the Kepler space telescope was sent up to do.

Kepler

The Kepler Space Observatory, which was launched in 2009, is a 15-foot by nine-foot craft consisting essentially of a photometer telescope, which can continuously monitor the brightness of 145,000 stars in a fixed direction.



MOLECULAR MECHANISMS

THE REGULATION OF CELL CYCLE VARIES AMONG DIFFERENT CELL TYPES, SAYS TAPAN KUMAR MAITRA

typical eukaryotic cell cycle comprises Gl, S, G2 and M phases following each other in orderly progression. Such a pattern is often the case, particularly in growing organisms or in cultured cells that have not run out of nutrients or space. But many variations are also possible, especially in the overall length of the cycle, the relative length of time spent in various phases of the cycle and the immediacy with which mitosis and cytokinesis are coupled. This variability tells us that the cell cycle must somehow be regulated to meet the needs of a particular cell type or species. The molecular basis of this regulation is a subject of intense interest, not only for understanding the life cycles of normal cells but also for understanding how cancer cells manage to escape normal control mechanisms. Currently one of the most active areas of biological research, cell cycle regulation is beginning to reveal its underlying molecular mechanisms.

Some of the most commonly encountered variations in the cell cycle involve differences in generation time. In multi-cellular organisms, generation times vary markedly among cell types, depending on their role in the organism. Some cells the inner lining of body organs such as the lungs and intestines. Human stem cells may have generation times as short as eight hours.

In contrast, cells of slow-growing tissues may have generation times of several days or more and some cells, such as those of mature nerve or muscle tissue, do not divide at all. Still other cell types do not divide under normal conditions but can be induced to begin dividing again by an appropriate stimulus. Liver cells are in this category; they do not normally proliferate in the mature liver but can be induced to do so if a portion of the liver is removed surgically.

Lymphocytes (white blood cells) are another example; when exposed to a foreign protein, they begin dividing as part of the immune response. Most of these variations in generation time are based on differences in G1, although S and G2 can also vary somewhat. Cells that divide very slowly may spend days, months or even years in the offshoot of G1 called G0, whereas cells that divide very rapidly have a short G1 phase or even eliminate G1 entirely. The embryonic cells of insects, amphibians and several other non-mammalian animals are dramatic examples of cells that have

very short cell cycles, with no G1 phase and a very short S phase. For example, during early

earth, and is positioned just behind the earth, with the distance increasing gradually, as Kepler moves slightly slower that the earth. And the craft is oriented so that sunlight does not enter the telescope, but only starlight from the most suitable direction. The huge mass of data that is transmitted to earth is then analysed by computer algorithms to find the patterns that indicate a planet, and also by human volunteer researchers, to pick up instances the computers may miss.

But in 2012, Kepler lost one of its four position-adjusting devices and another one in 2013. It did look like many planned mission objectives may need to be dropped. But with great ingenuity, making use of the pressure of light on the solar panels, it has now become possible to change Kepler's orientation, nevertheless, as it goes around the sun. The National Aeronautics and Space Administration has, hence, pressed

tinuously scan stars in a fixed field of view, it would be able to detect a possible exoplanet as soon as there is a rise in the intensity and alert an array of earth-based observatories. Simultaneous observation from a number of places would help confirm that it is a case of an exoplanet and as Kepler is 160 million km away, it would be possible to fix an exoplanet's distance and position.

Starting this month, K2 and some 50 earthbased observatories in five continents are carrying out a survey called *Campaign 9* to monitory a region of space near the centre of the Milky Way to look for earth-sized planets in orbit at long distances from their parent stars, or, in some cases, not even orbiting a star. Over the 80-odd days of the campaign, over 100 lensing events are expected, with about 10 per cent showing the characteristics of exoplanets in an unexplored part of space.

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Cracking hallucinogenic secrets BY BREAKING DOWN PARTS OF

• n a pioneering and controversial new study scientists have claimed that LSD makes the L brain more "complete". The drug, they say, breaks down the parts of the brain that usually separate different functions like vision and movement, creating a more "integrated or unified brain". They also found that people who have drug-induced hallucinations "see" with various other parts of their brain, not just the visual cortex that is active in normal vision.

Those effects might account for the religious feelings people often report after having taken the drug, the researchers say — a claim that, if true, could answer some of the deepest questions of drug culture. And those same effects on a person's wellbeing might carry on long after the effects of the drug have worn off.

"Normally, our brain consists of independent networks that perform separate specialised func-

THE BRAIN THAT ARE USUALLY SEPARATE, DRUGS LIKE LSD **RETURN US TO A CHILDLIKE** STATE \sim AND THE 'WELLBEING' COULD LAST LONG AFTER THE EFFECTS HAVE WORN OFF. **ANDREW GRIFFIN** REPORTS

embles the state our brains were in when we were infants: free and unconstrained. This also makes sense when we consider the hyper-emotional and imaginative nature of an infant's mind," said Dr Carhart-Harris.'

> And those effects could be even further encouraged with the use of music, according to results from the same study, which was published in the journal European Neuropsychopharmacology. Listening to music while under the influence of the drug led the visual cortex to receive information from the part of the brain that usually deals with mental images and memory — and the more it did so, the more people reported seeing complex visions, including those from earlier in their lives. Former government drugs adviser Professor David Nutt, director of neuropsychopharmacology at Impe-

> > rial College and one of the

project's senior researchers, said, "Scientists

have waited 50 years for this moment — the

revealing of how LSD alters our brain biology.

For the first time we can really see what's hap-

pening in the brain during the psychedelic state,

and can better understand why LSD had such a

profound impact on self-awareness in users and

on music and art. This could have great im-

plications for psychiatry and helping patients

Professor Nutt was removed from his job as

the chair of the government's drug advisory coun-

cil in 2009, after he said that drugs including

ecstasy and LSD were less harmful than alcohol

The new findings could prove similarly con-

troversial, with some involved in the study sug-

gesting that they could show how LSD could be

used for healing and for finding new forms of

knowledge. Eventually they might be used to

treat psychiatric disorders and allow research-

ers to treat conditions such as depression and

addiction, which tend to arise from entrenched

overcome conditions such as depression."

and tobacco.

thought patterns.

The vast majority of novel anti-cancer compounds that show promise in laboratory studies and in animal models do not make it through the rigorous and



challenging translational path necessary for approval by

the US Food and Drug Administration. Multiple factors contribute to the extremely low rate of successful drug development, including unexpected toxicity and/or lack of efficacy in humans, after a candidate compound has shown promise in rodent studies. As a result, researchers have begun to develop more accurate and more predictive model systems, such as genetically engineered murine models or patient-derived xenograft models. But there may be another solution to this translational problem: comparative oncology.

Studying tumor development and treatment in dogs and cats, in parallel with research on rodents and humans, could improve the successful translation of new cancer drugs. This study provides a unique opportunity for the scientific community to improve the drugdevelopment pathway, specifically through the inclusion of pet dogs and cats with naturally occurring cancers. Evaluation of novel agents in such pet animals can provide valuable information regarding drug metabolism, toxicity, pharmacokinetics, pharmacodynamics, efficacy and biomarker discovery in the context of mammalian species more similar in physiology and body size to humans.

In addition, companion animals develop cancers spontaneously under normal immune surveillance mechanisms, which more faithfully recapitulate the multi-step progression that occurs in people. Therefore, studying canine and feline models of cancer can generate valuable safety and efficacy data to support the further development of novel therapies. Over the past decade, the promise of such an approach for improving drug development has driven substantial growth in the discipline of comparative oncology. Of the 30 accredited US veterinary colleges, approximately 80 per cent now support laboratory and clinical research in medical, surgical, and radiation oncology, providing a rich foundation for a comparative approach.

THE SCIENTIST

Inflatable room

SpaceX has delivered an inflatable

International Space Station. The soft

compartment is the first of its kind to go

bedroom for astronauts to the



Amphibian eggs are very large, with enough cytoplasm to sustain many rounds of cell division after fertilisation. Each round of division during early development parcels the cytoplasm into smaller cells.

divide rapidly and continuously throughout the life of the organism as a means of replacing cells that are continually being lost or destroyed. Included in this category are cells involved in sperm formation and the *stem cells* that give rise to blood cells, skin cells and the epithelial cells that form



Under these conditions, the S phase is completed in less than three minutes, at least 100 times faster than in adult tissues. The rapid rate of DNA synthesis needed to sustain such a quick cell cycle is possible because the total number of replicons is increased, thereby decreasing the amount of DNA that each replicon must synthesise. Moreover, all replicons are activated at the same time, in contrast to the sequential activation observed in adult tissues.

In addition, these embryonic cells have little or no need to synthesise components other than DNA because the fertilised egg is a very large cell with enough cytoplasm to sustain many rounds of cell division. Each round of division subdivides the initial cytoplasm into smaller and smaller cells, until the cell size characteristic of adult tissues is reached. This means that cell growth need not be part of the cell cycle. As a result, not only is G1 lacking but G2 is also quite short, allowing cells to go almost directly from DNA synthesis to mitosis and back to DNA synthesis. In fact, S phase begins even before mitosis is complete.

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LSD tabs with a design on - each are roughly the size of a postage stamp.

tions, such as vision, movement and hearing as well as more complex things like attention," said Robin Carhart-Harris, who led the research and is the first scientist in 40 years to test LSD on humans. "However, under LSD the separateness of these networks breaks down and instead you see a more integrated or unified brain. Our results suggest that this effect underlies the profound altered state of consciousness that people often describe during an LSD experience. It is also related to what people sometimes call 'egodissolution', which means the normal sense of self is broken down and replaced by a sense of reconnection with themselves, others and the natural world.

"This experience is sometimes framed in a religious or spiritual way — and seems to be associated with improvements in well-being after the drug's effects have subsided," he said.

By breaking down the constraints that usually keep parts of the brain separate, psychedelic drugs return their users back to a state that is more like childhood, the researchers said in work published in the Proceedings of the National Academy of Sciences.

"In many ways, the brain in the LSD state res-





into space but it could be far from the last: its makers hope it will allow for inflatable habits on Mars, revolutionising the way astronauts live on space.

The company that made the small room, Bigelow Aerospace, hopes that within four years it can launch inflatable space stations made with the same technology that can then be leased out to commercial companies. The Bigelow Expandable Activity Module is able to be packed into much smaller spaces than traditional habitats. The room that went up to the ISS was packed tightly — but when it is blown up it will be as big as a small bedroom.

The inflatable room arrived on a SpaceX Dragon cargo ship that arrived at the ISS over the weekend. It was grabbed by a robotic arm on board the station. It will soon be attached to the space station, before it gets inflated in May. But it will mostly be left untouched by the six-man ISS crew while it is being tested, apart from occasional trips to take measurements and swap sensors.

THE INDEPENDENT





THE INDEPENDENT