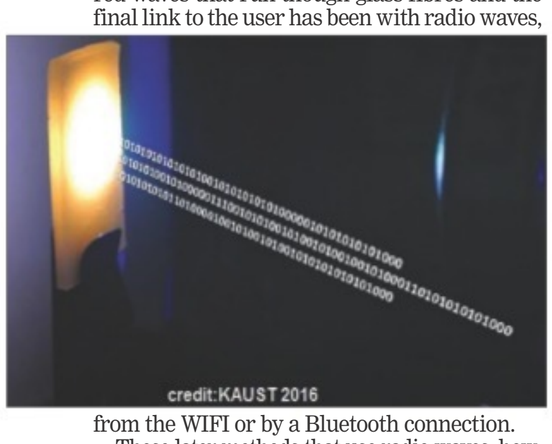
The reading light is also the message

ROOM LIGHTING MAY NOW DOUBLE AS A HIGH-CAPACITY WIFI TRANSMITTER, WRITES **S ANANTHANARAYANAN**

Light waves have long been used to carry information and light itself was first used at the lighthouse, in signal flares or the Morse flasher, and then invisible light was used as radio waves. While telephony got started with electrical signals, speech and data are now carried by infrared waves that run though glass fibres and the final link to the user has been with radio waves,

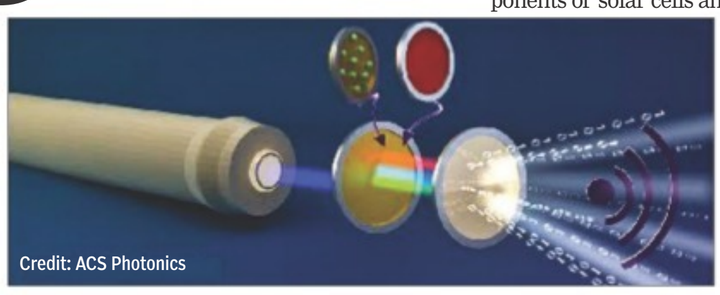


from the WIFI or by a Bluetooth connection.

These later methods that use radio waves, however, may not be good enough for coming demands for transferring images and large data. This is both because of limitations on the amount of data that can be passed on with the wavelengths used and also because radio waves are used for communications and only a limited range is available for computers and related devices. This apart, there are advantages if white light that is used for data transfer comes from the same sources as general room lighting.

Ibrahim Dursun, Chao Shen, Manas R Parida, Jun Pan, Smritakshi P Sarmah, Davide Priante, Noktan Alyami, Jiakai Liu, Makhsud I Saidaminov, Mohd S Alias, Ahmed L Abdelhady, Tien Khee Ng, Omar F Mohammed, Boon S Ooi and Osman M Bakr at the King Abdullah University of Science and Technology, at Thuwal, Kingdom of Saudi Arabia, report in the American Chemical Society journal, *ACS Photonics*, a development that overcomes limitations of existing lighting devices for use in data transfer.

The current technology of lighting that can be integrated with electronics is the *Light Emitting Diode*, wherein semiconductors, the material of transistors, have free electrons and also spaces called "holes" that "lack an electron" and which are kept apart. But when a voltage is applied, electrons rush to fall into holes and in the process they give off a flash of light. As LEDs can be switched on an off at a very fast rate, the flashes can be used to transmit large data in binary format. As the high-speed switching cannot be made out by the human eye, the LED can be used for illumination at the same time.


Credit: ACS Photonics

The trouble, however, is that LED light is of a specific colour and the illumination is not by white light.

A solution for general lighting use was to use a trio of LEDs, emitting in the primary colours. This led to the field of *Solid State Lighting* and also allows the LED to be used in displays, like full colour TV screens. For use for data transfer, where the light needs to be switched on an off, however, it is necessary that the light comes from the same source and not from three different LEDs. This, or *Visible Light Communication*, has been attained with the most recently developed blue light LED, or laser diodes, which are used along with materials that convert blue light into green and red, or yellow, to shine together as white light. The problem, however, has been that these colour-converting materials, which are called *phosphors*, are not fast enough for complementary colours to change as soon as the blue LED is switched on or off. The time taken, the KAUST paper says, is of the order of microseconds, or millionths of a second, and the switching of the white light for data transfer in existing VLC cannot be faster than three to 12 million times a second. Alternate colour converters that have been developed do allow speeds of 40 to 200 million cycles a second, but this still falls short of what is needed, the authors say.


Osman M Bakr and Boon S Ooi

Perovskites

They, hence, studied the properties of a class of materials called *perovskites*, a mineral variety with a particular generic structure, of an atom that has three outer shell electrons, one that has four and one that has two. These materials have most interesting electrical and optical properties and have become important components of solar cells and may take the place of silicon in some applications. The make-up of these materials can be arranged so that they have emission of light at specific frequencies, the authors say. They are also low cost and easily worked with at reasonably low temperatures, they say. Nanocrystals of one kind of perovskite, which contains cesium, lead and bromine atoms, they say, have a very high luminescent yield and the flash has a very short lifetime. These qualities have made the material useful in displays and for creating sources of white light.

The researchers studied the possibility of this material being used in VLC applications, side by side with being a white light source for SSL devices. They find, the papers says, that the material has excellent colour rendering capacity and also reacts very fast, in a time frame of seven billionths of a second, which makes for colour converting frequency of 491 million cycles a second. This is 40 times higher than the frequency of some 12.4 million cycles a second which is currently available.

The amount of data that can be carried over a channel that has a given range of frequency is dependent on the manner of coding that is used to represent the data, like binary, which is "on-off" or "phase shifting", which can double the data rate. The trials conducted with the lead and bromine containing perovskites showed that the data rate could go as high as two gigabits, or two billion units of information, which amounts to 125 million characters of text, every second.

Apart from this significantly higher data-carrying capacity, the emission is bright, white light, which can be used for home or office lighting. The white light from the switched LEDs, unlike light from incandescent lamps, is not continuous nor, like the fluorescent lamp, with a steady flicker at the frequency of alternating power supply. Instead, the light has a flicker in nanoseconds and the pattern of flicker carries exact information of data being transmitted. Optical sensors within the area that is lighted can hence pick up the data. With a capacity of two gigabits a second, different sets of data, meant for different devices, can be sent out at the same time, a versatility that a WIFI transmitter or a single Bluetooth device does not have.

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Bluetooth

Bluetooth is a convention of data transfer frequency and format that is designed for different classes of devices to communicate at the same time. The characteristic is that a specific range of frequencies is used and the manner, or format of data transmission, how the "0"s and "1"s would be spaced and how errors would be detected, is specified. When Bluetooth devices agree to communicate, they exchange information of a random way of switching from one frequency to another, out of the 79 slots into which the range has been divided, and they change frequency 1,600 times a second. The signal from a device can hence be read only by another device that "hops frequencies" at the same rate as the first device, and many pairs of devices can be in action at the same time. The technology thus represents a specification that manufacturers of different devices could agree upon to allow a variety of devices to work together, without the need for the exercise of "configuring". The standard was first agreed upon by Denmark, Norway, Sweden and Finland and was named after Harald Bluetooth, a 10th century ruler of Denmark who had first imagined a unified European state.

PLUS POINTS

New man-made epoch

Earth has entered a new epoch dubbed the Anthropocene because of the extent of humanity's impact on the planet, according to a group of experts. An international working group set up to consider the question voted by 34-0, with one abstention, that the Anthropocene was real in a geological sense. The warming temperature, higher sea levels, ash from fossil fuels, plastic waste, a dramatic increase in erosion, the spread of animal species around the world and radioactive particles left around from nuclear bomb tests would all contribute to permanent changes in the earth's rocks, the scientists said.

They are still considering what date should be chosen for the so-called "Golden Spike" -- a line in the rock the marks the boundary between the Holocene and Anthropocene epochs, but believe it should be in the mid-20th century. The announcement was made at the 35th International Geological Congress in South Africa. Their recommendation would have to be agreed by the International Union of Geological Sciences in order to be formally declared and enter textbooks.

A statement issued by Leicester University about the working group's "provisional recommendation" said, "The Anthropocene concept… is geologically real. The phenomenon is of sufficient scale to be considered as part of the International Chronostratigraphic Chart, more commonly known as the Geological Time Scale."

Dr Colin Waters, secretary of the Anthropocene working group, earlier this month compared the changes made by humans on earth to the end of the last Ice Age some 11,500 years ago, the start of the Holocene epoch. "In the last century we have had such a huge impact that we're actually taking the planet away from that natural (climate) oscillation and changing the trend for global temperatures from what should have been a cooling trend to a warming trend," he said.

THE INDEPENDENT

Radio technology

A team of US researchers has introduced a new radio technology that allows small mobile devices such as fitness trackers and smartwatches to take advantage of battery power in larger devices nearby for communication. Dubbed Braidio for "braid of radios", the technology can extend battery life hundreds of times in some cases, they said.

Technologies like Braidio opened up a new way of thinking about the design of mobile and wearable devices, said Deepak Ganesan, a professor at the University of Massachusetts,Amherst, and research team leader. "Wearable devices are often bulky due to large batteries needed for adequate battery life. Perhaps such energy offload techniques can reverse this trend and enable thinner and lighter devices."

To develop the new technology, the researchers embellished Bluetooth, a commonly-used radio technology, with the ability to operate in a similar manner to Radio-Frequency Identification, which operates asymmetrically. Braidio operates like a standard Bluetooth radio when a device has sufficient energy, but operates like Radio-Frequency Identification when energy is low, offloading energy use to a device with a larger battery when needed. So when a smartwatch and smartphone are equipped with Braidios, they can work together to proportionally share the energy consumed for communication, they explained.

Making sense

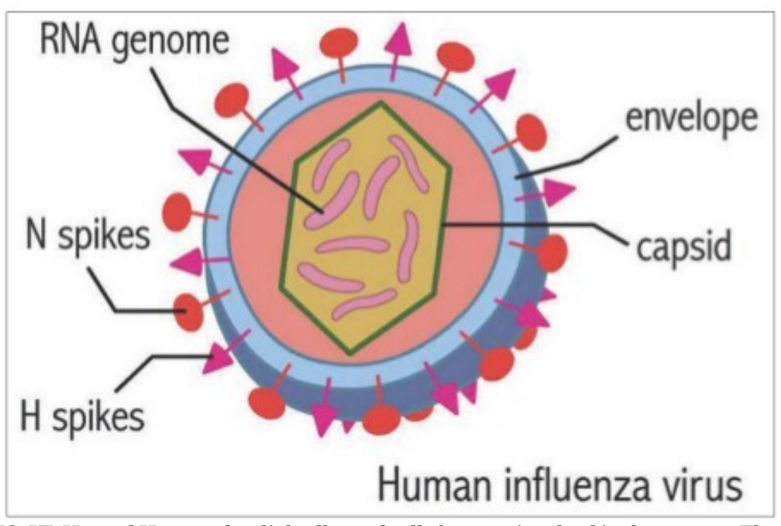
On 26 August, Mahindra and Mahindra Ltd announced the launch of their DiGiSENSE, a revolutionary technology solution that connects Mahindra vehicles, tractors, trucks and construction equipment to the cloud, opening up a whole new dimension to the experience of vehicle ownership. This technology, which is digitally-enabled sensing, makes the company the first in India to integrate its product line-up onto a cloud-based platform.

Fleet operators, drivers, dealers and service teams can access vital information about their vehicles, trucks, tractors or construction equipment on a real time basis from the driver's seat and afar. In fact, customers will be empowered to digitally build knowledge 24x7 about the performance and location of their vehicles.

VIRAL INFECTIONS

TAPAN KUMAR MAITRA EXPLAINS HOW THE INFLUENZA VIRUS PROLIFERATES AND THE WAYS IN WHICH IT CAN BE TREATED

The viral aetiology of type A influenza was ascertained in 1933 by W Smith, C Andrewes and P Laidlaw. They proved that filtered nasopharyngeal washings obtained from influenza patients in the early stages of the disease were infective. T Francis and T Magill discovered the virus of type B influenza in 1940 while type C was discovered in 1947 by R Taylor. Influenza viruses are spherical or oval in shape and have a diameter of 80-120 nm. The nucleocapsid is formed of a ribonucleoprotein helix enclosed in an outer lipid-carbo-hydrate-protein membrane. The virus is composed of single-stranded RNA, protein, lipids, and carbohydrates.



The viral proteins comprise seven different polypeptides. Four of them are joined to the nucleocapsid and three to the outer membrane. Haemagglutinin and neuraminidase that are included in the membrane differ from each other not only structurally but also with respect to antigenic and functional properties. Human influenza viruses have four haemagglutinin subtypes — HO, HI, H2, and H3 — and two neuraminidase subtypes (Nl and N2).

Coming to the structure, influenza viruses have two antigens — the S-antigen, which is connected with the nucleocapsid and is common to all types, and the V-antigen, a haemagglutinin that determines the type and strain-specificity of the virus.

The principal role in immunity belongs to haemagglutinin and nauraminidase, which are proteins located in the viral membrane — they undergo essential changes. It has been shown that during different epidemics the haemagglutinin and neuraminidase of the same type of virus have different antigenic properties. This is taken into account in designating the strains of the viruses and reflects the main stages of its evolution.

For instance, the influenza virus isolated in 1933 was classed as type A (HON1). In 1947 a pandemia was caused by virus A (H1N1), in 1957 by A (Singapore) (H2N1) and in 1968 by A (Hong Kong) (H3N2).

Such changes in antigenic structure are characteristic of type A influenza virus and are encountered every two to four years. Change in the antigenic variants of type B occurs less sharply at intervals of 10 to 20 years while type C is distinguished by marked constancy of antigenic structure.

The virus remains viable in a dried state and at low temperatures for quite long periods. It withstands exposure to glycerin, in which it retains its activity for three months. It is, however, very sensitive to drying and is rapidly destroyed in both alkaline and acid media. It is readily inactivated by all disinfectants -- chlorinated lime, chloramines and formalin among others such. Ultraviolet irradiation and supersonic vibration are destructive to the virus.

Having entered the body of a susceptible individual by the nasopharynx, the virus penetrates the cells of the surface epithelial layer of the upper respiratory tract mucosa. It is strictly pneumotropic and multiplies only in the cells of the respiratory tract epithelium. As the virus multiplies and the infection develops, the trachea, bronchi, bronchioli, and alveolar epithelial cells gradually become involved in the process. The injured ciliated epithelium loses its cilia and as a result becomes deprived of its defence function. It serves as a favourable medium for the penetration of secondary bacterial flora (streptococci, staphylococci, H influenzae, et al) which give rise to complications (bronchitis, pneumonia, pleuritis, encephalitis, influenzal meningitis). In addition, influenza activates chronic conditions (tuberculosis) and significantly lowers immunity to a number of infections.

Immunity is associated with the presence of virucidal and virus-neutralising antibodies. The condition of the throat is also of importance. The labile antibodies are the most active — they are produced relatively quickly in high titres in influenza patients. Interferon, which is capable of inhibiting the multiplication of the virus, plays a definite role in conferring immunity to influenza. It is also present in a healthy body but in small numbers. The number of interferons greatly increases in the presence of the influenza virus. Reproduction of artificial immunity with live vaccine not only gives rise to the accumulation of antibodies but also blocks sensitive cells and interferes with the natural influenza virus.

Complications caused by bacterial microflora are prevented by antibiotics (penicillin and chloramphenicol) given in association with sulphonamides.

Treatment with preparations of interferon and gamma globulin obtained from the immunised blood of donors has produced favourable results.

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'Ghost galaxy' of dark matter

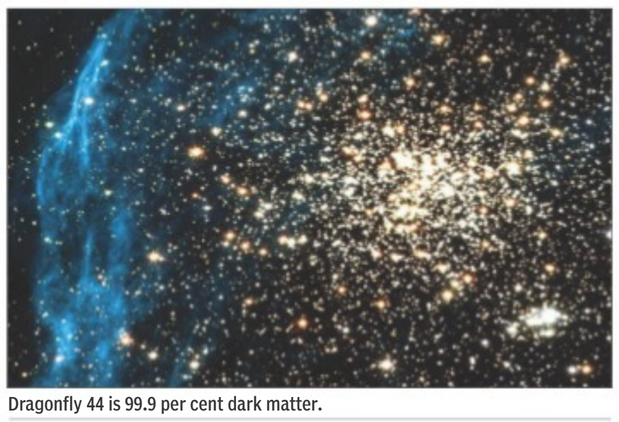
NOBODY KNOWS HOW SUCH A STRANGE, INVISIBLE BUT HUGE THING COULD HAVE FORMED, WRITES **ANDREW GRIFFIN**

Scientists have found Dragonfly 44, a "ghost" galaxy roughly the same mass as our own, but almost entirely made up of dark matter, the mysterious — and for now mostly theoretical — stuff that makes up 27 per cent of the universe but has never actually been seen.

Though the galaxy is relatively nearby, at least in the scale of the universe, it is so dark that scientists completely missed it for decades. But it was finally spotted last year, in the Coma galaxy cluster, about 330 million light years from us. When scientists looked at it further, they found that it was not just a normal set of stars -- though it has about the same mass as our own Milky Way galaxy, only one-hundredth of one per cent is made of up of the normal matter, like stars, dust and gas that surrounds us. Rather, it is 99.99 per cent made up of dark matter and nobody knows what exactly that is, how it came about -- or even how a galaxy could have arisen that looked that way.

Dragonfly 44 does have some normal stars of its own, but our galaxy has a hundred times more stars than are there. Astronomers found out about the strange ghost galaxy by looking at the movement of its stars — movement that seemed to be influenced by matter that doesn't by normal measures exist.

Professor Pieter van Dokkum, a member of the team from Yale University in the USA, said, "Motions of the stars tell you how much matter there is. They don't care what form the matter is, they just tell you that it's there. In the Dragonfly galaxy, stars move very fast. So there was a huge discrepancy. We found many times more mass indicated by the motions of the stars than there is mass in the stars themselves."


Dragonfly 44 is 99.9 per cent dark matter.

Scientists know that there must be something providing the gravity that is needed to hold the galaxy together. But the mass that would normally provide that isn't there. Researchers from the Keck Observatory in Hawaii found the galaxy, and reported their findings in the Astrophysical Journal Letters. They said that there may be many more of the strange, ghost galaxies waiting to be found.

Co-author Professor Roberto Abraham, from the University of Toronto in Canada, said, "We have no idea how galaxies like Dragonfly 44 could have formed. The... data show that a relatively large fraction of the stars is in the form of very compact clusters, and that is probably an important clue. But at the moment we're just guessing."

Dark matter remains perhaps the biggest mystery of the universe. While scientists know that it must exist — the calculations that account for the make-up of the universe require it — we've never actually seen it, and attempts to do so have failed. But the discovery could let us finally find more about the mysterious stuff that surrounds us.

"Ultimately, what we really want to learn is what dark matter is," said Dr Van Dokkum. "The race is on to find massive dark galaxies that are even closer to us than Dragonfly 44, so we can look for feeble signals that may reveal a dark matter particle."

Only five per cent of the interchangeable mass energy of the universe is made up of the kind of normal matter that we can see and touch. Dark matter makes up a large part of the rest. Despite the fact that it constitutes 27 per cent of the universe, it doesn't reflect light and can't be seen by any means so far. Experiments to understand it usually require doing so through other means — but even they have often failed.

The remaining part of the universe is made up of something even more confusing. Dark energy makes up 68 per cent of the universe, and is a kind of anti-gravitational force that is pushing galaxies apart, more and more quickly.

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