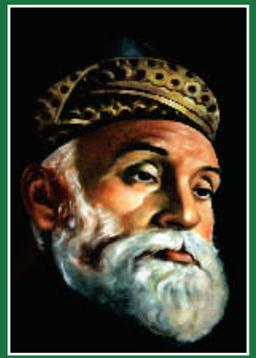


IISc Alumni

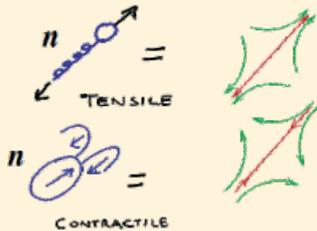


Newsletter of IISc Alumni Association

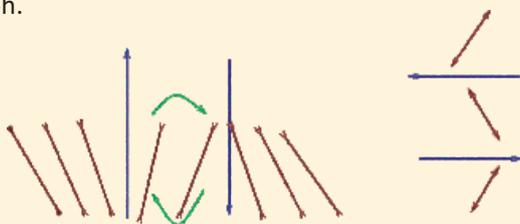
Volume 5 Issue 1 March 2012

Nonequilibrium Matter

I thank the IIScAA for this opportunity to write about my work on the physics of condensed matter systems far from thermal equilibrium, especially but not only in the living state. I am a condensed-matter physicist, trying to understand how large numbers of particles interacting with each other give rise to the states of matter that we see around us. The "particles" constituting our systems could be molecules, mustard seeds, microbes or mackerel, mobilized by Maxwellian thermal energy, mechanical agitation or metabolism. Rather than studying systems at fixed energy or temperature, my interest lately has been in the states formed when matter is prevented from relaxing, either because it gets trapped on the way, forming a glass, or because it's shaken or stirred, or because it's alive. Let me talk now only about living matter and its analogues.

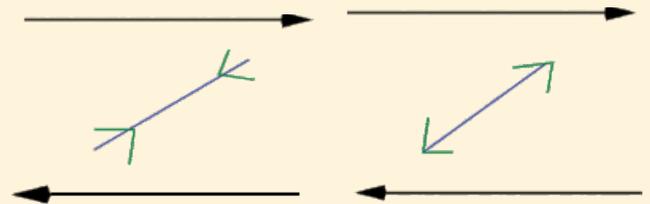


My students, colleagues and I generalized the equations of liquid-crystal hydrodynamics to the case where the "molecules" that formed the system were self-propelled, for example, flocks of bacteria or schools of fish. Think of two basic kinds of swimmers: bacteria, which we call pushers because they swim by pushing fluid behind them, and algae, which are pullers, that do a kind of breast-stroke, both illustrated in the drawing above this paragraph.



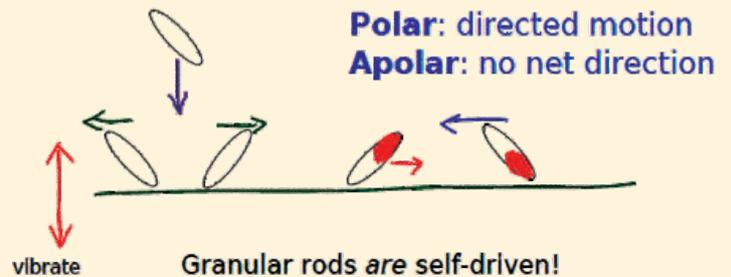
We showed that aligned states of slow, small swimmers in a viscous fluid are unstable to the least disturbance at large scales. The drawing above shows the mechanism for pullers (left), and pushers (right). A disturbance in the orientation produces a flow that pushes the disturbance further in the direction it's already going in. This provides an explanation for the "turbulence at zero Reynolds number" widely seen in collectively swimming bacteria.

The flows and stresses produced by swimming organisms should alter the measured viscosity of a fluid, as shown in one more cartoon, above. Flow imposed on a group of orientable organisms leads to a mean orientation shown by the blue line.



Flow and stress of swimmers changes fluid viscosity: Pullers (left) increase and pushers (right) decrease it.

The flows generated by the swimming activity (green arrows in the cartoon) then pull back on (left) or pushes out on (right) the fluid. So pullers resist, and pushers go with the flow. Experiments by two groups showed that we were right. Another prediction was that disturbances of density and swimming direction in schools of large, fast swimmers like fish travel as waves, whose speed has an intricate direction-dependence that we are able to predict -- and we'd love to see this tested.



Liquid-crystalline states of living cells that are elongated but have no head-tail distinction -- e.g., the cells that distribute pigment in your skin -- should display enormous density fluctuations, proportional to the mean density on all length scales, not decreasing as you increase the sample volume. This last we were able to test and confirm in a funny



Sriram Ramaswamy
Infosys Prize Awardee

experiment on a vertically vibrated horizontal plate covered by little segments of wire. Why such a setup is a validimitation is illustrated in the drawing above. Our work is a contribution towards understanding movement and force in living matter, in groups of organisms, collections of cells, and in the membrane and cytoskeleton of one cell. With time, and as physicists learn more biology and biologists more physics, I believe that these new ideas in physical biology will become part of mainstream thought. I hope too that our research alerts young minds to the beautiful physics of living matter.

President's Desk

Dear colleagues,

As you read this Newsletter, probably, this financial as well as academic year may be coming to the close. I am sure many would have exceeded the target and some have to catch up.

I am very happy to inform that your Association is able to contribute quite a bit to two successful events of students :

“Rhythmica” – a delightful Musical Evening organized by Students, Alumni and Faculty of IISc, which showcased the multi-skill of our family apart from academic and science.

“Samanway 2012 – National Students Conference on Connecting Science and Society”, which has been very successfully conducted by students with a good response from all over the country. We had a good share of supporting them. Further, IIScAANA also agreed to support this event. This sort of student, alumni joint programme goes a long way in enhancing the overall activity and image of IISc Alumni Association.

We have lined up many programmes. Looking forward to your enthusiastic participation. It is very heartening to note that students and faculty of IISc are being recognized by many awards.

V Babu Sathian

Editorial

Dear reader,

This issue is dedicated to the founder of the Institute - Jamsetji Nusserwanji Tata, on the occasion of his birthday, which is fondly remembered and celebrated by the Institute as the Founder's Day. J.N. Tata is a legend and a great visionary, who made the premier Institute of higher education and scientific research in India a reality giving birth to hundreds of scientists. We pay our tributes to the legend on this occasion.

In pursuit of knowledge and excellence, we have two articles, one by Prof. Sriram Ramaswamy, who received the first Infosys award, and the other, an interview with Prof. Navakant Bhat, who got the Outstanding Research Investigator award from the Department of Atomic Energy. The articles give a deep insight into their experiments and observations; the results are incredible and are foresighted.

In this issue we have information about the Department of Mechanical Engineering. It augurs well that the Department has initiated interdisciplinary research work along with the ongoing research programmes, which leads to greater interaction among various Departments. Over the time, the programme should lead to new and unexplored areas of discovery.

As the activities of Alumni association are growing, we request the Institute authorities to take initiatives to enroll every student as an alumnus for the bondage to become stronger and stronger.

Please feel free to express your views on the newsletter by writing to : iiscaanlg@yahoo.com

H. K. Anasuya Devi

Bio-mechanics and Bio-design

Research in Mechanical Engineering has always been at the interface of engineering and basic sciences; it has much overlap with almost every branch of engineering and also with basic sciences including Chemistry, Mathematics, and Physics. Although the link to biology too was there in the form of mechanics of bones, today this has become more apparent with the increasing trend of viewing organs, tissues and even biological cells as mechanical entities. In tune with this trend, the department of mechanical engineering at the Indian Institute of Science (IISc) has ongoing research in cell and tissue mechanics. Almost a quarter of its faculty have interest in mechanics of fluids or soft solids found in living organisms. Examples include multi-phase flow through blood vessels, modelling of transpiration and evaporation in leaves of plants, mechanics of swimming fish, modelling of arteries, studies on neuronal cells due to genetic variations, discerning the mechanical behaviour of bacteria and their mutants, micromanipulation and mechanical characterization of single cells, and protein design.

The Department has a new facility to culture cells. The cells considered for study include model cells such as HeLa, HuH-7, MCF-7, etc., fibroblasts, and endothelial cells. These studies aim to understand the factors underlying in vivo growth of cells and applying that to grow cells ex vivo in 3D environments towards understanding the development of vasculature and its importance in cell-growth. There are also instruments, either bought or developed in house, to measure the mechanical response of cells and tissues. There are bi-axial and tri-axial stretchers wherein tissues can be characterized. There is also a bio-micromanipulation system with a haptic interface using which individual cells can be grasped, rolled, squeezed, and lysed. A haptic robot (which helps the user feel the force just as virtual reality helps us see what is not in front of us) linked to a miniature

gripper or injector in a master-slave mode, is setup so that micron-sized cells can be manipulated with human hands with real-time force-feedback and vision. See Fig. 1. This experimental work is amply supported by computational work that aims to experimentally determine the mechanical properties of cells by solving inverse problems in elasticity.



Figure 1. Bio-micromanipulation system comprising a haptic robot, miniature grippers, micro-positioners, and a microscope. A zebrafish egg-cell grasped and pierced is also shown.

There is also work on developing enhanced surgical tools and intracranial pressure monitoring systems both of which are done in collaboration with clinicians. Activity in mechanobiology (a new field in which biology is studied with mechanics-orientation) and tissue engineering (a growing research area that one day hopes to engineer any tissue and organ in a laboratory) has also begun with a large grant from the Department of Biotechnology (DBT). This inter-disciplinary research involves collaboration with two biology departments in IISc, namely Molecular and Cell Biology (MCB) and Molecular Reproduction and Developmental Genetics (MRDG), as well as clinicians in St. John's and Fortis hospitals in Bangalore. Another facet to biology-oriented work in the Department is on bio-design, an area that concentrates on developing products and instruments for the medical industry. This is done in conjunction with the Centre for Product Design and Manufacturing (CPDM) in IISc.

G.K. Ananthasuresh

TranSensTor : Transistor Embedded Sensor Technology Platform

Navakanta Bhat: Outstanding Research Investigator Awardee



Prof. Navakanta Bhat received the Outstanding Research Investigator Award in 2011 from the Department of Atomic Energy, Govt. of India in recognition of his work to develop integrated transistor and sensor platform using Nanoelectronics Technology. He calls this “TranSensTor” platform to emphasize the high level of integration and proximity of sensor element along

with the transistors for signal conditioning. This is a very rich area, both in terms of research and technology development, which enables application of nanoelectronics in creating ambient intelligence.

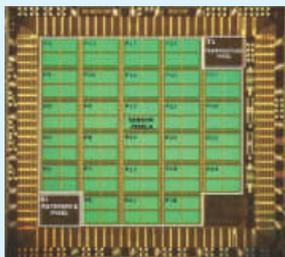
His group has developed suspended gate field effect transistor platform for inertial sensors, where the gate electrode forms the proof mass of the sensor. Through a clever design technique, the transistor is forced to operate in the sub-threshold region, resulting in an exponential response from the sensor with built-in amplification. This has potential applications to realize inertial grade gyroscopes, micro-g accelerometers and highly sensitive displacement sensors.

Another important application area is integrated gas sensor array platform. This research has resulted in a prototype chip on 350nm CMOS technology, with 30 pixels that can be functionalized independently for sensing different gases. In addition to the transduction, each pixel enables signal amplification and analog to digital conversion for digital readout from the chip. This work can potentially lead to the realization of “electronic nose” for gas sensing applications.

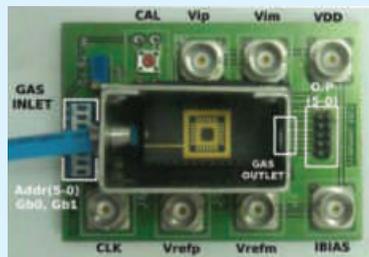
In the next few years, he plans to use this platform for lab on chip applications in biosensor and point of care diagnostics devices. His group has already initiated a few projects in this area. He envisions very novel devices in the near future, with the capability to create nano transistors at length scales of DNA.

This kind of work requires state-of-the-art Nanofabrication facility. The National Nanofabrication facility at the Centre for Nano Science and Engineering (CeNSE) department has been a great enabler in this direction (featured in December 2011 issue). Prof. Bhat is a faculty in CeNSE and ECE departments at IISc. His contact information:

URL : <http://www.ece.iisc.ernet.in/~navakant>
Email: navakant@ece.iisc.ernet.in



The micrograph of gas sensor array platform with 30 pixel elements



The packaged chip with other system components for gas sensing



Suspended gate inertial sensor device

H. K. Anasuya Devi

Awards and Recognitions

Students

Mr Damodaram Baviriseti	Prof S V C Aiya Medal + Cash Prize
Dr J Harshan	The Seshagiri Kaikini Medal + Cash Prize
Mr Sushruth N Donthi	Prof F M Mowdawalla Medal + Cash Prize
Mr M Pramod	The Alumni Medal + Cash Prize
Mr. Kallol Roy	APS IUSSTF Fellowship

Faculty

Prof. Arnab Rai Choudhuri	Outstanding Academic Title of 2010; Astrophysics for Physicists
Prof. K. Gopakumar	IEEE Fellow
Prof. S. Ramakrishnan	S.R. Palet Award Lecture at IACS Kolkata; J.C. Bose Fellow
Prof. E. Arunan	Fellow of IUPAC Elected to the International Advisory Board for the Horizons in Hydrogen bond research Conference
Prof. G. Mugesh	Board member of a new ChemPubSoc Europe Society Journal, Fellow of the Indian Academy of Sciences, AstraZeneca Excellence in Chemistry Award, Editorial board, J. of Chemical Sciences
Prof. S. Sampath	Editorial board, JI. of Chemical Sciences
Prof. S. Vasudevan	Elected to the Indian National Science Academy
Prof. P.S. Mukherjee	NASI-Scopus Young Scientists award
Dr. Ramulu More	Prestigious National Geoscience Award-2010 for Mining Technology from Ministry of Mines.

IIScAA Science Forum – Popular Lecture Series

The Twentieth Lecture (December 24, 2011)

Topic : 2011 Nobel Prize in Chemistry : Quasicrystals, where Art Meets Science

Speaker : Prof. S. Ranganathan, Emeritus Professor, IISc & Homi Bhabha Visiting Professor, NIAS

Moderator : Prof. E. S. Dwarakadasa



The Twenty Second Lecture (February 18, 2012)

Topic : Sparking curiosity, creativity and leadership in disadvantaged children

Speaker : Mr. Ramji Raghavan, Founder Chairman, Agastya International Foundation, India

Moderator : Dr. V. K. Aatre



The Twenty First Lecture (January 21, 2012)

Topic : Sustainable Energy Security for India : Challenges & Options

Speaker : Dr. Anil Kakodkar, DAE Homi Bhabha Chair Professor, BARC

Moderator : Dr. V. S. Ramamurthy



Upcoming Lecture :

Dr. Surendra Pal, Prof. Satish Dhawan Professor & Senior Adviser, Satellite Navigation (ISRO), ISRO Satellite Centre, Bangalore, on "Global Navigational Satellite Systems – an Indian Perspective", Saturday, March 17, 2012, 4.00 p.m. at the Faculty Hall, IISc. Prof. P. R. Mahapatra, Professor, Department of Aerospace Engineering and Dean, Faculty of Engineering, IISc, Bangalore, will be the Moderator.

H R Parthasarathy

Upcoming Events

- Conference on Signal Processing & Communications, SPCOM 22-25 July 2012 - JN TATA Auditorium
- Workshop on Ramanujan & Indian Mathematics; 13th April 2012, GJH, ECE Dept.
- Conference on Optical Engineering, ICOE 2012, 26-28 July 2012 - VTU, Belagum

IIScAA Activities

Dear member,

IIScAA organized a friendly Cricket Match among Alumni on Sunday, January 29, 2012 at the Gymkhana Ground, IISc. The Chief Guest for the event was Shri Sadanand Viswanath, Ex-Member, Indian Cricket team. 65 members including 30 players representing 27 organisations around Bangalore participated in the event.

IIScAA sponsored the Musical Evening Programme Rhythmica, on Sunday, February 5, 2012 held at Satish Dhawan Auditorium.

IIScAA has enrolled 85 members during the period – 1st June 2011 till 29th February 2012.



L N Satapathy

Membership

Membership information, the fee details and ID card application can be downloaded from <http://www.iiscalumni.com/about-us/membership.htm>

Please send your application to the General Secretary, Alumni Association, IISc, Bangalore - 560 012

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