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Editorial

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John Terrence Tate was a mathematician whose fundamental contributions led to his name adorning several notions in present-day mathematics. Many major directions of research in algebraic number theory and arithmetic geometry are only possible because of the incisive contributions and illuminating insights of Tate.

Already, his PhD Thesis from 1950 is a famous work that gave a very novel approach to understand some classical results as well as discover new results in number theory; he used harmonic analysis on something called the 'adele group' that captures and explains a lot of number theory. Ever since, his ideas have played a central role in number theory.

When asked whether he would describe himself as a theory builder or a problem solver, Tate said in his usual modest manner:

"I suppose I'm a theory builder or maybe a conjecture maker. I am not a conjecture prover very much, but I don't know. It is true that I'm not good at solving problems. For example, I would never be good in the Math Olympiad. There speed counts and I am certainly not a speedy worker. That's one pleasant thing in mathematics: It doesn't matter how long it takes if the end result is a good theorem. Speed is an advantage, but it is not essential."

Dinesh Thakur, one of Tate's doctoral students at Harvard University, has written a wonderful article describing not only the mathematical work of Tate but also sketched some interesting as well as touching personal anecdotes. Dinesh Thakur also happens to be a nephew of the famous Marathi writer Pu. La. Deshpande. The *Wikipedia* mentions: "Deshpande married his colleague, Sunita Thakur who also went on to become an accomplished writer in

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her own right. The couple did not have any children, and loved their nephew, Dinesh Thakur like their own son."

Very fortuitously, we learnt that Jean-Pierre Serre, one of the most renowned mathematicians, was writing an article on Tate for the French Academy of Sciences. An English translation of that forthcoming article appears in this issue. We thank Serre for permitting us to publish it. He is well-known for his beautiful and clear mathematical writing. The Serre–Tate correspondence is famous for its mathematical content. They were also very close friends. For the typical reader of *Resonance*, this short article may be on the technical side (which says something about the standards maintained by the French Academy of Sciences!), but the initiated mathematics students, as well as teachers, would find it very informative. In this regard, it is wise to recall Tate's own views: Tate relished the beauty of mathematics but realized it was not something that could be easily shared with those not in his field. He once said, "Unfortunately, it is only beautiful to the initiated, to the people who do it. It can't really be understood or appreciated much on a popular level the way music can. You don't have to be a composer to enjoy music, but in mathematics you do. That is a really big drawback of the profession. A non-mathematician has to make a big effort to appreciate our work; it is almost impossible."

In the "Classics" section, we reproduce a lovely exposition by Tate on what the reciprocity law entails in modern parlance. From Gauss's time, many central discoveries in number theory are expressed in terms of certain "reciprocity laws". For instance, the Langlands Reciprocity Conjecture is central to the Langlands Program which is a kind of grand unification program in mathematics. Tate's thesis was also an inspiration for the Langlands Program.

A collection of photographs of mathematicians' blackboards called *Do Not Erase* by Jessica Wynne, a photographer and professor at the Fashion Institute of Technology in New York, will be published by Princeton University Press later in 2020. Most mathematicians love their blackboards and chalk and would not have

them completely replaced with whiteboards or slide show presentations. Chalk is fun to write with, cheaper, biodegradable, smells better than whiteboard markers and is easier to clean up. Many of Tate's photographs feature him lecturing on the good old blackboard writing with white chalk.

In other relatively recent news from the mathematical world, one remarkable discovery from August 2019 uses 'Kirigami' (a lesser-known cousin of origami). Kirigami uses a pattern of cuts in a flat paper sheet to change its flexibility and allow it to morph into three-dimensional shapes. Researchers have developed a mathematical framework and algorithms that can turn any sheet of material into any prescribed shape. Their approach, combining geometry, topology and optimization, highlights the potential for generalized kirigami tessellations as building blocks for shape-morphing mechanical metamaterials.

In January, to mark the 25th year of *Resonance*, a workshop – Resonance@25 – was held at St. Joseph's College, Bengaluru. The meeting featured several excellent talks and experimental demonstrations on diverse subjects. The workshop started with a talk by one of the principal architects of *Resonance* N. Mukunda, which was titled 'The privilege of creating Resonance'. This issue of *Resonance* carries a write-up of this talk which reveals the trials and tribulations of starting such an enterprise, and how it has grown over a quarter of a century.

This issue also includes the 11th in the series of articles by Gadagkar on how simple, and cleverly framed experiments can reveal the outcome when fish fight. As he argues, the outcome is not only based on their intrinsic fighting abilities but also on extrinsic factors such as prior winning and losing experiences.

Abhinaba Das describes the liquid drop model (LDM), which has been successfully used in nuclear physics to estimate the average properties of nuclei. How this simple model can be applied in materials science to explain a peculiar property in nanoparticles, namely the depression of melting point from that of bulk, is presented in this article.

Tejaswi, who has proposed many problems for the mathematics olympiad competitions all over the world, enlightens us as to how one goes about creating this. Tejaswi himself was a gold medalist in an IMO several years back.

In an extremely engrossing write-up, Sushanta Dattagupta presents in simple terms, the underlying ideas behind the epithet of 'Dirac solid' being attributed to graphene. As he describes, the Dirac equation, which marries quantum mechanics with the special theory of relativity, is relevant to particles that move with nearly the speed of light c. Then, why do electrons, which in a semi-metal like graphene, travel with a speed that is estimated to be one-three hundredth of c, and are believed to have properties akin to Dirac fermions? Further, he discusses why these fermions are endowed with zero mass, which immediately lends them chirality.

Govind Krishnaswami and Sachin Phatak talk about how accelerated bodies and elementary particles can gain inertia. Swimmers, air bubbles, submarines and airships are slowed down by the associated 'added mass' force which is distinct from viscous drag and buoyancy. In particle physics, an otherwise massless electron, quark, W or Z boson, moving through the Higgs field acquires a mass. The authors introduce the fluid mechanical added mass effect through examples and use its analogy with the Higgs mechanism to intuitively explain how the carriers of the weak force (W and Z bosons) get their masses while leaving the photon massless.

Rajiva Raman discusses in detail what makes an individual a male or a female and elaborate on the role of genetic predisposition and environmental factors in sex-determination during embryo development.

It is the current practice to pay an honorarium to the authors, whose articles appear in *Resonance*. The Editorial Board wishes to discontinue this practice henceforth. It was felt that in the present era of open knowledge, it is the moral obligation of scientists to share their knowledge with students and society freely. Student authors are already being rewarded in the form of the article published, and it may not be appropriate to encourage stu-

dents to write for monetary benefits. This decision to discontinue the award of an honorarium will not apply to those articles that have already been received. We hope that the contributors would agree with our view and continue to contribute to the growth of *Resonance*.