6-1-2020

Editorial

B. Sury
Indian Statistical Institute Bangalore

Editorial*

B Sury, Associate Editor

Email: surybang@gmail.com

This issue features one of the most cited and productive mathematicians Louis Nirenberg who passed away in January 2020. He is arguably one of the greatest mathematicians of the 20th century. In the last few months, the world has lost several well-known mathematicians including Katherine Johnson at the age of 101, S S Shrikhande at the age of 102, Freeman Dyson at the age of 96, and John Conway, who died in April due to Covid-19 complications. Nirenberg's ideas have completely reshaped the way we understand dynamical systems, right from cells to markets. He was unique in seamlessly straddling across areas making no distinction between what is seen as pure mathematics and what is seen as applied mathematics. Nirenberg and John Nash Jr. shared the Abel Prize "for striking and seminal contributions to the theory of nonlinear partial differential equations and its applications to geometric analysis." Tragically, four days after the Abel Prize meeting, Nash and his wife were killed in a road accident in New Jersey.

Nirenberg's contributions encompass a large landscape and only a few topics could be described in this issue. Perhaps the most well-known problem to which Nirenberg made seminal contributions to is the Millennium Prize problem on the well-posedness of the Navier–Stokes equation describing the flow of incompressible fluids. One of the most important steps towards understanding whether or not the Navier–Stokes equations provide a deterministic description of the flow of a viscous incompressible fluid was taken by Nirenberg and collaborators. They introduced a new notion of suitable weak solutions in space-time domains focusing on differentiability properties. This makes the problem of regu-

*Vol.25, No.6, DOI: https://doi.org/10.1007/s12045-020-0990-2

larity a local one. Another outstanding paper of Nirenberg and collaborators established important results on monotonicity and symmetry of solutions to nonlinear second-order elliptic partial differential equations. This is one of the most cited papers, of which Nirenberg once said, "I made a living off the maximum principle." Nirenberg's diverse ideas have been applied in new and exciting ways by a large body of mathematicians. Vamsi Pingali and Mousomi Bhakta have described some of Nirenberg's work in two articles in this issue. It is astounding to know that Nirenberg has been cited over ten thousand times by over five thousand authors. Two of the—by now standard—notions introduced by Nirenberg, are those of pseudo-differential operators and the theory of functions of bounded mean oscillation which is used to study the behavior of both elastic materials and games of chance known as martingales.

Among the several awards that Nirenberg received in his illustrious career, there are two that could be highlighted. One is the Abel Prize mentioned in the beginning and the other is the inaugural Chern Medal. In 2010, the International Congress of Mathematicians was held for the first (and only) time in India. During ICM 2010, a new medal was established and named after the famous Chinese geometer Shiing-Shen Chern. Nirenberg was awarded this Chern Medal; this is given "to an individual whose accomplishments warrant the highest level of recognition for outstanding achievements in the field of mathematics."

To give a peek into Nirenberg's personality—especially, his generosity and humility—here are two comments that were made after he passed away. Steven Heilman said, "He brought his Chern Medal in a nondescript plastic bag, to show students at the celebration honoring that achievement. Perhaps greatness within a humble exterior best describes him." Brenton LeMesurier said, "One fond memory from my days as a student at the Courant Institute was the gentle questions that Nirenberg would ask in seminars, not because he did not know the answer, but to ensure that us graduate students got the explanation we needed." Charles

Fefferman from Princeton University once said that for a while, mathematicians were wont to take Nirenberg's recommendations of junior colleagues lightly as he was incapable of being unkind or critical of anybody!

He concluded one interview by saying, "I must say all the people I have worked with have been extremely nice. It is one of the joys of working with colleagues. Peter Lax seems like a brother to me. One paper with Philip Hartman was elementary but enormous fun to do. That is the thing I try to get across to people who don't know anything about mathematics, what fun it is! One of the wonders of mathematics is you go somewhere in the world and you meet other mathematicians and it is like one big family. This large family is a wonderful joy."

This issue carries an interview with the eminent mathematician M S Narasimhan, well-known not only for his fundamental mathematical contributions, but also for his instrumental role in establishing centers, institutions and bodies that nurture top-class mathematical research in India and abroad. His 88th birthday falls this month.

The serendipitous discovery of mercurous nitrite by Acharya Prafulla Chandra Ray in 1896 created a sensation. Asim Das discusses different thermodynamic and kinetic aspects of the stability of mercurous nitrite in a gripping narrative. It is interesting to note that P C Ray set up the Bengal Chemicals that manufactured hydroxychloroquine which is so much in the news now.

Navketan Batra and Goutam Sheet reveal intriguing connections between ideas from topology and condensed matter physics. Different from the regular insulators are a new class of materials called topological insulators displaying novel quantum properties. The authors use the beautiful Su-Schrieffer-Heeger (or SSH) model as a simple toy medal to understand the basic ideas behind topological insulators.

The relatively recent discipline of synthetic biology combines the chemical synthesis of DNA with advances in genomics, enabling researchers to manufacture catalogued DNA sequences and assemble them into novel artificial biological pathways or novel genomes. Using data on yeast genome sequences, the Sc2.0 project was undertaken to rewrite the *S. cerevisiae* genome (Sc1.0) into a designer synthetic yeast version with certain desired properties. The complete design and synthesis of all the chromosomes were achieved, thus establishing *S. cerevisiae* as an ideal system for designer eukaryotic genome biology. This Sc2.0 project offered an excellent framework for undergraduate student participation in cutting-edge interdisciplinary research. In their article, "Rewriting the Genome of the Model Eukaryote, Saccharomyces cerevisiae", Vijayan Sambasivam, Desirazu N Rao, and Srinivasan Chandrasegaran have narrated to us this fascinating story.

Raghavendra Gadagkar has established and nurtured a top class school of experimental research on animal behavior, ecology and evolution over the last four decades, and has been educating us through his scintillating series of articles in *Resonance*. The twelfth episode appearing in this issue discusses how the male túngara frogs sing for sex but intriguingly curb the instinct in a struggle for survival.

In current science news, an article in *Nature* reports evidence of mirror-symmetry violation in bound nuclear ground states within the mirror partners strontium-73 and bromine-73. In a research news item, Indulekha explains the technicalities to us in simpler terms.

In other current science news, for the first time, astronomers may have seen direct evidence of a planet forming around a young star. Astronomers from the University of Bordeaux, France have used infrared observations from the Atacama Large Millimeter/submillimeter Array and the Very Large Telescope, both in Chile, to spot a spiral and a small S-shaped twist which is near the center of the spiral and surrounds a young star AB Aurigae.

The the twist is said to be the precise spot where a new planet maybe forming.

Last year, the first image of a blackhole was voted as The Breakthrough of the Year. It may not be well-known that one of the runners up showcased stunning findings from Mexico where researchers drilled rock cores from the Chicxulub crater. The cores chronicled in minute-by-minute detail the asteroid impact that wiped out the dinosaurs 66 million years ago.