

Probability Theory Ensures the Abel Prize 2024 to Michel Talagrand

A marathon runner with an eye on “probability theory” and “functional analysis” having outstanding applications in “mathematical physics and statistics” wins the Abel Prize 2024. Nicknamed the “Nobel Prize in Mathematics” and established in honour of the all-time great Norwegian mathematician Niels Henrik Abel, it is awarded to a person who has made original contributions to the field of mathematics. In the current year, the Abel Committee, comprising five internationally recognised mathematicians, has recommended the name of the famous French mathematician Michel Talagrand for it. Michel Talagrand received the award on 21 May 2024 at the Award Ceremony in Oslo.

Michel was born on 15 February 1952 in France. His father was a Mathematics professor, and his mother was a French teacher. At the early age of five, Michel lost an eye due to a genetic illness, and his other eye was also affected some years later, raising the fear of his going blind. However, fortune favoured him to save it, and he was able to pursue his study in mathematics at the University of Lyon.

He got a research position at the “National Centre of Scientific Research (CNRS)” in 1974 and completed his PhD there in 1977. He also worked there until 2017 before retiring as its Research Director. In the early period of his career, he worked with the famous mathematicians “Gustave Choquet, Gilles Pisier and Vitali Milman” and was greatly influenced by them. Talagrand was a member of the “Functional Analysis Team” of the “Institute for Mathematical Sciences” in 1985. Besides, he was elected as a “Fellow of the French Scientific Academy” (2004) and has been “Chevalier de la



Michel Talagrand, Abel Prize Winner-2024

Legion d’Honneur” since 2011. He is also the recipient of several awards, including the “Loeue Prize” (1995), the “Fermat Prize” (1997) and the “Shaw Prize” (2019). He was married to “Wansoo Rhee”, who is at present a retired professor of management science at “Ohio State University”.

According to the “Norwegian Academy of Science and Letters” press release, which has instituted the prize, he has been selected “for his work on probability theory and stochastic processes”. His work focuses on understanding the different aspects of random processes that shape our world, which greatly impacts various fields ranging from “weather forecasting” to “large language models”.

Much of his work involves using and working on the “Gaussian Distributions”, also known as the “Normal Distribution” or the “Bell Curve”, because of its shape. “Gaussian distribution” is a probability distribution that describes how the values of a variable are distributed around the mean, and it almost guides our whole life. For example, the “weight of babies at birth”, the “test results students get at school” and the “ages athletes retire”. Similarly, take the “heights of the people”, which will most likely be nearer to the mean. The further we go from this mean (in “higher and lower heights”), the fewer people you will get.

The three specific areas of Talagrand’s work for which he has been honoured with the Abel Prize — 2024 are as follows:

- (1) “Suprema of Stochastic Processes” — A “stochastic process” produces a sequence of random values, and the “supremum”

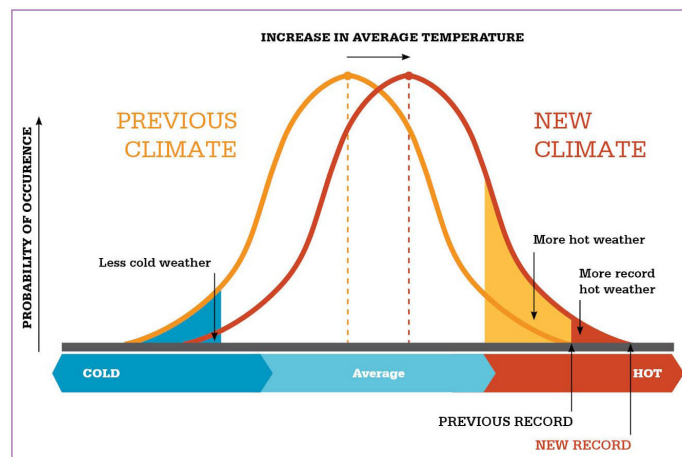
New Elements in Asteroids!

In the periodic table of chemical elements, 118 elements are arranged in order to increase the atomic number (number of protons or electrons in the atom). The first one is Hydrogen, and the last one is Oganesson. Oganesson has an atomic number of 118 and is the densest element in the periodic table. It was first synthesised in 2002 by bombarding Californium-249 with Calcium-48 atoms. Elements up to Uranium (atomic number 92) are available in nature on Earth, and beyond that, the

elements have been synthesised in the laboratory, and their half-life is very short. Elements towards the higher end of the periodic table tend to be unstable, radioactive and have very short half-life.

Recently, a team of physicists from the University of Arizona have found the possibility of Compact Ultradense Objects (CUDO) with a mass density greater than Osmium, the densest naturally occurring stable element with an atomic number of 76.

The researchers have found that the mass density of the asteroid 33 Polyhymnia is far greater than the maximum mass density of familiar atomic matter, and it can be classified as a CUDO with an unknown composition. Physicists have



Source: Modified from IPCC, 2007

Example of a Bell Curve for temperature distribution — and how that is changing with global heating. Credit: Climate Commission Australia

is the largest value expected from a collection of these values. Talagrand has given us tools to predict it. For example, this can refer to the “maximum expected height” or the “biggest wave or flood” likely to hit a place.

- (2) “Concentration of Measure” — Talagrand has demonstrated that “multiple random factors” can, counterintuitively, produce more predictable outcomes through their interaction. In other words, “one single random event is random”; however, “multiple random events may reveal a pattern”. He developed various ways to produce “quantitative estimates” for this phenomenon with great implications across various fields.
- (3) “Spin Glass Theory” — Leaving abstract probability theory behind, his work extended beyond mathematical theory and onto physics. Specifically, “spin glass” is a “magnetic state” characterised by randomness, and Talagrand used his knowledge of “statistics and probability” to demonstrate how “spin glass matter” can behave. Thus, he completed the proof of “Giorgio Parisi’s” Nobel Prize-winning work (2021).

Accordingly to “Lise Ovreas”, the President of the “Norwegian Academy of Science and Letters”, “Talagrand is an exceptionally prolific mathematician, whose work has transformed probability theory, functional analysis and statistics”. His research has led to the

building of new mathematical theories. He disseminated many of his insights through very influential research monographs. His books on the “Generic Chaining” and “Spin Glasses” are valuable references in these fields. The introductory volume to the “Quantum Field Theory” represents another aspect of his research interest, and his contributions to this field will be helpful to various researchers.

That his interest is rooted in a quest for uncovering and understanding problems down to their most fundamental level is evident from his website. After receiving the “Shaw prize” in 2019, he invited the mathematical community to win rewards by solving puzzles published in it, which he named as “Become Rich with My Prizes”. He invested his prize money for the purpose.

Dr Sunita Chand, Professor, ITER, Siksha ‘O’ Anusandhan (Deemed to be University), Bhubaneswar, Odisha. Email: sunitaritam@gmail.com

Dr Ramesh Chandra Parida, Retired Professor, Odisha University of Agriculture & Technology, Usha Nivas, 124/2445, Khandagiri Vihar, Bhubaneswar-751030. Email: paridanana47@gmail.com



Osmium, the densest naturally occurring stable element

modelled elements beyond the periodic table, predicting their properties. The Arizona team used the relativistic Thomas-Fermi model of the atom, attempting to estimate the mass density of elements of atomic number 110 and higher.

The team found that none of the periodic table elements has high enough mass densities to explain what has been observed of the asteroid

33 Polyhymnia. However, elements with atomic numbers nearer to 164 (theoretically) whose mass density values have been predicted between 36.0 and 68.4 g/cm³ are reasonable candidates.

They further wrote, “If some significant part of the asteroid were made of these superheavy metals, it may be possible that the higher mass density could be near the experimentally measured value.” They have further written that if the superheavy elements are sufficiently stable, they could exist in the cores of dense asteroids like 33 Polyhymnia.

Contributed by Mr Mayadhar Swain, Editor, *Science Horizon*. Email: mayadhar2002@yahoo.co.in

West Nile Fever From Nile Delta to Global Concern

IN the lush green landscapes of Kerala, a new and concerning pathological phenomenon has emerged — the spread of West Nile fever. Once considered a distant threat, this mosquito-borne illness has found a foothold in the southern state of India, presenting a unique set of challenges to public health officials and researchers alike. West Nile fever is a viral disease caused by West Nile Virus (WNV), which belongs to the *Flavivirus* genus of the Flaviviridae family. This class of viruses are responsible for other fatal diseases such as Japanese encephalitis and yellow fever.

The story of West Nile fever begins in the Nile Delta of Uganda in 1937, where it was first isolated in a feverish woman. WNV was identified in birds, mainly in crows and Columbiformes. Still, it was regarded as non-pathogenic in birds until the death of different bird species, which presented signs of encephalitis and paralysis in Israel in 1997. Though the infection in humans by WNV was earlier reported in many countries, it was in 1999 when an outbreak was reported in the USA, highlighting that the importation and establishment of vector-borne pathogens outside their current habitat represent a serious danger to the world. The virus of West Nile fever gradually spread its wings and embarked on a global journey. As per data from the World Health Organization, Greece, Romania, Russia, Israel, and the USA were the countries that faced the largest outbreaks.

A mosquito-bird-mosquito cycle sustains the WNV in nature. It is found that birds serve as the primary reservoir hosts for WNV, while mosquitoes, particularly those of the *Culex* genus, act as efficient vectors, transmitting the virus to humans and other mammals through their blood-feeding

habits. Mosquitoes get infected when they feed on WNV-infected birds. Once in the blood of birds, these viruses incubate for a few days and eventually get into the salivary glands of mosquitoes. Infected mosquitoes then spread WNV to humans and other animals by biting them.

Human infections typically occur during monsoon season, peaking in the summer and early fall when mosquito populations thrive. The incubation period of WNV in humans is usually 3 to 14 days. It is a matter of some relief that humans, horses and other mammals are ‘dead end’ hosts of WNV; they do not develop a threshold level of virus in their bloodstream and cannot pass it on to other biting mosquitoes. Nonetheless, the virus can potentially be transmitted among humans through blood transfusion and organ transplantation. Limited accounts have outlined the potential for transmission from a mother to her newborn through the intrauterine route or via breastfeeding. No authentic reports are available on the spread of WNV by sneezing, coughing, or touching the infected birds; however, this topic is still under investigation.

WNV is a zoonotic mosquito-transmitted virus, a positive-stranded RNA virus and has been reported in more than 300 species of birds. Image reconstruction and electron microscopy techniques have elucidated the spherical icosahedral structure of WNV with a 50 nm diameter and envelope of lipid surrounding an icosahedral nucleocapsid consisting of capsid proteins associated with the RNA genome.

During the entry of WNV in a cell, the envelop protein interacts with cell surface receptors, binds and fuses with the cell membrane, leading to the uncoating of the nucleocapsid and the release of the RNA genome into the cytoplasm. The WNV genome acts as messenger RNA for synthesising all viral proteins and serves as a template for RNA replication. These replicated copies are then enclosed within newly formed virus particles, which are transported in vesicles to the cell membrane and are released.

Interestingly, infection with WNV remains asymptomatic for most individuals or causes only mild, flu-like symptoms such

A new moreshwar keratin beetle discovered in India

A new beetle species has been discovered in India and published in the New Zealand-based peer-reviewed international journal *Zootaxa*. This study is a continuation of last year’s discovery of the beetle, i.e., *Omorgus* (*Omorgus*) *Khandesh Strumpher and Kalawate, 2023*. The newly discovered beetle has been named *Omorgus* (*Afromorgus*) *moreshwar* Kalawate and Strumpher, 2024, was collected from the western part of Maharashtra state in India. There are nine species from the subgenus *Afromorgus* Scholtz, 1986, and with this new species now, the diversity stands at ten from India. The new beetle is important for

forensic science as it helps detect the time of death of an animal or human.

The beetles from the family Trogidae are necrophagous and are, therefore, called keratin beetles. The newly discovered beetle is from the family Trogidae. After the death of an organism, during the decomposition of a body, blowflies are amongst the first ones to arrive in the early stages. Meanwhile, the final successional stage is with the arrival of the keratin feeders; thus, their importance in forensic science is immense.

“In the same paper, we have given an illustrated catalogue of all 22 valid species with their available synonyms of the subgenus *Afromorgus*, which is known from the Oriental and Palaearctic Regions and has some taxonomic changes. This will help the budding researchers who want to research this

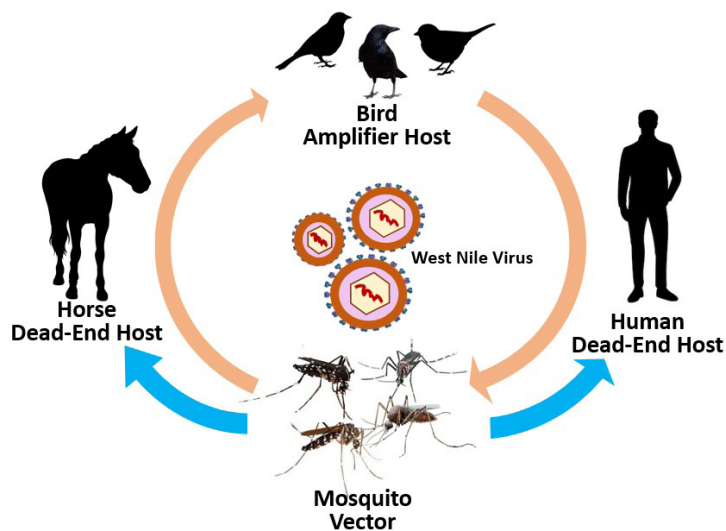


Omorgus (*Afromorgus*) *moreshwar* Kalawate and Strumpher, 2024

as headache, body aches, joint pains, vomiting, diarrhoea, or rash. Such patients recover completely; however, the weakness remains for weeks or months depending upon the medication, healthy food intake and immunity of the individual. In approximately 1% of cases, the virus infiltrates the central nervous system, giving rise to severe neurological complications such as encephalitis (inflammation of the brain), meningitis (inflammation of the membranes surrounding the spinal cord and brain), or acute flaccid paralysis. The other symptoms may include high fever, disorientation, headache, neck stiffness, blurred vision or vision loss, stupor, tremors, convulsions, and muscle weakness. Though there is no age bar for the WNV infection severity, the elderly and immunocompromised individuals are particularly susceptible to these grave outcomes, highlighting the disproportionate impact of the virus on vulnerable populations.

A cascade of immune responses is initiated upon viral invasion, involving both innate and adaptive immune mechanisms. While these defences aim to neutralise the virus, they can inadvertently contribute to tissue damage, fuelling the severity of neurological complications. Understanding the delicate balance between viral clearance and immunopathology is paramount in developing targeted therapeutic interventions.

Prevention remains the cornerstone of West Nile fever management without specific antiviral treatments. No specific medication or vaccine is available for WNV infection. Sufficient



West Nile Virus Transmission Cycle

rest, intake of healthy fluids, and over-the-counter pain medications may relieve some of the symptoms associated with West Nile fever. Since no cure is available, raising awareness of the disease and associated risk factors is the only way to prevent the infection. Generally, the peak of WNV infections typically aligns with when mosquito vectors are most active and temperatures are conducive to virus replication. Using garments that fully cover the body, employing

mosquito nets and repellents, and maintaining cleanliness in one's living environment and surroundings may be among some effective precautions to prevent WNV infections. The elusive nature of the virus underscores the importance of ongoing surveillance and research to stay one step ahead of its relentless spread.

Contributed by Dr Kanti Bhooshan Pandey, Principal Scientist, CSIR-Central Salt & Marine Chemicals Research Institute, GB Marg, Bhavnagar-364002, Gujarat.
Email: kbpandey@csmcric.res.in

Dr Prachee Dubey, Lecturer of Chemistry, Govt GI College, Malwan, Fatehpur, UP. Email: prachee287@gmail.com

complex and the less studied groups in India,” said Dr Aparna Kalawate from Zoological Survey of India, Western Regional Centre (WRC), Pune.

The beetles of this group are sometimes called hide beetles as they tend to cover their body under the soil and hide. They are not photogenic; they are usually black or grey and encrusted in dirt. Their bumpy appearance is distinct, with short, dense setae all over the body.

Further, Dr Aparna informed that the new species is morphologically most similar to *Omorgus (Afromorgus) desertorum* (Harold, 1872). *Omorgus (Afromorgus) desertorum* (Harold, 1872), has been redescribed and raised from a subspecies of *Omorgus (Afromorgus) niloticus* (Harold, 1872) to a species level in the same paper. It has also been illustrated in the same paper to enable accurate recognition of both species.

The beetles from this family are mainly associated with bird and mammal nests or burrows, and their life histories are poorly known. They feign death upon being disturbed and become motionless.

“Keratin beetles are generally studied less in the Oriental region and India particularly than in other parts of the world,” said Dr Aparna. She is the first Indian scientist working on trogid beetles and has described two new species. Till date, only foreign scientists have described the Indian trogid fauna.

These tiny creatures are helping mankind clean the ecosystem by devouring and feasting on the carcasses of dead organisms. Also, their presence on the dead body may be helpful for forensic scientists to calculate the death of the organism. To conserve these tiny beetles, we need to make the general public aware of its importance and appearance. My aim is to document more species from this less studied group from India as our country is biodiversity rich and many more species are yet to be uncovered/described, said Dr Aparna.

Dr Aparna Sureshchandra Kalawate from Zoological Survey of India, Western Regional Centre, Vidya Nagar, Akurdi, Pune-411044, Maharashtra.
Email: aparna_ent@yahoo.co.in; k.aparna@zsi.gov.in