VIGYAN PRASAR

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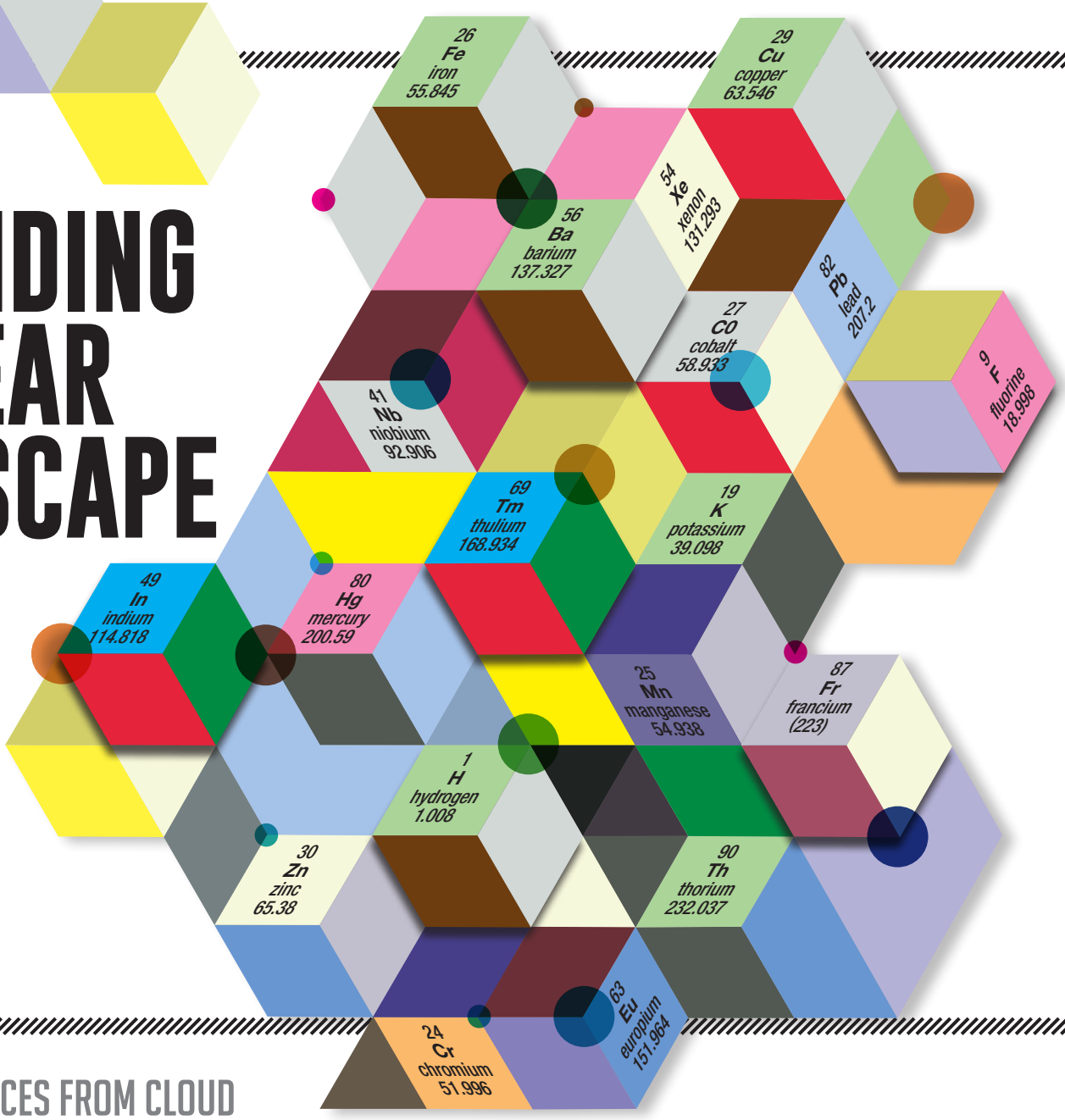
THE EXPANDING NUCLEAR LANDSCAPE



UNSDG GOAL 2: ZERO HUNGER ROLE OF SCIENCE & TECHNOLOGY IN ACHIEVING IT

RAINING OF SERVICES FROM CLOUD

VIGYAN PRASAR'S NEW RADIO SERIAL ON ARTIFICIAL INTELLIGENCE, AANE WALA KAL

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MY WORD

NAKUL PARASHAR

Communicating Science, Popularising Science

COME February, and we all remember Sir CV Raman for having discovered the Raman Effect on 28 February 1928. Indeed, it was a proud moment for all of us that got India its first Nobel Prize in Physics in 1930. Such a feat deserves to be remembered annually. That is whence in 1987, the first National Science Day was celebrated all across the nation. Kudos to the National Council for Science and Technology Communication of the Department of Science and Technology, Government of India. The Council stepped forward to establish this day as National Science Day. A number of programmes are organised all over the country to celebrate our country's rich scientific lineage. This day also recognises individuals or institutions-those who have done remarkable work in the area of science and technology communication, popularisation, and extension.

Interestingly, the draft of STIP 2020 (Science Technology Innovation Policy 2020) also talks about science and technology communication, popularisation and extension in the country. It emphasises Science Communication and Public Engagement and on capacity building and research, outreach, and mainstreaming science communication. The draft mentions that creative and cross-disciplinary platforms of science communication will be promoted to enable dialogue and knowledge transfer between researchers, science communicators, and the public. It also mentions that community-centric programmes and regional science centres will be encouraged to promote science communication in regional languages with local and hyper-local contexts for last-mile connectivity. During past two years, Vigyan Prasar has been organising several activities on Indian languages like Urdu, Bangla, Tamil, Kannada, Gujarati and Marathi. In 2021, we would expand our base into Assamese, Oriya, Maithili, Telugu, Punjabi, Malayalam, and Nepali. Besides, monthly newsletters in Gujarati and Marathi have been duly planned and they shall be published shortly.

The STIP 2020 draft also talks about facilitation of the publicly accessible, constantly updated and searchable databases of science communication-related resources and opportunities for the common man. Vigyan Prasar maintains a huge repository of resources on science communication, popularisation and extension. One can access this repository through the Vigyan Prasar website.

The draft STIP 2020 has a reference to the national policy on SSR (Scientific Social Responsibility), where scientists and researchers would be motivated and incentivized to engage in science communication. Vigyan Prasar in its 32 years of existence has worked relentlessly in this direction. While the Draft talks about earmarking a percentage of SSR fund for science communication and public engagement activities, Vigyan Prasar's entire focus has been on the same since its inception.

Science communication, popularisation and extension is a highly sought-after domain in every S&T policy and national-level decision-making.

Vigyan Prasar is the only government organisational interface between, society, scientists, media and policymakers. It was created to fulfil the constitutional mandate under Article 51 A(h) of the Indian Constitution, namely scientific temper and spirit of enquiry.

The journey thus continues and every year we proudly celebrate the spirit of science communication, popularisation and extension by way of the national science day.

Happy National Science Day!

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BIMAN BASU

RECENT DEVELOPMENTS IN SCIENCE AND TECHNOLOGY

LIQUID GLASS-A NOVEL STATE OF MATTER

Glass is one of the most enigmatic substances we use in our daily life. It is one of the world's oldest and most versatile human-created materials. Glass is made by heating a mixture of sand, sodium carbonate and calcium carbonate at high temperature when molten glass is produced. Although we consider it a solid, glass is actually both a liquid and a solid, or neither. Scientists describe glass as an amorphous material -a material which has no definite shape or form.

Recent research led by professors Andreas Zumbusch (Department of Chemistry) and Matthias Fuchs (Department of Physics), both based at the University of Konstanz in Germany, has just added another layer of complexity to the glass conundrum by studying the behaviour of ellipsoid colloidal particles. A colloid is a homogeneous mixture with particles that are microscopic but still bigger than atoms and molecules, and easier to study. It has properties between those of a solution and fine suspension. In traditional colloids, the colloid particles are spherical in shape. But in the present case, using polymer chemistry, the team led by Zumbusch manufactured small plastic particles, stretching and cooling them until they achieved ellipsoid forms and then placed them in a suitable solvent. He says, due to their distinct shapes the ellipsoidal particles have orientation-that is, they point preferentially to a certain direction as opposed to spherical particles and this

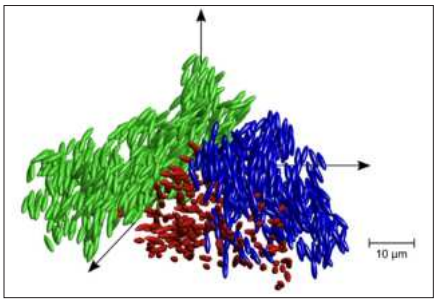

Image of the position and orientation of ellipsoidal particles in clusters of a liquid glass. (Credit: research groups of professor)

gives rise to entirely new and previously unstudied kinds of complex behaviours.

Using a technology called 'confocal microscopy' and suspensions of tailor-made ellipsoidal colloids, the researchers uncovered a new state of matter, which they term as 'liquid glass', hidden inside mysterious transformations that happen between liquid and solid states of glass. Being ellipsoid in shape, in liquid glass, individual particles are able to move but unable to rotate.

The researchers describe liquid glass as a 'novel state of matter' and say this is a complex behaviour that has not previously been observed in bulk glasses. According to them, liquid glass forms because the particles are able to move but unable to rotate-which results in local particle clusters that obstruct each other and thus prevent an ordered state of matter from forming. The research has been published in Proceedings of the National Academy of Sciences (PNAS) on 19 January 2021.

What the researchers have termed as liquid glass is a result of these clusters mutually obstructing each other and mediating distinctive long-range spatial correlations. These prevent the formation of a liquid crystal which would be the ordered state of matter expected from thermodynamics.

PROTEIN FOUND IN FINGERTIP 'CAPSULES' CRITICAL TO OUR SENSE OF TOUCH

Our skin acts as the protective barrier between our internal body systems and the outside world. The skin's "sense of touch" is what gives our brains a wealth of information about the natural environment, including temperature, humidity, and air pressure. Most importantly, the sense of touch lets us feel physical pain, which is a necessity for avoiding injury, disease, and danger. Recent research has identified a key molecule called usherin, a protein found in a mysterious capsule-like structure in our fingertips, that plays a crucial role in our sense of touch. Past research has shown that usherin is important for our sense of touch and that a mutation in the gene called USH2A that codes for it, causes a disorder called 'Usher syndrome'-a rare inherited disease that leads to blindness, deafness, and an inability to feel faint vibrations in the fingertips.

To further explore usherin's role in touch, the researchers recruited 13 patients with a form of Usher syndrome that specifically affects touch. The team -led by Gary Lewin, a neuroscientist at the Max Delbrück Centre for Molecular Medicine, Berlin, Germany-measured

Continued to page 18 →

PM Launches pan India rollout of COVID-19 vaccination drive

The Prime Minister, Shri Narendra Modi launched the pan India rollout of COVID-19 vaccination drive via video conferencing on 16 January, 2020. This is the world's largest vaccination programme covering the entire length and breadth of the country. A total of 3006 session sites across all States and UTs were virtually connected during the launch.

The Prime Minister complimented the scientists associated with the development of the vaccines. He said, usually it takes years to prepare a vaccine

but here, in such a short time, not one but two made-in-India vaccine were launched. The Prime Minister cautioned the people to be careful about not missing taking two doses. He said that there will be a gap of one month between the doses. He asked people to keep their guards up even after taking the vaccine as only two weeks after taking the second dose; human body will develop necessary immunity against Coronavirus.

The Prime Minister put the unprecedented scale of the vaccination drive in perspective by informing that, in the first round itself, 3 crore people are being vaccinated. He said that this needs to be taken up to 30 crores in the second round when elderly and people with serious co-morbidities will be vaccinated. The Prime Minister asked people not to give heed to rumours and conspiracy theories as Indian vaccine scientists, medical system, Indian process and institutional mechanism in this regard is trusted globally and this trust is earned with a consistent track record.

Fresh evidence and advice on airborne COVID-19 spread

A new study by CSIR laboratories in Hyderabad and Mohali has found fresh evidence that the risk of airborne transmission of the novel coronavirus is quite low if sufficient physical distance is maintained and prolonged interaction with an infected person is avoided.

The transmission of SARS-CoV-2 was initially thought to be happening mainly through contact and droplets coming out during speech, coughs or sneezes. But several studies later reported transmission among people who were suitably distanced but had shared enclosed spaces, like a closed room or vehicle.

Scientists at two laboratories of the CSIR, the Centre for Cellular and Molecular Biology in Hyderabad and Institute of Microbial Technology in Chandigarh, have studied the extent of transmission through air. The study conducted in hospitals in these two cities found that the risk of exposure in closed rooms through airborne transmission was higher if there were more infected people present, but that in normal circumstances the virus was not found more than four feet from the infected person.

"Virus could not be picked up at a distance of even 4 feet when COVID positive individuals spent a short time (20 minutes) in the room. This indicates that short duration of exposure to a COVID-positive individual may not put one at a significantly increased risk. The samples collected at 8 feet and 12 feet subsequently were also negative," the Study said.

DNA Xperts: Faster COVID-19 diagnosis solutions

Several start-ups have come up with potential solutions to address the COVID-19 challenges. DNA Xperts, a start-up supported by the DBT's Biotechnology Industry Research Assistance Council (BIRAC), has come up with solutions that offer faster COVID-19 diagnosis. They have come up with a

rapid COVID-19 RT-PCR kit and a Viral Transport Medium (VTM) kit. The RT-PCR kit's in vitro amplification assay is designed for a highly sensitive, accurate and fast qualitative detection of viral RNA from clinical specimens.

The kit gives Fast-RNA to PCR results in 57 minutes. It is based on CDC guidelines and validated by NIV/ICMR. It is compatible with various Real-Time PCR instruments available in the market and is highly scalable. It is highly sensitive with a superior limit of detection. It has high specificity as well.

The Viral Transport Media Kit, in turn, is designed for efficient sample collection and transport of clinical samples to the test site for molecular detection. It is a specially formulated liquid medium and can be used for the recovery of viral agents including; Coronavirus, Herpes Simplex Type I, Herpes Simplex Type II, Cytomegalovirus (CMV), Influenzae A, Influenzae B, Respiratory Syncytial Virus (RSV), Echovirus, Adenovirus.

COVID-19 Newsletter Team of VP

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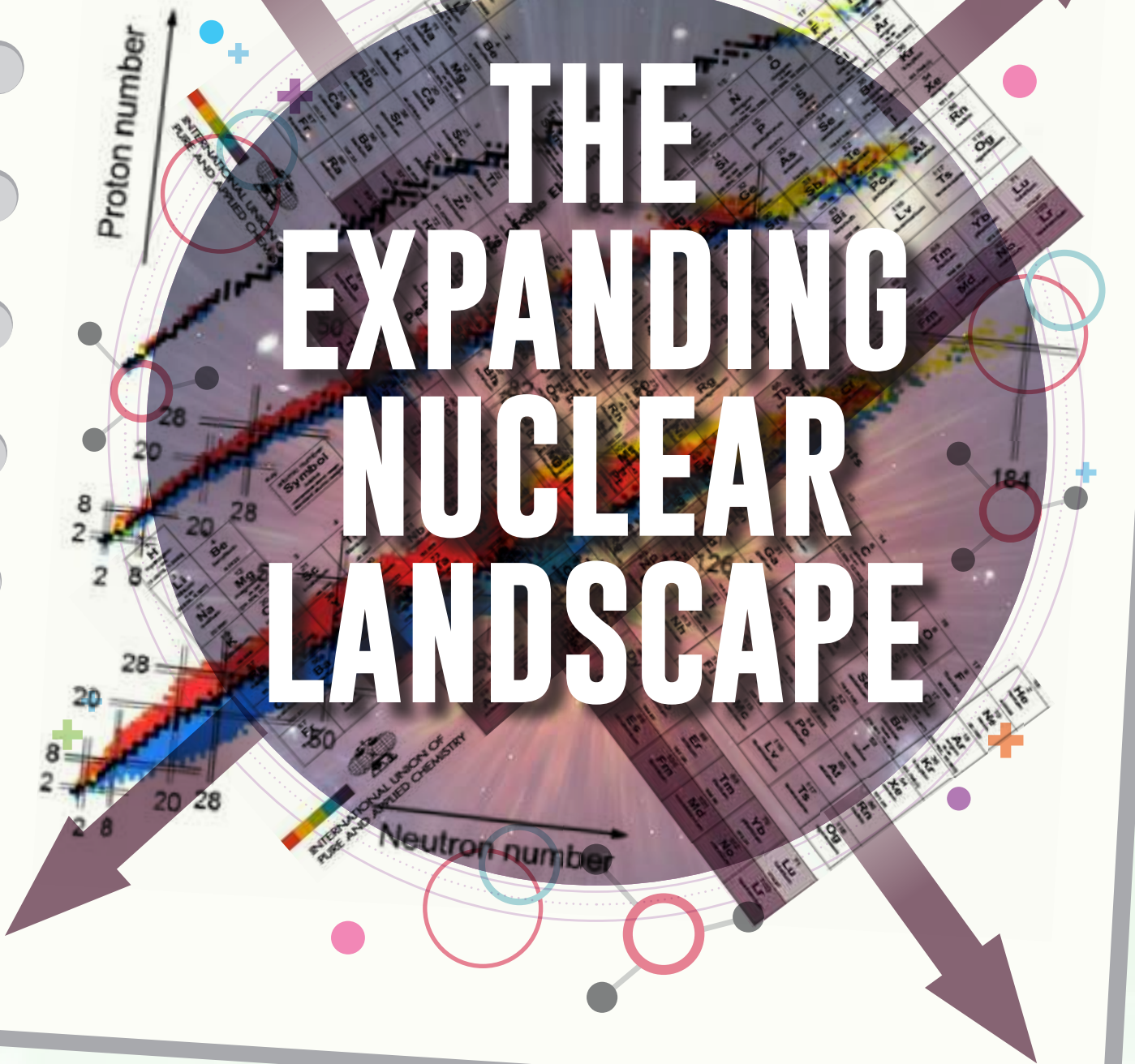
SUBIR NATH

THE EXPANDING NUCLEAR LANDSCAPE



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Periodic Table and the Chart of Nuclides would help us in refining our knowledge about the interactions acting among the smallest constituents of matter. Like elements, studying the properties of individual nuclides is also very important. Knowledge of all the nuclides is crucial for our understanding of the universe.

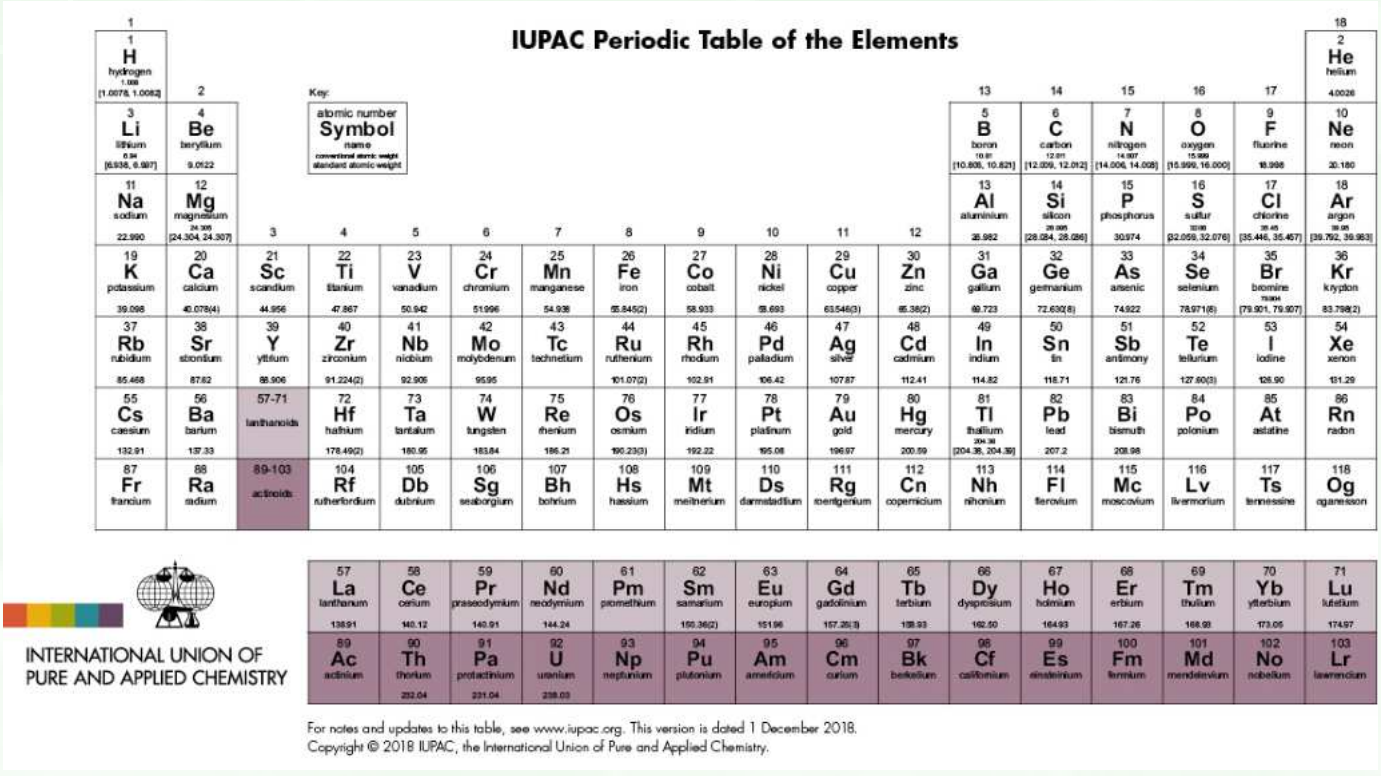
Building blocks of nature

Searching for order and patterns in the seemingly chaotic world that we live in is one of the major goals of science. What are the building blocks of nature? Can we build the known material world with a few basic units, following a set of natural laws? Curious minds have been contemplating such questions since time immemorial. We now know that 'everything is made of atoms'. In fact, everything on the Earth (and possibly in the universe), including us, is made up of 90 odd types of atoms. These are called natural elements. There are also 28 artificial elements which are synthesised in the laboratory. Our knowledge about the composition of matter, gathered collectively over a few millennia, has been summed up in the Periodic Table of Elements. The latest version of the Periodic Table (Fig. 1) was released by the International Union of Pure and Applied Chemistry (IUPAC) on 1 December 2018.

Each atom has a nucleus at its centre. Identity of each element is determined by the number of protons (Z) in the nucleus of its atoms. Thus, atoms with a single proton in their nuclei are atoms of hydrogen ($_1$H). Similarly, all atoms of helium ($_2$He) have two protons in their nuclei. Proceeding further, atoms of the heaviest known element oganesson ($_{118}$Og) would have 118 protons in their nuclei.

Positively-charged protons alone, though, do not constitute the nuclei (except in the lightest atom of hydrogen). Neutrons, which are electrically neutral, make up the rest of the nuclei and provide stability to atomic nuclei. A delicate balance between the electromagnetic force (acting on the protons) and the strong nuclear force (acting on both protons and neutrons) primarily determine whether a specific combination of protons and neutrons would be stable, long-lived or ephemeral.

Unlike protons, the number of neutrons (N) in the atoms of a specific element may vary, creating atoms of the same element with varying masses, which are called isotopes. This term was coined by the English chemist Frederick Soddy



(1877-1956) in December 1913 from two Greek words *iso* and *tope*, meaning 'same' and 'place', respectively. It is interesting to note that the underlying physics was not known at that time. Isotopes were simply atoms of the same element having different masses which occupy the same place in the Periodic Table. True nature of a nucleus was established nearly two decades later, when the English physicist James Chadwick (1891-1974) discovered the neutron in 1932.

The nuclides

We may, at this point, define the term nuclide. It is a distinct nucleus characterised by a specific number of protons (Z) and neutrons (N). All isotopes can be called nuclides, but only nuclides of a given element with same number of protons are isotopes. Mercury ($_{80}$Hg) is currently known to have 46 isotopes, the most among all the elements.

Like elements, studying the properties of individual nuclides is also very important. Knowledge of all the nuclides is crucial for our understanding of the universe. Radioactive nuclides or radionuclides have important medical, industrial and scientific applications, for example, in the diagnosis and treatment of diseases (iodine–131), powering spaceships (plutonium–238), archaeological dating of artefacts (carbon–14), to name a few. Stable nuclides are helpful in finding the geographical origin and migratory routes of birds and animals.

Chart of nuclides

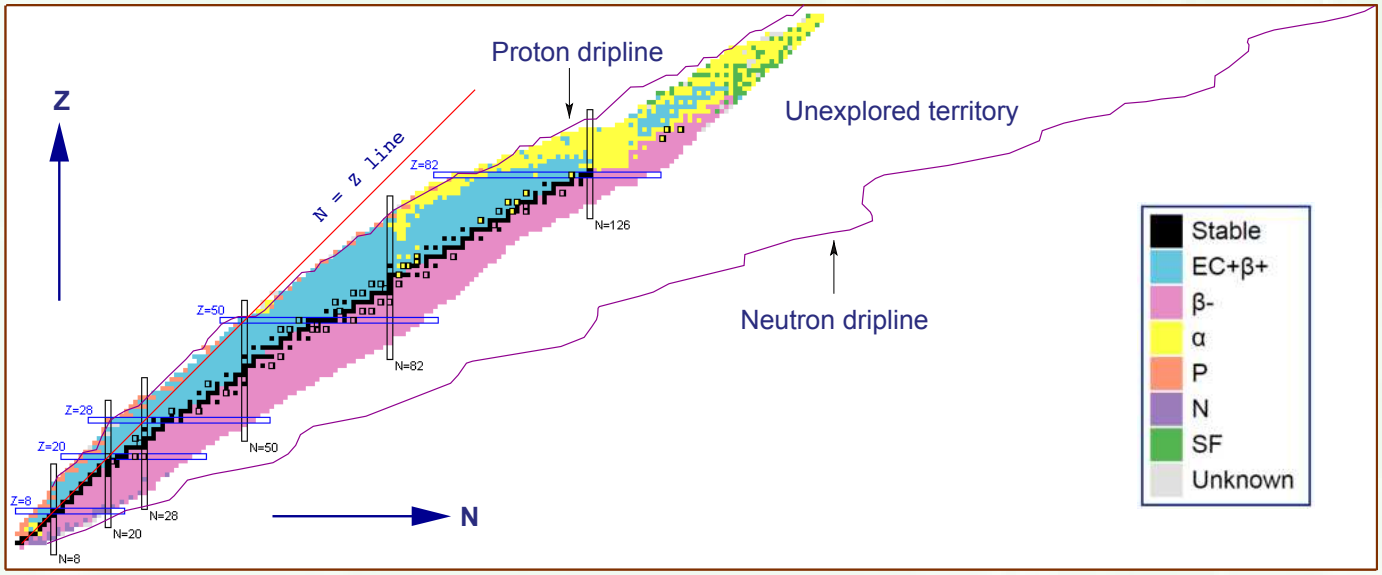
The first attempt to arrange the nuclides in a two-dimensional map was by the Italian physicist Giorgio Fea in 1935. The isotopes of natural elements, 327 in all, were arranged according to their proton and neutron numbers. It later came to be known as the Segré Chart, after the Italian-born American physicist, Emilio Segré (1905-1989). It is actually a very simple two-dimensional plot (Fig. 2) in which the horizontal and the vertical axes represent N and Z, respectively. Each point on the plot stands for a nuclide with specific values of N and Z. One may consider the Chart of Nuclides as an extended Periodic Table for nuclear physicists, in which each row corresponds to an element. The number of known nuclides has been steadily increasing since the discovery of natural radioactivity by the French physicist Antoine-Henri Becquerel (1852-1908) in 1896. How does one create nuclides? To have a new nuclide, one needs to add or subtract proton(s) and/or neutron(s) to or from one of the known nuclides. The technical name of this rearrangement process is 'nuclear reaction'. Simply put, energetic ions of a nuclide, obtained from an accelerator, are collided with atoms of another nuclide. A plethora of nuclides can be created in the collisions.

The number of known nuclides has increased more than tenfold since the first appearance of the Chart of Nuclides. Michael Thoennessen of Michigan State University, USA, has been systematically documenting discovery of nuclides since 2007. According to this Discovery of Nuclides Project, a total of 3,308 nuclides have been discovered until the end of 2019. An annual update is published at the end of each year.

Classification of nuclides

The nuclides, like elements, can be classified into two major groups—natural which are found in nature and artificial, which are created in the laboratory. All the artificial nuclides are unstable. They emit radiation and eventually decay into lighter stable nuclides. The natural nuclides are further sub-divided into two categories. Nuclides existing since before the birth of the Earth are called primordial. Such nuclei can be both stable and unstable. At present, 252 nuclides are known to be stable.

One might ask, why are some nuclides stable while others are not? Nuclear matter can be conceived as a charged fluid and a nuclide is thus a droplet. Its stability depends critically on the value of the ratio N/Z. A nuclide is also a quantum many-body system with internal structure. Similar to electronic orbitals

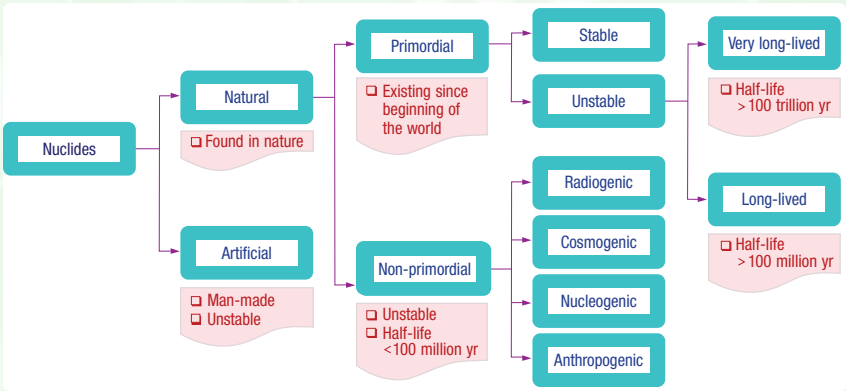


The Chart of Nuclides. The two driplines, limiting the number of bound nuclides, are also shown. *Adapted from https://www.nndc.bnl.gov/*

in an atom, nucleons (common name for neutron and proton) in a nuclide stay in specific energy levels called shells. Certain 'magic' numbers of protons and neutrons, which result in the completely-filled outermost shells, make the nuclides stable. The tendency of protons and neutrons to form pairs also adds to the stability of a nuclide.

It may be mentioned here that the number of stable nuclides may change! Some nuclides, which had been regarded as stable earlier, owing to their very long half-life (time needed for half of the nuclei of a specific radioactive substance to disintegrate, denoted by $T_{1/2}$), were observed to decay in the recent past. Stupendous improvement in experimental sensitivity made these measurements possible. Three such nuclides are bismuth-209 ($T_{1/2} = 1.9\times10^{19}$ y), xenon-124 ($T_{1/2} = 1.8\times10^{22}$ y) and tellurium-128 ($T_{1/2} = 2.2\times10^{24}$ y). To put these numbers in perspective, we may note that the estimated ages of the universe and the solar system are 13.8 and 4.6 billion (10^9) years, respectively.

Twenty-four primordial nuclides have half-lives greater than 100 trillion (10^{12}) years and are often considered practically stable. Ten more primordial nuclides have half-lives longer than 100 million (10^6) years with uranium-235 being the shortest-lived ($T_{1/2} = 7.04\times10^8$ y). So, there are 286 known primordial nuclides which form nearly all matter of the visible world. About 60 more nuclides are found in nature. These are non-primordial nuclides with half-lives shorter



Classification of known nuclides

than 100 million years. They have varied origins—radiogenic (products from the decay of three naturally-occurring radioactive chains), cosmogenic (products of interactions of cosmic rays with primordial nuclides), nucleogenic (products of other naturally-occurring terrestrial nuclear reactions), and anthropogenic (nuclides created by human activities like nuclear explosion, etc.). Thus, there are only about 350 natural nuclides. One should note that natural nuclides constitute only about 10% of the known nuclear landscape.

It can be also stated that there are 83 primordial elements (elements with at least one primordial isotope). Of these, 80 are stable (elements with at least one stable isotope)—$_1$H to $_{82}$Pb barring $_{43}$Tc and $_{61}$Pm. The three radioactive primordial elements are $_{83}$Bi, $_{90}$Th and $_{92}$U. Seven elements, viz., $_{84}$Po, $_{85}$At, $_{86}$Rn, $_{87}$Fr, $_{88}$Ra, $_{89}$Ac and $_{91}$Pa are natural but non-primordial. Rest of the elements, i.e., $_{43}$Tc, $_{61}$Pm and the 26 transuranic elements ($_{93}$Np to $_{118}$Og) are man-made.

Contours of nuclear landscape

The stable nuclides (represented by solid black squares in Fig. 2) populate the central region of the Chart of Nuclides. Nuclides residing above this valley of stability are neutron-deficient. They have lesser number of neutrons than what is needed for stability. As one moves farther away from the valley of stability, protons gradually become less-tightly bound until the point where the last proton is unbound. The nuclides residing below the valley of stability are neutron-rich, as they have excess neutrons than what is needed for stability. Thus, only limited combinations of N and Z lead to bound systems and a narrow patch of the N-Z landscape, fenced by the two driplines, is populated. Nuclides may exist even beyond the driplines as a resonance for a very short time! Many such nuclides have been experimentally studied by sophisticated techniques and many more are expected to be observed in near future. These are very special nuclides as they represent the extreme limits of nuclear many-body systems.

Possibilities of expansion

According to the latest estimate, based on nuclear density functional theory, about 7,000 nuclides are bound with respect to neutron or proton emission. Out of about 3,700 unexplored nuclides (3,308 are already known, as mentioned earlier), experts believe that about 1,200 could be synthesised in the coming decades. It is a challenge for the experimentalists to prove this prediction true. The remaining 2,500 nuclides may never be accessible! Why is it important to expand the Periodic Table and the Chart of Nuclides? It is fundamentally driven by the human curiosity for knowing the unknown. The trait of never being satisfied with our knowledge is what distinguishes us from other creatures. Humans always try to push the boundary of the known world. More elements and nuclides will help us refine our knowledge about the interactions acting among the smallest constituents of matter. How did the universe come into being? What were the processes by which nuclides and elements were created? We may obtain better answers to these fundamental questions about our existence. Society at large is also expected to be directly benefitted by the many spin-offs from such investigations. Exploration into the subatomic world started at the end of the nineteenth century. Armed with unprecedented growth in accelerator technology, detection and computational techniques, scientists are sure to continue the expedition for a long time to come.

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NAKUL PARASHAR

UNSDG Goal 2: Zero Hunger
Role of Science & Technology in achieving it

United Nations Sustainable Goals are targeted to achieve their objectives by 2030 and its goal #2 is no exception. Reports, researches, surveys, and studies show that after decades of steady decline, there has been a gradual increase post-2020 in the global food supply. But the question looms large whether we would be able to contain the monster and then kill it! The answer can be provided by none other than the global saviour – mighty science and technology. Would science and technology be able to falsify predictions that indicate the population affected by hunger would surpass 840 million by 2030? The majority of the starving populace is in Asia followed by Africa. Nearly one in every ten persons is exposed to severe hunger. Alarming isn't it?

These challenges in the path of achieving zero-hunger thus continue. Reasons like man-made conflicts, climate change, unprecedented pandemic, and economic downturns continue to top the list of such challenges. Recent studies reveal that the COVID-19 pandemic has put an additional 130 million people suffering from hunger by December 2020. In fact, it would not be inappropriate to say that we are heading towards a quarter billion of the population with acute starvation. Thus, we need nothing but swift actions, both short-term and long-term ones, to combat this growing global menace. Science and technology, as usual, is the only way for humanity to fight this growing threat.

Thus, it is important for all of us to understand the salient points of UNSD Goals #2, which is focussed on achieving Zero Hunger. (see Box)

Science and Technology, as always, has stepped forward to take on any challenge that humanity ever faces.

- 2.1. By 2030 end hunger and ensure access by all people, in particular the poor and people in vulnerable situations, including infants, to safe, nutritious and sufficient food all year round.
- 2.2. By 2030 end all forms of malnutrition, including achieving by 2025 the internationally agreed targets on stunting and wasting in children under 5 years of age, and address the nutritional needs of adolescent girls, pregnant and lactating women and older persons.
- 2.3. By 2030 double the agricultural productivity and incomes of small-scale food producers, in particular women, indigenous peoples, family farmers, pastoralists and fishers, including through secure and equal access to land, other productive resources and inputs, knowledge, financial services, markets and opportunities for value addition and non-farm employment.
- 2.4. By 2030 ensure sustainable food production systems and implement resilient agricultural practices that increase productivity and production, that help maintain ecosystems, that strengthen capacity for adaptation to climate change, extreme weather, drought, flooding and other disasters, and that progressively improve land and soil quality.
- 2.5. By 2020 maintain the genetic diversity of seeds, cultivated plants and farmed and domesticated animals and their related wild species, including through soundly managed and diversified seed and plant banks at the national, regional and international levels, and promote access to and fair and equitable sharing of benefits arising from the utilization of genetic resources and associated traditional knowledge, as internationally agreed.
- 2.A. Increase investment, including through enhanced international cooperation, in rural infrastructure, agricultural research and extension services, technology development and plant and livestock gene banks in order to enhance agricultural productive capacity in developing countries, in particular least developed countries.
- 2.B. Correct and prevent trade restrictions and distortions in world agricultural markets, including through the parallel elimination of all forms of agricultural export subsidies and all export measures with equivalent effect, in accordance with the mandate of the Doha Development Round.
- 2.C. Adopt measures to ensure the proper functioning of food commodity markets and their derivatives and facilitate timely access to market information, including on food reserves, in order to help limit extreme food price volatility.

Source: https://indicators.report/goals/goal-2/

For food, agriculture is the prime representative of science and technology. Most of the countries that have gained the objective of zero or almost no-hunger, have done it through enormous advances in agricultural techniques, plant breeding, and engineering schemes for irrigation and drainage. India's figures from the past when compared to the ones today speak volumes of efforts made by the government in enhancing the production of various crops through newer and improved techniques of agriculture and associated engineering.

Yet, much more still requires to be done. Improvement in agricultural production and technology, additional research, improved biofuels, efficient farm produce business practices, educating the masses, and improving the storage facilities are some major areas that require the immediate attention of those involved in the mission of eradicating hunger from the planet.

In order to enhance agricultural production, factors like quantity and quality requirements of the growing population need to be balanced with those of the changed dietary requirements of the developed nations due to rising incomes. Striking a balance between the nations that have and those that do not have or have lesser than the former need to be given due priority. This is so due to increasing production that should correlate with expanding the caloric output of food and the feed.

From technology standpoint, increased productivity is majorly dependent on it. Researchers have indicated that the use of biotechnology has played a key role in the growth and efforts made to combat challenges emanating from the fight against hunger.

Farmers have always had the lead role in combatting the global crisis of hunger. Thus, climate change, which is an integral part of the farming process, has made its presence felt in discussions related to agriculture, and in turn our current agenda of zero hunger. We have all witnessed how our weather predictions have improved over a period of time, thereby enhancing the efficacy of our farming practices. This has resulted in augmented production of food. At the same time, scientists and technologists have laid emphasis on the production of more drought-resistant, saline-resistant, and less-thirsty plants for the production of food crops. Besides, efforts to reduce post-harvest-related losses through improved storage and transportability is yet another important point in this discussion. Besides quantity, quality improvement through enhanced nutritional content of popular foods with the help of biofortification is also an ongoing process.

Eradicating hunger from the planet of course is as important as UNSDG #1 (Zero Poverty), and these goals are linked to each other. Producing adequate quantity and quality of food to meet the requirements through advancements in science and technology has been found to have acquired notable milestones. Once the quantity is produced, this produce is required to be sold and made available to the needy in time and at prices affordable to them. Thus comes the scientific and duly calculated mechanism of setting up minimum support price of the crop produced. The idea is that while hunger eradication remains the prime objective, the grower is duly encouraged and rewarded by appropriate pricing. Agricultural produce, whether vegetables or animal produce, needs adequate storage as well. In India, storage facility through cold storages and other physical storage has improved over a period of time. Sources reveal that food storage and transportation infrastructure in the country has also improved over a period of time by leaps and bounds.

In this journey to achieve zero hunger, it is heartening to see how science communication and popularisation have also played an important role in highlighting this UNSDG through various media types like print, electronic, social, and digital. Instead of showing pictures that depict the dark side of hunger, science communicators have highlighted the positive side of lush and vast green fields of wheat and rice that depict growth in food production. At places, science communicators have relayed how scenarios have changed with the adoption of best practices of farming and agriculture.

To sum up, challenges shall continue to arrive on the scene but as sentinel of human happiness, science and technology would continue to own its responsibility and stand firm to assist vital UN Sustainable Goals even if unprecedented challenges like COVID-19 continue to emerge.

Image Courtesy: UN SDG

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SOUMADIP SEN

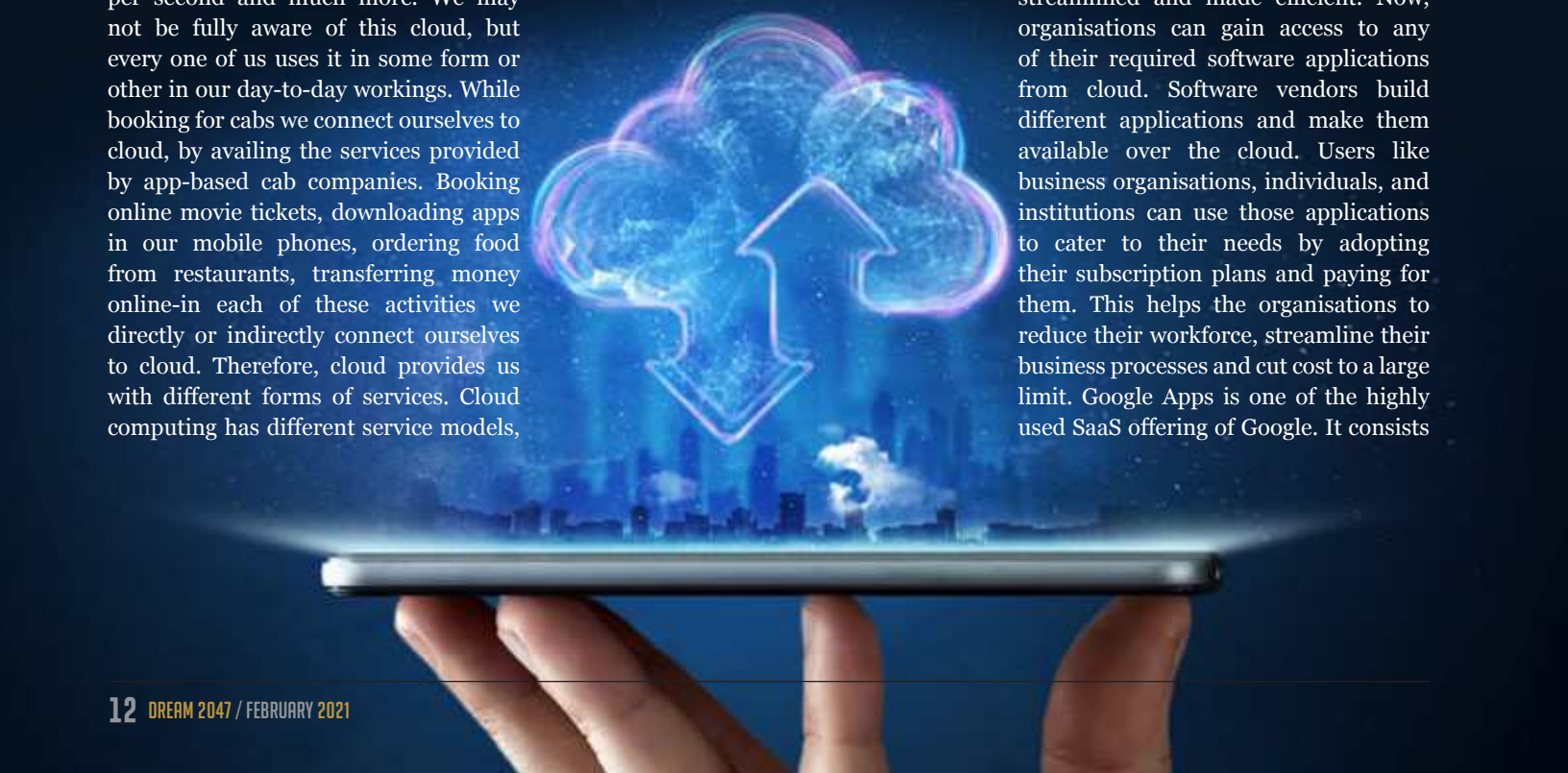
Cloud is a word with which we are quite familiar since our childhood days. Clouds are the first thing that we see when we look-up at the sky. We all have read in our school days about the "Water Cycle" which says that cloud contains tiny droplets of water (moisture) and plays an important role in maintaining the continuous hydrological cycle on Earth. But today we also talk about another "cloud"! This one is artificial. Today the world is driven by technology and online systems are predominant in almost every sector of society. This rapid digitization has created a digital world around us, which is connected to the physical world in which we live. Internet plays a vital role is this digital world through the medium of "cloud computing"-a concept that has helped the world to attain new heights. Cloud computing is the on-demand availability of computer system resources, especially data storage and computing power, without direct active management by the user.

In the simplest form, this "cloud" refers to a giant remote space linked through the Internet. This space contains a huge number of computing devices, software applications, development tools, mammoth data repositories with trillions of bits of data being generated per second and much more. We may not be fully aware of this cloud, but every one of us uses it in some form or other in our day-to-day workings. While booking for cabs we connect ourselves to cloud, by availing the services provided by app-based cab companies. Booking online movie tickets, downloading apps in our mobile phones, ordering food from restaurants, transferring money online-in each of these activities we directly or indirectly connect ourselves to cloud. Therefore, cloud provides us with different forms of services. Cloud computing has different service models, each having its own usefulness and providing advantages to intended users.

Let's take an analogy to understand the concept of cloud computing. Suppose you live alone and one fine morning you are very hungry. So, you need to cook for yourself. To prepare the food, you must have certain things available. You need to have vegetables or the raw food items (resources) that you will cook; cooking utensils and oven (infrastructures); and a kitchen (platform) where you can cook. Once you have these things, you can cook your meal. This is one approach, but in this you need to have some knowledge about cooking, also you need to maintain the things needed for cooking.

Raining of Services from Cloud

Many leading institutions and several researchers have tried to frame a formal definition of cloud computing, but till now no such single agreed-upon definition exists, the reason being: cloud is still an evolving paradigm.



The other alternative is: you can order food from a restaurant and have a tasty delicious food delivered to your home. In this, you need not have to bear the headache of cooking; you just need to select your favourite food and order it online as per the quantity you want to have. This process seems much more convenient, reliable, scalable and effective than cooking the food yourself.

Cloud provides various service models which can be broadly classified into three types: SaaS (Software as a Service), IaaS (Infrastructure as a Service), and PaaS (Platform as a Service).

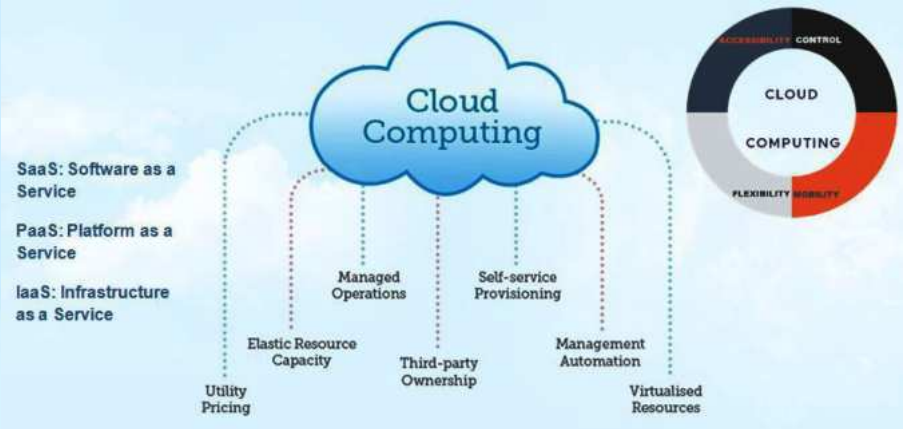
Software as a Service or SaaS is a cloud model that provides quick access to online cloud applications. We can use those applications on subscription by paying as per our usage. Since everything is maintained online, we do not have to download or install the application in our devices (computers, mobiles, etc.). Application developers and vendors take care of application support and maintenance, thereby reducing our burden or headache. In earlier days, business organisations had to hire developers and expert professionals for developing and maintaining their business applications. But with the concept of SaaS offered by cloud computing, all the different activities have been streamlined and made efficient. Now, organisations can gain access to any of their required software applications from cloud. Software vendors build different applications and make them available over the cloud. Users like business organisations, individuals, and institutions can use those applications to cater to their needs by adopting their subscription plans and paying for them. This helps the organisations to reduce their workforce, streamline their business processes and cut cost to a large limit. Google Apps is one of the highly used SaaS offering of Google. It consists

of Gmail, Google Drive, Docs, Google Photos and many more. Microsoft Office 365 is a subscription-based cloud SaaS offering of Microsoft. Small and medium businesses (SMB) having budget issues and limited resources for on-premise hardware, SaaS is an ideal choice.

Infrastructure as a Service or IaaS is another important cloud offering. It provides us with virtual computing resources over the cloud. Through IaaS, cloud providers give the complete range of computing infrastructures like data servers, storage facilities, networking facilities along with maintenance and support. With IaaS, we no longer have to buy costly servers, databases, or computing resources and get it from cloud in an on-demand and pay-as-you-go manner. Thus, it helps avoid the cost of buying and complexity of managing own physical servers, data-centre infrastructures and other computing resources. Google Compute Engine (GCE) is a well-known IaaS offering of Google Cloud Platform. Amazon Web Services (AWS) and Microsoft Azure are some of the top players in the IaaS model.

Platform as a Service or PaaS provides an efficient environment where users can develop, deploy and test their applications with the availability of all the necessary run-time tools, functionalities and features. This model is also subscription based and gives flexible pricing options depending on organisational requirements and business needs. Google App Engine (GAE) is a popular PaaS offering of Google for developing and hosting web applications.

These cloud services are provided to end-users via some deployment models. Cloud deployment models indicate how the cloud services are made available to users and who can have access to these services. There are primarily four deployment models in cloud computing. They are: Public, Private, Community and Hybrid. As the name suggests a public cloud provides or sells services to anyone over the internet. On the contrary, a private cloud is intended for a limited number of users, with definite access and permissions settings. Hybrid cloud is a combination of more than one deployment model, whereas community cloud provides services to a community comprising of multiple organisations with necessary and restricted access settings.



Research, statistics and trends clearly indicate that cloud is going to be the future technology. Already, there is a sharp increase in the adaptation of cloud technology by organisations and institutions be it small, medium or large. It has also been forecasted that SaaS is going to be the largest market segment in cloud services in coming years.

With the growing significance of cloud, organisations are willing to invest more on cloud technologies. They are in a hurry to shift their existing digital assets from on-premise to cloud on grounds of its added advantages.

Today, cloud computing is providing a reliable, trustworthy and beneficial alternative to traditional computing and information technology. It is not only a digital technological model but also an economic model having massive utility and benefits. With each passing day, its scope is increasing, its prospect is being enlarged and its utility is enhancing.

For better governance and speeding up the delivery of e-services, India has already started an ambitious initiative on harnessing the advantages of cloud computing. This initiative called "MeghRaj", is technically known as "GI Cloud". An important report of the Department of Electronics and IT (DeitY), Government of India published in April 2013 titled "Government of India's GI Cloud (MeghRaj) Strategic Direction Paper" shows the ambition and objective of the Government of India to provide information and communication technology (ICT) services at the most reliable manner at a cheaper cost. As per the report, the GI Cloud is the Government of India's cloud computing environment that will be used by government departments and agencies at the centre and states to provide services to citizens and businesses via internet and mobile connectivity. It will enable the government to leverage cloud computing for effective delivery of e-services and optimise ICT spending of the government.

Every new technological advance has its own advantages and certain associated bottlenecks and cloud computing is no exception. Data privacy, compliance, and certain security and control issues are some of the cloud challenges that are being worked upon and are gradually being eliminated. Today cloud computing is a well-accepted and effective service model. It allows cost-saving and cost-reduction by its "pay-per-use" feature. Its on-demand subscription plans provide scalability and elasticity. Mobility and reliability are the prime characteristics of cloud computing. Efficient control mechanisms with advanced security features and maintenance make it the best alternatives for businesses and organisations.

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BK TYAGI

Vigyan Prasar's New Radio serial on Artificial Intelligence, Aane Wala Kal

Artificial intelligence (AI) has already made an inroad in our daily life and progressively entering every aspects of our life. Ubiquitous presence of 'smart' mobile phones is perhaps the most common examples of it. As soon as we write the first word while messaging, our phone suggests different word options to complete the sentence. Voice-activated assistants in tablets and desktops are capable of following voice commands and complete the tasks, which is another example of AI. A network of algorithms runs in the background of most of the websites that monitor the visitors' online behaviour and collects data. It analyses their browsing history and then collapses hundreds of data points to form an intelligent guess on deciding which product would entice the user or which advertisements to be displayed. AI has made them more intelligent in the users' immediate personal space and it is not even realised by the users.

AI, in common parlance, is the simulation/ mimicking of human intelligence processes by machines, especially computer systems. More so, it is the ability of machines to perform cognitive tasks like thinking, perceiving, learning, problem-solving, auto-correction and decision making. John McCarthy, the father of Artificial Intelligence, defines it is "The science and engineering of making intelligent machines, especially intelligent computer programs."

AI has provided us with immense processing power, storage capacity, and access to information. If we give a curious look at the history of human civilisation, we find the exponential development of technology in the form of spinning wheel in the first, electricity in the second, and computers in the third. AI has now been termed as "the fourth industrial revolution" *(the World Economic Forum 2016)* that has radically transformed the way we live and connect with each other. However, it has also given us numerous regulatory challenges, such as labour protection and data ownership.

India, being the fastest growing economy with the second largest population in the world, has a major stake in the AI revolution. It was proposed in 2018-19 budget speech for establishing National Program on AI by NITI Aayog to utilise the potential of AI in transforming our economy. The program would guide research and development in new and emerging technologies. A 'three-pronged approach' was adopted by NITI Aayog that included undertaking exploratory proof-of-concept; AI projects in various areas; and crafting a national strategy for building a robust AI ecosystem in the country by collaborating with various stakeholders and experts. All the ministries were asked to identify relevant areas in which AI can be used to boost the economy and social development.

NITI Aayog identified and focussed on five sectors to maximize the application of AI in solving societal needs. These were

a) Healthcare: Increased access and affordability of quality healthcare;

b) Agriculture: Enhanced farmers' income, increased farm productivity and reduction of wastage;

c) Education: Improved access and quality of education;

d) Smart Cities and

Infrastructure: Efficient and connectivity for the burgeoning urban population; and

e) Smart Mobility and Transportation: Smarter and safer modes of transportation and better traffic and congestion problems.

Today, the AI ecosystem is evolving very rapidly not only in India but across the world and the very nature of the society is changing. It is the time for self-introspection. We as society need to answer some question like managing the data ethically; bridging the digital divide in our country; and allocation of funds on deciding the innovations/research for investing public funds and partnerships.

Considering the current relevancy of the theme which is aligned with national agenda *(in line with the recommendation four, Spreading awareness on the advantages AI offers, Discussion Paper, National Strategy for Artificial Intelligence, NITI Aayog 2018)* and the objectives of Vigyan Prasar of science communication and popularisation, it has been proposed to produce a 52-episode radio serial on AI, entitled "Welcome tomorrow" in English and "Aane Wala kal" in Hindi. Target group for the programme will be common citizens, civil society awareness facilitators, and managers.

It is pertinent to mention here that promoting science and technology through the radio has been one of the flagship programmes of Vigyan Prasar since 2008. Mega science serials are being produced and broadcast from All India Radio as part of MoU between Vigyan Prasar and Prasar Bharti. In the past, mega serials on themes and issues of national importance has been produced and broadcast like Planet Earth, Astronomy, Biodiversity, Mathematics, Grassroots Innovation, Chemistry in Daily Life, Disasters, Sustainable Development and Climate Change and Global Warming. These programmes were produced in 19 languages and broadcast from more than 119 AIR Station to cover more than 85% geographical area of the country. The major objective of these radio programmes is to create awareness on the S&T issues of national relevance and priority through engagement approach to ensure people participation besides developing the capacity for informed decision making.

OBJECTIVES OF THE PROPOSED RADIO SERIAL ARE

- **a.** Create awareness about the emerging world of AI and its potential use for enhancing the economic growth and solving the societal problem.
- **b.** Promote academic interest among the science student about AI to take up this area as a carrier option.
- **c.** Highlight the science and scientific thinking facets of the AI in a simple and understandable manner.
- **d.** Optimise the reach radio provides.
- **e.** Bring several prominent subject experts, technologists and the planners to speak about the depth and spread of AI, the research being undertaken, India's priorities and the social and economic implication of the AI and the role AI can play to achieve the intended goals.

The serial will be produced in 19 national languages including Hindi and English. The broadcast schedule will be announced soon. The serial will have five to six broad segments comprising of to six/seven episodes in each. The concluding episode of each segment will be interactive by inviting subject experts to answer the queries of the listeners.

The programme will have a docudrama format. The issues covered in the serial will include various facets of science of AI, its potential especially in social sectors, the emerging R&D ecosystem of AI in India and across the globe, AI in literature, and the potential threats or the apprehensions. More than 300 science writers, subject experts, and programme producers of AIR from 18 States will be associated with the production and broadcast of the serial. The programme will be broadcast on 107 Medium Wave and 17 FM station of All India Radio. To ensure the interactivity, two questions at the end of each episode will be put up for the listeners. For correct answers, the selected winners will be provided additional material in the form of books and kits of Vigyan Prasar.

PROPOSED THRUST AREAS FOR THE SERIAL EPISODES

- **a.** Understanding the science of AI and the fourth Industrial/economic/social revolution
- **b.** The potential of the AI
- **c.** Research in AI in India and across the world
- **d.** Emerging Ecosystem of R&D in AI in India
- **e.** The world of AI and literature (science fiction, novels, stories etc.)
- **f.** Uses of AI in Industrial and Social sectors (health, education, agriculture, communication, transportation, etc.)
- **g.** AI and the futuristic society (Smart cities and Infrastructure, Smart Houses, Transport etc.)
- **h.** AI and the apprehensions

SPECIAL FEATURES OF RADIO SERIAL

- **a.** Produce 52 standalone thematic episodes
- **b.** Each episode of 27 minutes
- **c.** Docudrama/feature format
- **d.** Produce in 19 Indian Languages simultaneously
- **e.** Broadcast from more than 124 AIR Stations (MW and FM both) simultaneously
- **f.** Audio Programmes made available for sale after the broadcast

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ISFFI 2020: Spreading Science through Films

International Science Film Festival of India (ISFFI) is a major attraction of India International Science Festival (ISFFI). It was virtually organised during 22 to 25 December 2020. This year the ISFFI received 634 science film entries from 60 countries. The Ministry of Science and Technology, Govt. of India, in collaboration with other central ministries, had organised the annual ISFFI event since 2015. The theme for this year's festival was 'Science for Self-Reliant India and Global Welfare'.

Speaking on the occasion Dr Harsh Vardhan, Union Minister for Health & Family Welfare, Science and Technology, and Earth Sciences said that these films have a huge variety as they are based on themes like science, technology, awareness related to COVID-19 and India's efforts to be self-reliant.

Film star, Mr Amitabh Bachchan, appreciated the efforts being made by the Union Ministry of Science and Technology to help take science to the common man through various means including films, television programmes and other modes of communication.

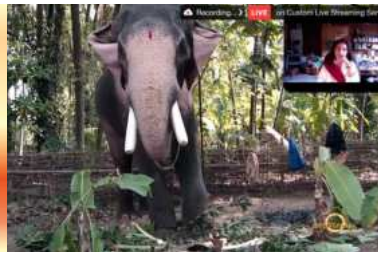
In a video address to the award ceremony of India International Science Film Festival, organised as part of the sixth India International Science Festival, he noted that science and technology had an important role to play in the socio-economic development of a country and emphasised that there was a need to impart knowledge and disseminate information on science and technology to the general public. The holding of the science film festival was commendable, he added.

President of the Film and Television Institute of India and internationally acclaimed filmmaker Mr Shekhar Kapur, who was the chief guest of award ceremony, said there was a need for scientists and filmmakers to work together as scientific pursuit requires a sense of curiosity and adventure and good filmmakers could help develop this quality among the younger generation by producing inspiring films on science and scientists.

"Every year the film festival is growing and now we also feel the need to give some workshop session and handholding to the upcoming science film makers. There is a huge potential and we can share our experience to nurture them," said Mike Pandey, Filmmaker and ISFFI jury chairman.

Dr Uy Hoang, President, Public Health Film Society, United Kingdom addressed the ISFFI and said that science communication was poised to face the challenge of bringing people together and film makers have started addressing this issue and hopefully it was going to be achieved.

Dr Nakul Parashar, Director, Vigyan Prasar said, "This time the event has successfully emerged as a global platform for science filmmakers, 634 entries from 60 countries is a strong proof of this. Apart from India, filmmakers and experts



from United Kingdom, Switzerland, Israel, Germany and Netherlands are addressing the master classes on important aspects of film production. Apart from this, science films from across the globe have been screened online during the festival. Germany's World renowned institutions like Deutsche Welle and Discovery Channel are also participating in the event."

Mr Nimish Kapoor, Principal Coordinator of ISFFI and Senior Scientist, Vigyan Prasar told, "The jury has selected 209 films from 32 countries for screening, these include science documentaries, short films and animation videos. Apart from India, films from Switzerland, Israel, Chile, France, Belgium, Austria, Afghanistan, Iran, China, Spain, Turkey, Netherlands, Germany, United Kingdom, and Taiwan have made it to the festival this year."

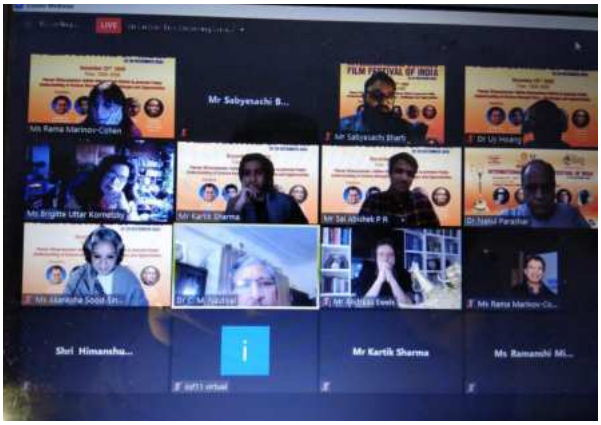
Master classes and panel discussions with the veteran science filmmakers and television programmers were organized during the ISFFI. A total of 20 films bagged awards. Six films bagged the awards for the international categories and 14 for the national categories.

In the international categories, the award winners include The Insect Rescuer (English), produced by ZDF and directed by Andreas Ewels of Germany (Best of Festival Award on the theme "Science for self-reliant India and/or Science for global welfare") and Night Nurse (Persian), produced by Hasan Rahmani and directed by Ashkan Hatami of Iran (Best of Festival Award on the theme "Science and awareness on COVID-19 and other health emergencies"). The other winners in foreign categories were: 'A natural code (English), produced and directed by Cristina Ceuca of U.K.; 'iRony' (English), produced by Radheya Jegatheva and Jay Jay Jegathesan and directed by Radheya Jegatheva of Australia; 'Keep Your Smile' (Silent), produced and directed by Hassan Mokhtari of Iran (Jury Awards) and 'Chemical Industries vs COVID-19' (Italian), produced and directed by Vittorio Caratozzolo & Class 3 A (Jury Special Mention).

The awards for Indian films were presented under two classifications- Independent filmmakers and college/ school students.

The winners among Independent filmmakers include 'The Trials and Triumphs of G.N. Ramachandran' (English), produced by Vivek Kannadi and directed by Rahul Iyer (Best of Festival Award in the theme "Science for self-reliant India and/or Science for global welfare"); 'Raja, Rani aur Virus' (Hindi), produced by Beacon Television and directed by Seema Muralidhara (Best of Festival Award in the theme "Science and awareness on COVID-19 and other health emergencies").

Among other winners were 'Return of The Holy Grain' (Malayalam), produced



and directed by G.S. Unnikrishnan Nair; 'Worth Their Salt' (English), produced by Vigyan Prasar and directed by Seema Muralidhara and H.B. Muralidhara; 'Humans vs Corona' (English), produced and directed by Anshul Sinha; and 'My Mom' (Silent), produced by Dark Room Studio and directed by Rakesh Moirangthem, that bag- ged the Jury Awards.

Besides, 'If Every- body be like this...!' (Tamil), produced and directed by Rajkumar; 'Mangroves: Nature's Hardy Foot Soldiers' (English), produced by Educational Multimedia Research Centre, Calicut and directed by Sajeed Naduthody; and 'The Cheruvayal Raman Effect' (Malayalam), produced and directed by G.S. Unnikrishnan Nair got 'Jury Special Mention'. The winners among college/school students included 'Croaking Frogs' (English), produced and directed by Aditya and 'Catching The Sun' (Hindi), produced by Nilambar Pathak and Karunesh Singh and directed by Rahul Kumar (Best of Festival

Award on the theme "Science for self-reliant India and/or Science for global welfare"); 'Can Break Cancer' (Hindi), produced and directed by Neelu Sharma (Best of Festival Award on the theme "Science and awareness on COVID-19 and other health emergencies"); 'Mask' (Hindi), produced and directed by Santu Kumar and 'Corona At Doorstep' (English), produced by Raghul M.R. and directed by Moumita Mazumdar (Jury Awards).

India Science Wire team

← Continued from page 3

Andreas Zumbusch and professor Matthias Fuchs
Close-up of fingertip.

how well each person sensed pain, temperature changes, and tiny vibrations at 10 and 125 hertz (Hz), mimicking the sensation of moving a fingertip across a rough surface. The scientists then compared the patients' results against those of 65 healthy volunteers. They found that people with Usher syndrome did just as well as their counterparts at sensing temperature changes and mild pain. But they were four times less likely to pick up the 125-Hz vibrations and 1.5 times less likely to detect the 10-Hz vibrations.

To probe further, the researchers replicated the experiment using mice with or without the USH2A gene and found that, as with their human equivalents, mice in both groups were fine at detecting temperature changes and pain, but mice carrying the USH2A gene were better at detecting both degrees of vibrations than those without it, as reported in Nature Neuroscience on 7 December 2020 (doi:10.1126/science.abg1226). The study also unveiled a surprising source for usherin. It was found that the protein is typically present in nerve cells responsible for vision and hearing. But in mice and humans the scientists found it in the "Meissner corpuscle," a microscopic, oval-shaped capsule that surrounds nerve endings in fingers hands and feet that increases sensitivity to touch.

According to the researchers, the find adds to an emerging area of research: exploring how molecules outside neurons, once thought to merely support or protect nerve cells, shape our sense of touch. Lewin and his team plan to determine exactly how USH2A works to help us detect vibrations, noting that further work with both the gene and protein could lead to a better understanding of how we gauge and control our grip strength.

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