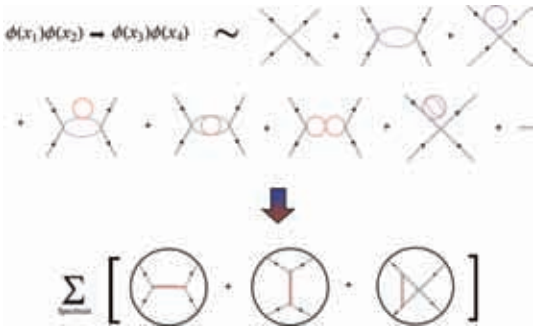
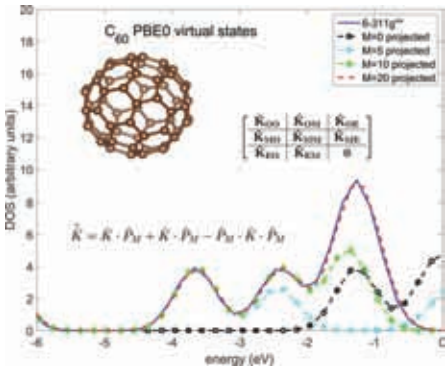
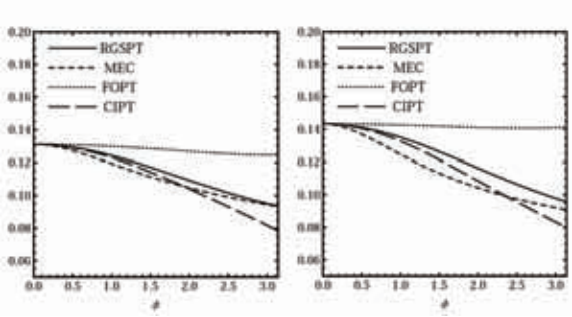
The usual expansion in quantum field theory in terms of Feynman diagrams is tedious and leads to infinities. A new method, which is finite, uses a different basis in terms of a new set of diagrams. The method correctly reproduces old results and promises to produce new results which have never been computed using the Feynman diagram expansion (Gopakumar R, Kaviraj A, Sen K and **Sinha A.** Conformal Bootstrap in Mellin Space. *Physical Review Letters.* 2017. 118(8):081601).





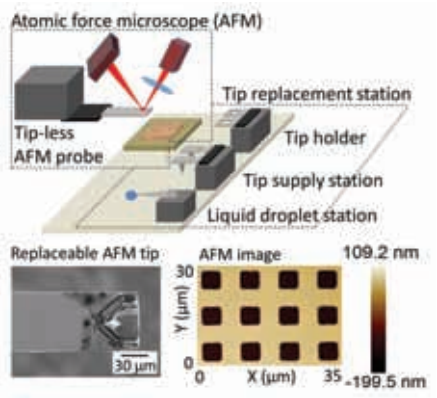
Computing the properties of molecules using density functional theory is computationally expensive, especially for larger systems. A new scheme speeds up such computations by two orders of magnitude (Boffi NM, **Jain M,** and Natan A. Efficient Computation of the Hartree–Fock Exchange in Real-Space with Projection Operators. *Journal of Chemical Theory and Computation.* 2016. 12:3614–3622).

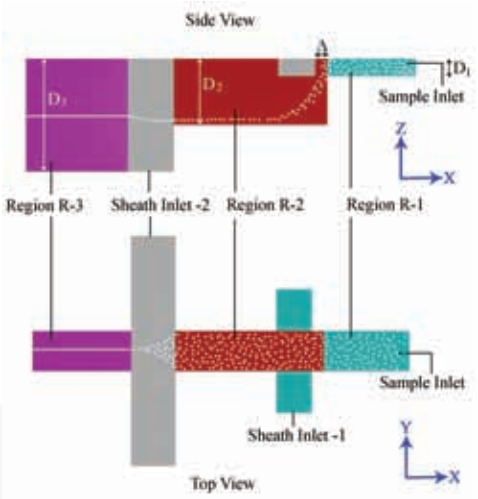
The strange quark cannot be seen in isolation, making the notion of its mass tricky. A new method, renormalization group summed perturbation theory, or RGSPT, has been developed to extract the mass of the strange quark from experimental data, and the results compare well with existing methods (**Ananthanarayan B** and Das D. Optimal Renormalization and the Extraction of the Strange-Quark Mass from Moments of the tau-decay Spectral Function. *Physical Review D.* 2016. 94:116014).



RESEARCH SNAPSHOTS 2016

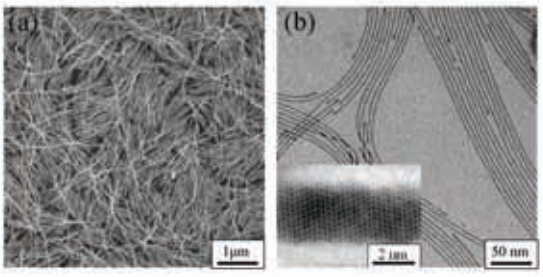
A system to replace quickly replace and reuse tips in an atomic force microscope has been developed. A prototype with the replaceable tip gave images of similar quality as conventional AFM tips (Mrinalini RSM and **Jayanth GR.** A System for Replacement and Reuse of Tips in Atomic Force Microscopy. *IEEE/ASME Transactions on Mechatronics.* 2016. 21(4)).



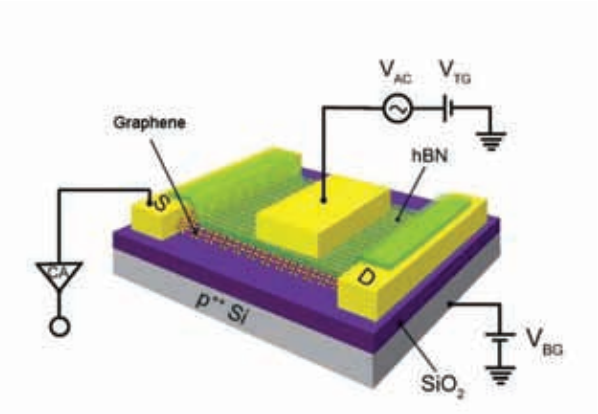


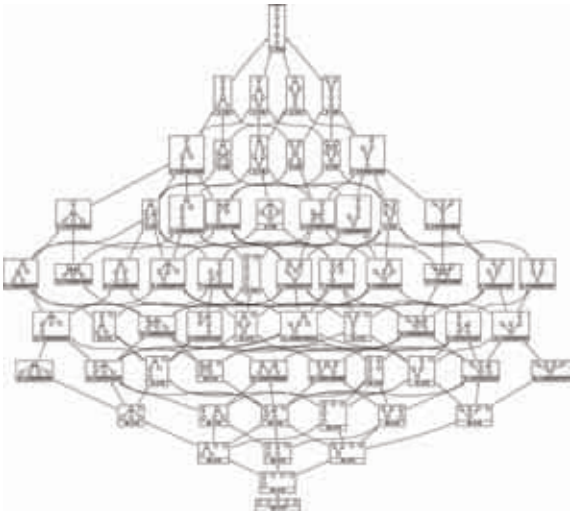
A new method to achieve both 2D and 3D flow focusing in a microfluidic device. The method uses abrupt channel depth variation and a shift in one of the junctions where the sample and sheath fluids meet (Eluru G, Julius LAN and **Gorthi SS.** Single-Layer Microfluidic Device to Realize Hydrodynamic 3D Flow Focusing. *Lab on a Chip.* 2016. 16:4133-4141).

Gold nanowires of diameter 2 nm were found to be very sensitive to their ambient environment and could detect methanol or acetone. This may enable them to be used for making chemical sensors, hitherto made using wires of semiconductors or metal-oxides (Amin KR, Kundu S, Biswas S, Roy A, Singh AK, Ravishankar N and **Bid A.** Effect of Ambient on Electrical Transport Properties of Ultra-Thin Au Nanowires. *Applied Physics Letters.* 2016. 109: 253108).



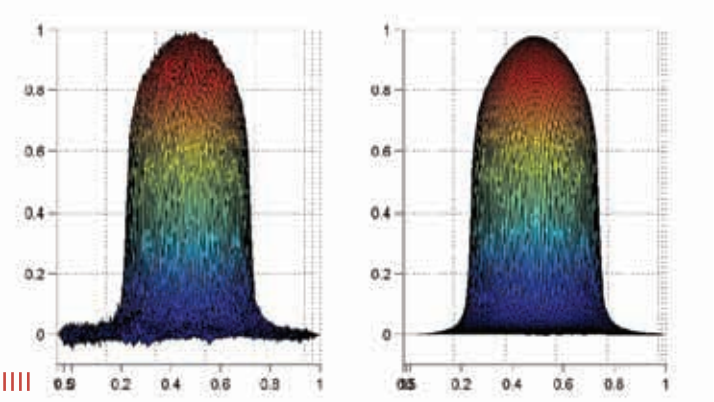
Electrons behave differently depending on whether they are present inside or outside a solid. This image shows the schematic of the measurement setup, where an atomic layer of graphene is encapsulated between insulating atomic layers of boron nitride. Electrons in graphene flow from the source (S) to the drain (D) when a small bias voltage is applied; the number of electrons is monitored by applying gate voltages (Kumar C, Kuiri M, Jung J, Das T and **Das A.** Tunability of 1/f Noise at Multiple Dirac Cones in hBN Encapsulated Graphene Devices. *Nano Letters.* 2016. 16(2):1042-1049).



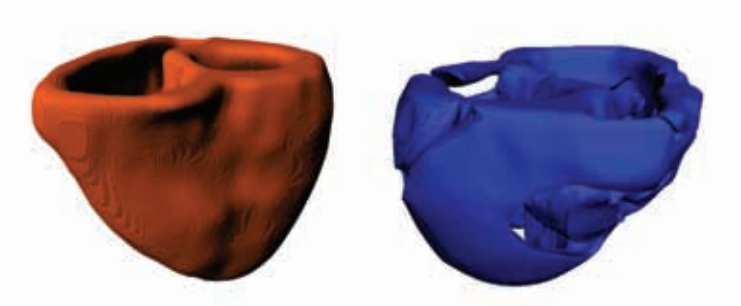


The Hasse diagram of all partially-ordered sets of size 5 ordered according to order relations. Next to each partially-ordered set P is the second-largest eigen value of the transition matrix of the P-random-to-random shuffle Markov chain (**Ayyer A,** Schilling A and Thiery NM. Spectral gap for random-to-random shuffling on linear extensions. *Experimental Mathematics.* 2017. 26: 22-30).

Supressing spurious oscillations efficiently by a new patch-wise local projection method for the convection-diffusion equation. Unstabilized solution (left) and Stabilized Solution (right) (Dond AK and **Gudi T.** Patch-wise local projection stabilized finite element methods for convection-diffusion problem. To be published).



Left: Image of our anatomically realistic simulation domain for the right and left ventricles of a human heart. Right: Screenshot from a movie showing the transmembrane potential from simulations of the chaotic spatiotemporal evolution of a broken scroll wave of electrical activation in this anatomically-realistic, 3D simulation domain (512^3 collocation points and with information about muscle-fiber orientation); it uses the Ohara-Rudy ionically realistic mathematical model for cardiac cells. These simulations have been carried out on the SahasraT by Soling Zimik (in the group of **Rahul Pandit**). Such simulations help us to develop a detailed understanding of life-threatening cardiac arrhythmia like ventricular fibrillation, which is the leading cause of death in the industrialized world (one in every six deaths).



RESEARCH HIGHLIGHTS

The Division of Physical and Mathematical Sciences comprise the Departments of Instrumentation and Applied Physics, Mathematics, and Physics, including the Astronomy and Astrophysics Programme, and the Centres of High Energy Physics (CHEP) and Cryogenic Technology (CCT). Faculty members in this Division have received several awards and honours for their research. Their research has been supported by grants from major agencies and ministries such as the Department of Science and Technology, The Council for Scientific and Industrial Research, the Department of Biotechnology, the Defence Research and Development Organization, the Indian Space Research Organization, and the University Grants Commission.