What was current science for *Current Science* 50 years ago?

Iva Kostadinova

The end of the year always invokes a retrospective journey back in time. Some choose to walk a short distance, while others embark on a long journey through decades and centuries. But they all search for one thing – the coordinates of where they are with respect to where they started from, and where they are heading to. The genius of humankind has managed to compartmentalize time in a strict order, thus making the job of comprehending and analysing it as easy as possible. The continuity of all retrospective journeys is guaranteed by the endless number of people and the history they have created, that serve as 'toll-free bridges' across compartments. It goes without saying, that the coveted coordinates you are searching for vary a lot, depending on which route you take to get to your starting point. What I want to do in the following lines, is drop you in the compartment of 1960, then zoom in and show you what was current science then for the journal which you are holding in your hands right now. Should I succeed in provoking you to start a retrospective voyage of your own, choosing the route as you please, I can dare to dream that something, somehow, for someone may take a different course in the future.

The year 1960 was a leap year that is largely remembered as 'the year of Africa', when Harold Macmillan, the Prime Minister of UK gave his famous 'Wind of Change' speech that blew the wind of change and brought independence to many African nations. The same year, the canton of Geneva granted women the right to vote, the first television station started broadcasting in Auckland, New Zealand, and the famous presidential debate between Richard Nixon and J. F. Kennedy was televized and watched by more that 66 million people, eventually leading to the election of Kennedy as the next President of the United States. The Cold War was ominously present and China was suffering the consequences of the Great Leap Forward, that had rather led to the Great Chinese Famine. The population of the world was a little over three billion people.

The world of science and technology is also marked with inventions and discoveries tagged with a 'born in 1960' label. Theodore Maiman devised and experimentally tested the first working ruby laser; John H. Reynolds estimated the age of the solar system to be 4.95 billion years after studying isotope ratios in a meteor that had fallen in North Dakota in 1919; and the first CERN particle accelerator became operational in Geneva, Switzerland. For USA, 1960 was a year of conquering the space outside the earth. The Americans managed to launch the first weather satellite TIROS-1, the first satellite navigational system TRANSIT-1b, and the first passive communication satellite under the project Echo. The same year, project Ozma, the pioneering Search for Extraterrestrial Intelligence (SETI) experiment started at the National Radio Astronomy Observatory, West Virginia. For most people like my parents who were kids at that time, 1960 will always be associated with the images of the two dogs, Belka and Strelka, who travelled in space for a day on Sputnik 5, along with 40 rats, two mice and a variety of plants.

India entered 1960 with Rajendra Prasad as its President and Jawaharlal Nehru as its Prime Minister. In May, what was then known as the Bombay state, split into the current states of Gujarat and Maharashtra. The conflict over the Indus-basin rivers was mediated by the World Bank, which led to the Indus Waters Treaty that granted exclusive rights to India for the three eastern rivers – Ravi, Beas and Sutlej, while the western Indus, Jhelum and Chenab were to be used by Pakistan. The population of India was growing fast and the reforms in agriculture and food production were desperately trying to cope with this. In 1960, most of the IITs were not yet established, Bollywood movies were still black and white, and the famous beaches of Goa were not yet a part of India.

Current Science was still in its twenties, full of energy and enthusiasm to entertain its readers every fortnight rather than once a month, but unable to do so because of its 'precarious financial position' (the fortnightly publication of *Current Science* started in 1964)[1]. The editor of the journal at that time was Dr A. S. Ganesan, who was convinced to take up that position in 1958 by C. V. Raman. The subscription rate was 12 rupees within India and 16 rupees abroad. All the articles which today are embellished in categories like Scientific Correspondence, General Article, Review Article, Research Article and Research Communication were back then dressed in the same simple uniform of 'Letters to the Editor'. Sitting in the library of Raman Research Institute, Bangalore, I am flipping the pages of a leather-bound collection of all twelve 1960 *Current Science* issues, until I reach exactly 50 years back – the December 1960 issue.

The cover page is forever lost and I encounter the second part of a beautifully written essay by S. Pancharatnam, structured in a way that takes you smoothly on a reflective and explanatory journey to the world of coherence properties of electromagnetic radiation. The maturity of his understanding of the subject and the clarity of his writing make it hard to believe that Pancharatnam was only 26 at that time. He had already been elected a fellow of the Indian Academy of Sciences, Bangalore and four years earlier, in 1956, had discovered the Pancharatnam phase – a geometric phase in polarization optics used in various applications today. Without doubt, Pancharatnam was inspired to write his essay because of the recent successful experiments that Theodore Maiman conducted with a synthetic ruby crystal to show for the first time the effects of the laser. Pancharatnam writes: 'Very recently, effects depending on light amplification by stimulated emission of radiation (LASER action) have been observed experimentally. We shall, in the last section, return to these experiments – which must certainly be classed among the most spectacular and fundamental experimental observation in the field of optics in recent times'[2]. Pancharatnam passed away at the early age of 35 and Maiman died in 2007 from systemic mastocytosis for which currently there is no cure. But both have found a way to build their firm and long-lasting 'toll-free bridges' across time.

The end of Pancharatnam's essay meets the beginning of a exhaustive analysis of data collected over a period of one decade that 'throws light on some of the fundamental principles of sanitation' and natural purification of sewage water[3]. The study was a collaborative effort between a group of researchers at the Department of Biochemistry, IISc, Bangalore and the Department of Public Health, Bangalore. At that time, Bangalore had a population of 1.4 million people and according to the study, 60 million litres of sewage were dumped daily in the city's outskirts through an underground sewage system (available only in the centre of the city) that connected to three outfalls, from where the sewage flowed freely into three natural channels. The analysis of the physical features of the sewage channels (length, gradient, etc.), the microorganism content (bacteria, fungus, algae, protozoa, rotifera, etc.), and chemical properties of the sewage (pH level, turbidity, dissolved oxygen, nitrogen, etc.) were used to identify the 'more important factors influencing purification of the flowing sewage'[3]. The authors conclude: 'The above observations are of scientific interest as well as of practical importance as they not only relate to a sanitary principle in Nature and its bearing particularly on the modern methods of sewage disposal but indicate the possibility of increasing the efficiency of the activated sludge process and other methods of aerobic treatment of sewage'[3]. Today, the population of Bangalore has risen to the staggering number of 8 million (http://www.karnataka.com) and its citizens produce 700 million litres of sewage daily. According to the Bangalore Water Supply and Sewerage Board (BWSSB) which was established 4 years after the study, and is currently responsible for sewage disposal and water supply in Bangalore, the city now has 13 operational sewage treatment centres with 20 more to come at some unknown time in the future. I wonder if from 1960 until now, the collaborative efforts of academic institutions and BWSSB to solve the poignantly putrid sewage problem of Bangalore have increased in proportion with the rise in amount of sewage.

The bulk of the *Current Science* issue which I am holding in my hands is dedicated to more than 20 articles printed under the 'Letters to the Editor' section. The geographical spread of the institutions that contributed to that last issue for 1960 speaks about the truly national character of the journal. If one wants to take a new and unconventional route to tour India, something which is not suggested by Lonely planet or any other travel guide, then I suggest you follow the 'Letters to the Editor'. It will take you from Shimla in Himachal Pradesh, Udaipur in Rajastan, Kanpur in Uttar Pradesh, Baroda in Gujarat and Darbhanga in Bihar, to Cuttack in Orissa and Karaikudi in Tamil Nadu, as well as India's major intellectual centres – Bangalore, Mumbai, Hyderabad, New Delhi and Kolkata. A leisurely walk through the articles will offer a journey of its own. Just a few years before Norman Barloug was invited to India and his high-yielding wheat and rice strains marked the beginning of the Green Revolution in the country, *Current Science*, was already reflecting the efforts of the scientific community to address and solve the urgent problems facing India's fragile socio-economic conditions.

Many of the articles deal with issues like rice breeding, effect of insecticides on crops yield, citology of the Indian bean (*Dolichos lablab* Linn.), fungus infections on a variety of crops and plants, effect of specific hormones on spinach growth, developments in parthenocarpic (seedless) guava, tiller in millets, insecticide control of sweet potato weevil and even innovative controlled propagation of *Althea rosea* – an ornamental plant commonly known as holyoke. Long before DDT and other insecticides were

COHERENCE PROPERTIES OF ELECTROMAGNETIC RADIATION
PART II
S. PANCHARATNAM

1. Resonance Radiation and Induced Emission

Towards the beginning of this century, R. W. Wood discovered the phenomenon of resonance radiation in sodium vapour: when the monochromatic yellow light of sodium was passed through sodium vapour, the latter in turn exhibited a yellow fluorescence of the same character, the incident radiation being rapidly absorbed on passing through the vapour. The term resonant fluorescence or resonance radiation to describe the emitted light arose from the classical explanation of the phenomenon, which it is worthwhile to outline in some detail—since it gives correctly the coherence properties of the secondary radiation which we shall require in later sections.

When a plane wave of light traverses a medium composed of classical dipole-oscillators the latter will be set into forced oscillation at the frequency ν of the incident wave. Because of the periodic dipole thus induced each atomic oscillator will emit radiation of the incident frequency ν—which may be observed as a feeble Rayleigh scattering transverse to the beam. However, when the frequency of the incident light coincides with the natural frequency ν_0 of the dipole-oscillators, the amplitude of the forced oscillation (and consequently the intensity of the secondary scattered radiation) should build up to large values because of the phenomenon of resonance. It must be noted that the induced dipole-oscillation will have a specific phase-relationship with the exciting light field (amounting to a phase lag of $\pi/2$ at exact resonance). Thus in turn the resonance radiation from an atom should be *coherent* with the exciting radiation. This explains at once the apparent absence of secondary radiation in the exact forward direction, *i.e.*, in the exact direction of the exciting beam, and the attenuation or absorption of the latter. For, it may be shown that all the secondary wavelets from a plane of atoms normal to the incident beam will coalesce to form a plane wave travelling in the same direction as the incident beam, but exactly *opposed* in phase to it. Thus, it is really the destructive interference of the resonance radiation scattered in the forward direction with the incident beam that leads to the progressive attenuation of the latter.

On the quantum theory, resonant fluorescence arises because the incident photons are of the right energy to raise the atoms from the normal or ground state to a higher energy state, the atom then returning to the initial state with the emission of resonance radiation. The coherence of the emitted radiation with the incident, however, indicates that the two transitions, *viz.*, to the higher energy state and back, must not be regarded as independent processes, but as part of a composite process. If we treat radiation alone classically, we may say that the oscillating dipole moment (corresponding to the double-transition) lags in phase by $\pi/2$ behind the phase of the perturbing light wave—as also happens when the atom, too, is regarded as a classical oscillator.

We have considered the atom to be initially in the lower state but the quantum picture naturally leads us to ask the following question: Could we also expect a form of resonant fluorescence when the atom is initially in the upper or excited state, and the energy of the incident photons coincides with the energy difference between the initial state and a *lower* energy state of the atom? The answer is yes, but the phenomenon is termed *induced* emission to emphasize that this radiation is induced by the presence of the light field, and thus represents something distinct from spontaneous emission: the latter is due to the natural decay of the excited atom from the upper to the lower state and would continue to exist even in the absence of an external light field. Induced emission is usually described as a transition from the initial excited state to a lower energy state under the influence of radiation of the appropriate resonant frequency, *i.e.*, which lies within the natural line-width. However, in the author's opinion it should perhaps be considered—as in the analogous case of resonant fluorescence—as involving a double-transition, *viz.*, to a lower energy state and back. As in the case of resonant fluorescence, the radiation from an atom due to induced emission is coherent with the light wave which stimulates it. However, an important difference in the present case is that the phase of the oscillating dipole-moment (corresponding to the double-transition of the atom) is advanced by π relative to that obtaining in normal resonant fluorescence. Thus, if we have an assembly of atoms which are—by artificial means—being kept in an excited state, then when a plane

Important figures in Indian science like Pancharatnam were regularly publishing essays and notes in *Current Science*.

proven harmful and their usage was banned, the Division of Entomology, Department of Agriculture, Bangalore was conducting studies to test the plant–body reaction of various crops to such insecticidal treatment in the absence of insect population[4].

Several articles discuss various topics from the field of zoology. Just few years after its synthesis in 1952, diazinon (a colourless dark chemical, formerly used as insecticide to control cockroaches and fleas) was already widely used for gardening and pest control. Indian researchers from the State Forensic Sciences Laboratory in Madras reported a novel, sensitive colorimetric method for diazinon detection in biological materials[5]. At the same time, scientists from the Indian Agricultural Research Institute, New Delhi, were on a quest to study in detail the amino acid constituents of the notorious carpet beetle – a rather destructive wool pest that is also known to infest certain stored goods as well as specimen in museum collections[6]. Concurrently with the carpet beetle research, the Department of Zoology in The Institute of Science, Bombay reported its finding of backwater oysters affected by what was known as Shell disease[7]. Further studies were prompted as oysters were (and continue to be) an important component in the diet of many coastal communities in India. Again in Bombay, a study from the Haffkine Institute looked at the alarming increase in the number of giant rats (*Bandicota bengalensis*) in the city and more importantly, their rising resistance to plague (the rats were injected with a dose of *Yersinia pestis* – the bacterium responsible for such ghastly epidemics like the Black Death that wiped away almost half of Europe's population in the 13th century)[8]. While reading through these words on the paper that carries the yellowish scar of time, I remembered something that Mahatma Gandhi wrote for Young India in 1925. He had listed seven social sins and one of them was 'science without humanity'. It seems to me that in 1960, science in India, as caught on the *Current Science* pages was still largely done 'with humanity'.

The editor Dr A. S. Ganesan was a prominent physicist who had worked for

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LETTERS TO THE EDITOR

ULTRASONIC ABSORPTION MEASUREMENTS IN SOME PURE LIQUIDS

IN recent years considerable attention is being given to the study of ultrasonic absorption in liquids because of the anomaly that the observed absorption coefficients are usually greater than the theoretical values. The authors have recently developed a technique for the study of absorption in corrosive liquids by using the diffraction method and the results of absorption measurements carried out for some esters and a corrosive liquid using this technique are presented in this communication.

The ultrasonic absorption is measured by the well-known optical diffraction method.[1–3] In this method a parallel beam of monochromatic radiation of constant intensity is passed through the experimental medium which is itself traversed by plane progressive ultrasonic waves in a direction perpendicular to the direction of light propagation. This results in the diffraction of the emergent light, and a measurement of the diffracted light intensity of the first order which is proportional to the sound intensity, for low values of sound intensity, enables the estimation of the ultrasonic absorption coefficient. In the present investigation a sodium vapour lamp driven by a constant voltage transformer is used as the source. The crystal holder is a pyrex glass sheet with a deep circular depression in the centre, which serves simultaneously as the lid of the ultrasonic cell. The bottom surface of this depression will be in contact with the liquid in the cell. The top surface of the lid is silvered and the piezo crystal rests in the depression with a film of oil to give acoustic contact. An electrode pressing on the top silvered surface of the crystal and another on the silvered surface of the lid will serve as the electrodes for exciting the crystal. The diffracted light intensity of the first order is measured accurately by means of a sensitive Photovolt multiplier photometer. An X-cut quartz crystal driven at one of its odd harmonics by a low power, variable frequency Hartley oscillator generated the ultrasonic waves. The frequency is maintained constant using a heterodyne wavemeter of high accuracy. The specially designed all-glass crystal holder was necessary to isolate the corrosive liquid from the silvered quartz crystal. Measurements were carried out at high frequencies of 25 and 35 Mc./sec. such that progressive waves can be easily set up in a small quantity of liquid in the cell. Temperatures of the liquids are maintained constant to within 0·1° C. The values of α/f^2 thus obtained are presented in Table I.

TABLE I

Liquid	Temp. in °C.	$(\alpha/f^2)\times 10^{17}$ in nepers/sec.^{2} cm.$^{-1}$		
		Experimental values		Theoretical values
		25 Mc./sec.	35 Mc./sec.	
Phosphorus oxychloride	31·7	199	212	..
Methyl Benzoate	32·7	62·7	61·3	16
Ethyl Benzoate ..	35·0	68·0	49	21
Benzyl Benzoate	40·5	158	132	45
Benzyl formate ..	32·9	..	53·3	14
Benzyl acetate ..	34·2	..	63	18

It is evident from Table I that the observed ultrasonic absorption is considerably higher than the theoretical value, a common feature which has been reported in many liquids. The apparent discrepancy in the observed values of α/f^2 for the two different frequencies in some of the liquids studied is characteristic of the particular liquids and warrants a detailed study of the absorption variation over a wide range of frequencies.

The authors wish to express their thanks to the Council of Scientific and Industrial Research for the financial aid in connection with this project.

Ultrasonic Labs., Physics Department, Andhra University, Waltair, *November* 3, 1960.
H. S. RAMA RAO.
B. RAMACHANDRA RAO.

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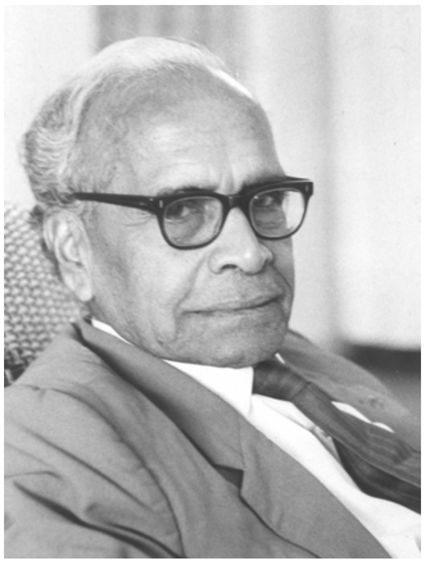
POTENTIAL CONSTANTS OF CERTAIN PLANAR XY_2Z MOLECULES

USING Wilson's[1] FG matrix method and employing the most general force field, the force constants of CH_2O, CD_2O, CF_2O, CCl_2O, BF_2Cl and BBr_2Cl are evaluated. The usual notation is employed in listing the constants in Table I.

For a long time in the history of science, correspondence and dissemination of scientific knowledge happened through personal letters of one scientist to another, primarily written in active voice. The emergence of scientific journals changed that, but slowly ... in 1960 still most of the scientific articles were categorized as 'Letters to the Editor'. Today, with the new trends of science blogs where scientists speak about their work from the prospective of 'What I experienced, tried and discovered', the old, personal touch to science is coming back.



It was under the editorship of A. S. Ganesan in 1964 that *Current Science* became a forthnightly journal. In an obituary, published by *Current Science* in 1986 after Ganesan's death, M. R. A. Rao wrote: 'a man of strong principles and a strict disciplinarian, he (Ganesan) was known for his impartiality as an editor'.

many years along with Sir C. V. Raman. Naturally, a handful of the 'Letters to the Editor' had a flavour of physics. A group at Andhra University reported on a new 'technique for the study of ultrasonic absorption in some pure liquids'[9]. The 60s were marked by a rapid development in the area of ultrasound, especially for medical diagnosis, and India was making its own contribution in the field. Another group at Osmania University, Hyderabad compared their gravimeter data with the seismic record from Nizamiah Observatory and concluded: 'that earthquake shocks felt within the vicinity of the Gravity station have a considerable effect on the continuous Time–Gravity variation curve. It suggests that the gravimeter is acting as an accelerometer'[10]. This last statement puzzled me as in 1960 it was well known, from Einstein's theory of relativity, that gravimeter is a kind of accelerometer. What exactly was the purpose of this study and what was the significance of its finding is a matter of deeper investigation that may lead to many other interesting 'compartments of time'.

The 'Letters to the Editor' section is followed by a 'Reviews' section that features book review articles for 14 highly specialized, technical books and monographs like 'The Chemistry and Biology of Sialic Acids and Related Substances', 'Principles of Dairy Science', 'Ticks, a Monograph of the Ixodoidea' and 'Ultracentrifugation in Biochemistry'. What really struck me was the fact that not a single article covered a publication, be it, a book or a monograph, written by an Indian author. Today, if you open randomly the 'Book Review' section of any recent *Current Science* issue, you will almost surely find a lot written about books by Indian authors. Such positive trend is encouraging. It is a sign not only of the spread of a conducive research environment across the country, but also of the willingness of scientists to communicate their work to the large public – something of great importance for a fast-developing country like India.

The last three pages of the December 1960 issue of *Current Science* have been dedicated to 'Science Notes and News'. Two pieces of news caught my attention. The first one was a report on a symposium titled 'Plant Embryology' that took place on 11–14 November 1960. The report says: 'Prof. P. Maheshwari suggested that a book on the 'Comparative embryology of angiosperms' … be written as a joint undertaking by various authorities in India and abroad'[11]. Thirty-two years later, in 1992 *Comparative Embryology of Angiosperms* was indeed published by Springer, with Brij M. Johri, Kunda B. Ambegaokar and Prem S. Srivastava as its authors. The second news was an announcement for the United Nations conference on New Sources of Energy to be held in Italy in August 1961: 'The United Nations Conference on New Sources of Energy will examine practical problems and experience in the utilization of solar energy, wind power and geothermal energy … the conference will focus attention on applications … giving prominence to lines of action which have already led, or are about to lead, to commercial energy applications'[11]. In 1960s, such international conferences, regarding renewable energy sources were most likely triggered by the global environmental movement that picked up after the Second World War. I have not done any historical research to find out what was the real impact of that UN Conference, but I have a feeling that meetings like the one in Copenhagen and Cancun repeat the same story dressed in a different suit. I can only hope that if 50 years from now somebody opens the history of our times and comes across the term 'sustainable future', it would resemble their present.

I close the heavy leather-bound volume of *Current Science* and the nostalgic smell of the past lifts-off the old, brown pages and invades my senses. Two thoughts are quick to emerge and demand my attention. If the December 1960 issue was to disappear and the only account of it left in the world were my words, would I write these same words? When the answer 'yes' slowly takes shape in front of me, I move to my second thought. Next time, I have some of this highly precious and courageously fought for free time, which issue of *Current Science* should I open?

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