

India at Neyveli. Among his other distinguished contributions were his commentary on the distinct orogenic trends of the Archaean rocks in different parts of India and their correlation (*GSI Memoir 81*, 1953), the classification of various volcanic episodes, in particular, those within the crystalline complexes, and their interpretation in relation to tectonic trends. He had also contributed to the petrography of the rocks of Girnar and Osham hills of Saurashtra (now in Gujarat), about lateritization of the peculiar meta-sedimentary rocks called the khondalites, on the mineral resources of former Central Provinces and Berar (now forming parts of Madhya Pradesh), the geology of the Vindhyan formations of northern India, the Deccan traps, the Tertiaries of Tanjore (Tamil Nadu), and some interesting observations on some of the extinct rivers of the north (Indobrahm and Saraswathi).

Krishnan never rested on his laurels and had always explored avenues to keep Indian geology abreast with advances the subject had made over the years in the fields of mapping, exploration and basic studies and added new

sections in the GSI to cover them. His contemporaries and juniors at the GSI recall that he was modest in his bearing, and easily approachable and ever willing to recognize new thinking or ideas even when it came from the juniors. He was open-minded, unlike many persons of his age, position or brilliance, who often held dogmatic or prejudiced views. This attitude of his enabled him to spot talent and bring it up. For instance, early in his stewardship of the GSI, he realized the importance of geophysics in exploration geology, and lost no time to introduce it by tapping the expertise of noted contemporary geophysicists in the country to organize geophysical investigations. These moves resulted in proper evaluation of many of the promising mineral deposits of the period. The oil exploration in India, through the application of geophysical techniques like aeromagnetic, gravimetric and magnetic surveys was one among several successful projects to benefit from his vision. As the Director of GSI, his two other notable contributions to exploit economic mineral potential of the country were the mining of the lignite deposits at Neyveli overcom-

ing problems of huge aquifer and clay cover, and the resurrection of gold mining in Karnataka, particularly the boosting of the mining operations in Hutti.

India has been fortunate to have a person of the caliber of Krishnan at a time when the country, on the threshold of industrialization soon after independence, badly needed one who could organize and plan suitable surveys for some of the economic minerals and ores, and help to build proper infrastructure for their recovery. It is but fitting that Krishnan's lifelong dedication to Indian geology was recognized and he was honoured with the *Padma Bhushan* by the renowned President of India, S. Radhakrishnan, in January 1970. Eight months later, during a visit to his native village near Tanjore, he underwent an abdominal operation, but did not survive the surgery and breathed his last on 24 August 1970, on his 72nd birthday.

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The spirit of a giant*

G. Venkataraman

We are gathered here today to honour the memory of an outstanding scientist, a remarkable man, and above all a great son of India, who fifty years ago founded this Institute. There is nothing special about establishing a research institute. Many have done so and in this country itself two other institutes were started by eminent contemporaries of Raman, and around the same time too, give or take a few years – I am here alluding to the TIFR founded by Homi Bhabha, and the Saha Institute founded by Meghnad Saha. But Raman's act was unique in that he started this Institute

with his own money and his own savings. He did not take one paisa from the Government; indeed, he went out of his way to summarily reject a handsome grant that came to him on a platter even without his asking. That, in my opinion, is one of the remarkable aspects of the origin of this Institute. I doubt if there is any other parallel in this country, at least in this century. Perhaps the only other example could be the founding in 1876, of the Indian Association for the Cultivation of Science by Mahendra Lal Sircar; I leave you to speculate whether Sircar in any way provided Raman the inspiration.

There was an important reason why Raman rejected Government funds. It was not that he had plenty of money – far from it. He did not take Government

money simply because he did not want to be tied down in any way – one knows how skillfully the bureaucracy can tie one into knots, besides literally driving one crazy. Moreover, Raman wanted to be able to speak out his mind, which he did boldly and without fear whenever the occasion demanded. To me it is this extraordinary and defiant spirit of Raman that stands out prominently in his life, especially in the post-retirement period. Therefore, what I would like to do today is to try and capture for you glimpses of that great, rare and noble spirit.

Life sketch of Raman

It is useful to begin with a thumbnail portrait of Raman. No doubt the story of

*Text of the Golden Jubilee Lecture, delivered on 7 November 1998, during the Golden Jubilee Celebrations of the Raman Research Institute.

Raman is well known^{1,2}, especially to the older members of this audience, but, for the benefit of the younger ones, let me quickly run through the highlights. Chandrasekhara Venkata Raman was born on 7 November 1888 in a small village near Tiruchirapalli in Tamil Nadu. When he was four years old, his father moved to Vishakapatnam to serve as a teacher there in the Mrs A. V. Narasimha Rao College. Young Raman was a precocious child and by the age of eleven he had not only read all the thousand and odd books in his father's collection, but had also qualified for the University with top honours. In 1903, he joined the Presidency College in Madras, sailed through the B.A. and M.A. classes with effortless ease, and knocked off all the University Gold Medals available. Indeed he was something of a minor celebrity, having published original papers in the prestigious *Philosophical Magazine*, papers which invited correspondence from no less a person than the great Lord Rayleigh himself.

The year was 1907. Since science as a career was then unthinkable for Indians, Raman joined the Indian Financial Service, of course topping in the entrance examination. His appointment was in Calcutta where, as is now well-known, he one day accidentally discovered the existence of the Indian Association for the Cultivation of Science (IACS), founded with great hopes decades earlier but now languishing for want of research scholars. Literally single-handed, Raman, through his numerous investigations, not only acquired for himself an international scientific reputation but also made the Association famous – all this, while serving as a Finance Officer of the British Government!

In 1917, Sir Asutosh Mukherji, the Vice Chancellor of the Calcutta University invited Raman to take up the Palit Professorship in Physics, and Raman immediately jumped at the offer. The Colonial Administration was aghast because it had high hopes for Raman. It tried hard to dissuade Raman from committing what it honestly believed was professional harakiri but Raman's mind was set. No doubt by becoming a full-fledged Academic Raman took a substantial salary cut, but this was more than made up by his scientific accom-

plishments as well as the honours that he received. In 1924 he was elected a Fellow of the Royal Society, in 1928 he discovered the Raman effect, and in 1930 he was awarded the Nobel Prize – in a few short years, he had reached the summit. And then came the first great traumatic shock of his professional career. For years Raman had held the post of Honorary Secretary of the IACS but jealous of his success and achievements, forces opposed to him engineered a coup in the Association annual elections and he was ignominiously voted out of office.

Shortly after this, Raman was appointed as Director of the Indian Institute of Science. He was the first Indian to be so appointed, and the job was considered to be a very prestigious one. However, trouble followed Raman very quickly. Since he was intolerant of both sloth and mediocrity, Raman soon made enemies (Raman once declared: 'I easily make enemies!') that included some influential Englishmen. All kinds of charges of irregularities were trumped up against him, and a dubious inquiry was conducted. In the end Raman was forced to resign as the Director and be content with serving as the Head of the Department of Physics. This, so to say, was the unkindest cut of all; Raman could never forget this treachery nor forgive it.

RRI comes into existence

In 1948, Raman turned sixty, the age for superannuation. He retired from the Indian Institute and promptly set camp here, and that was how this Institute came into being. At long last, he could pursue his first love, namely science, in an institution of which he was the sole master and in an environment that was wholly congenial. Looking at the beautiful campus of the Institute today and the wonderful facilities it now boasts of, one cannot imagine how difficult it was for Raman in those early days. But he was a man of tremendous spirit and a great fighter, and he faced problems with firm determination instead of allowing them to overwhelm him. Professor Jayaraman who happily is with us today recalls those days. He says²:

For the first year at the Raman Research Institute there was no elec-

tricity, but that did not deter Raman from carrying out several beautiful optical experiments with sunlight, a few lenses and a pair of polaroids. He considered a beam of sunlight as the best source, and in Bangalore there was no shortage of blue sky and bright sun. A manually-operated heliostat, kept in operation by voice communication, produced astonishing results.

In March 1948, Raman paid a brief visit to Coimbatore to meet that great self-made man G. D. Naidu, whom Raman described as his 'kindred-soul'. Speaking at a party hosted by Mr. Naidu in his honour, Raman said³:

I am building a new Research Institute in Bangalore. I laid no foundation stone to my Institute, but it has just grown up; it will go on doing so. You would not have heard of me during the past five years because I have not taken part in any function....

It is my desire to make that place [the RRI] a most active Research Institute in the whole of Asia. ... People from India and other parts of the world will come and work in that Laboratory... I hope the Institute will become the Mecca of scientists.

Considering the description given by Jayaraman about the RRI of those days, it is really remarkable that Raman could so forcefully make such bold forecasts. No doubt many at that time might have dismissed Raman's statements as mere reflections of his famous ego. To me, on the other hand, they reflect his supreme confidence, his determination, his fighting spirit, and above all, his firm faith in the future.

It is not as if Raman merely proclaimed what his Institute would be like in the future. He was totally involved and immersed in building it up, especially the infrastructure. Reports in the press that appeared in February, 1949, testify to this. In an interview given to the Associated Press of India in Bombay, Raman disclosed that he had cancelled a scheduled Lecture Tour of the United States, because of his preoccupation with Institute affairs. In the course of the interview, Raman explains his priorities and what prompted

him to cancel his American tour. He says⁴:

My immediate task is to get my Research Institute functioning vigorously ... I have recently purchased some workshop equipment and an oxygen plant, which I hope to convert into a liquid nitrogen plant. ... I lack many things, notably a building to house the workshops and a hostel for the research workers, as well as funds needed for the recurring expenditure.

Recalling this, I cannot help wondering how many people today would forego a foreign junket so that they can stay back and help to build up their institution.

Love of nature

For Raman, science was a living religion to which he related at various levels. His own private motivation for doing science came from a deep inner desire to experience the grandeur of Nature. His tastes in science were not shaped by current fashions but by the beauty that Nature exhibits while concealing her secrets. Where Nature was concerned everything was absolutely marvellous, fantastic, incredible, etc., and there weren't enough superlatives for him to describe Nature's glory. More than a century ago, Charles Kingsley declared that superficial physical science was the devil's spade, and advised:

Do not study matter for its own sake, but as the countenance of God. Try to extract every line of beauty, every association, every moral reflection, every inexpressible feeling from it.

Raman did precisely that. For example, marvelling at the butterfly, that miracle of Nature, Raman exclaimed during his address to Lucknow University students in 1950 (ref. 5):

Think of the miracles Nature accomplishes. What is it that determines the pattern of colours in each species of butterflies? Why is Nature able to reproduce each colour in its fineness and shade?

Science was, for Raman, a vehicle for experiencing what Einstein once de-

scribed as a 'Cosmic religious feeling'. At the same time, Raman was quite alive to the unique place of science in human enterprise and Society in general. Thus, while he fiercely defended what is popularly termed pure science and basic research, he never stayed away from or hesitated to discuss matters that related to Science on the one hand and Society on the other. Let me illustrate.

Science and more science

Raman believed, as did Nehru, that the solution of India's economic problems lay in increasing agricultural and industrial production by 'harnessing science and scientists in the fullest possible measure'⁶. Addressing the Institution of Engineers in 1948, he spiritedly declared⁷:

There is only one solution for India's economic problems and that is science and more science. Let us not get away from the fact that the United States is the wealthiest country in the world. What is the reason? There is no country in the world that has so consistently and steadily encouraged scientific studies and scientific research, the basis of all wealth. Wealth does not grow on trees but is made by man. Science, more science and science for all time, is the answer.

Raman no doubt wanted more and more science, but he did not advocate that we blindly copy other countries in basic sciences, applied sciences or in technology. On the contrary, he often deplored what he referred to as camp-following. In an address delivered in 1950 to the Jadhavpur Engineering College, he said⁸:

In the past, India had shown her greatness in the fields of scholarship, philosophy and science but today, we are helplessly dependent on Western countries for knowledge of science.

India should not be a camp-follower but a leader in science. It is no use getting our ideas from the West. We have to think out our problems and find the solutions to them.

Incidentally, you might be interested to know that Aurobindo was the first Principal of this College.

Self-reliance

Raman was against camp-following in all areas, and he repeatedly attacked the craze for imported scientific equipment. Speaking once in the St. Joseph's College here in Bangalore, he denounced the 'superstition' in high quarters that equipment costing hundreds of thousands of dollars alone would aid research. He forcefully added⁹:

There will be no science in India if we continue to rely on imported American and German equipment for research work. I call it paying for our ignorance and incompetence. This is a terrible problem in the country. A halo of infallibility has been built around American and German-made gadgets.

Do not buy such equipment but make your own. Science can and shall advance in very simple ways. We often pay Rs 50,000 for something we can ourselves make for Rs 5,000. The balance in difference we pay for our ignorance. There will be no salvation and no real advance at this rate.

Raman was equally against the import of know-how and technology, so much favoured these days, and was most critical of the tendency to call overseas consultants for anything and everything. In his Convocation Address at IIT Madras in 1966, he really let himself go¹⁰:

We in this country have no future unless we learn to rely on ourselves for all that we need. It is far better to go to the Gandhian age and ride bullock-carts and throw away radio, television and all the rest of it than to cling, as we now do, to the coat-tails of European Civilization. If we cannot by our own efforts, make the things that we require, let us do without them. We must learn the lesson of self-reliance, and until we learn it there is no future for us.

I wonder what Raman would have to say in this age of liberalization, S.K.D.,

C.K.D., and all that. As a wag put it, it was good that Raman was cremated and not buried because if he had been buried, he would now be turning in his grave!

The true wealth of society

Raman involved himself with all aspects of science that touched the social fabric of the country. In fact, speaking at the first meeting of the Academy held in free India – this meeting took place in Cuttack – he made it very clear that scientists of India must rally to the call of the Nation to be of service to the common man and fight the battle against poverty, disease and illiteracy¹¹.

Raman frequently concerned himself with the future of the country. He never saw India as a poor country because he firmly believed that the Nation had an immense reservoir of talent. For him, the wealth of the country was not reflected by the amount of gold in the Reserve Bank or the foreign exchange holdings but by something entirely different. Way back in 1942, he said, while delivering the Convocation Address at the Madras University¹²:

The true wealth of a Nation consists not in the stored-up gold in its coffers and the banks, not in the factories, but in the intellectual and physical strength of its men, women and children.

Six years later we hear the same refrain in his address to the Orissa Chamber of Commerce¹³. On this occasion he once again asserted that the real wealth of a country depended not so much on the gold and silver it had but on the human material it possessed. The real growth of a country, he added, was in the hearts, minds, bodies and souls of the young men and women of the country.

Raman, the youth and education

Raman was always passionately committed to the youth of the country, and there were many reasons for this. Firstly, he firmly believed, as many others do, that quantum leaps in science occur on account of the daring plunges taken by the young rather than via the

cautious plodding of the middle-aged or the old. As he said in a radio broadcast in 1943 (ref. 14),

... the principal requisite for success in scientific research is not the maturity of knowledge associated with age and experience, but the freshness of outlook which is the natural attribute of youth.

Some of you might recognize this as a quote frequently used by AIR until recently. More than even the progress of Indian science, Raman saw the future of the country itself in the youth. Describing himself as 'a farmer in the garden of youth'¹⁵, Raman seized every opportunity to meet the young, talk to them and give advice to them. He enjoyed shaking hands with the young and complimented them for their 'hefty grip'; and he never failed to praise their vitality, intelligence and brightness. Speaking in Allahabad in 1949 at a meeting organized by scientists to felicitate him on crossing the age of sixty, he said¹⁶:

I give myself to the younger generation. I speak to them with candour. I know that my words will not fall on barren ground because there is the quality of sincerity, feeling and understanding. I am confident they will go home to the minds of the young and take root.

The talent of the youth cannot flower unless it is nursed properly. In turn, this implies a proper educational system, good universities, etc. Aware of public and Governmental apathy concerning such vital matters, Raman never missed an opportunity to articulate vehemently about them. Delivering the Convocation Address at the Madras University in 1942, he said¹²:

If you ask me what is the greatest industry of a Nation – the key industry – I have no hesitation in saying that it is the production and diffusion of knowledge. There is no nobler work for a man or an institution than to bring up a young generation in health and strength and in the vigour of intellectual and physical activity.

Raman was quite concerned about the backward state of our universities and

constantly pleaded for their vitalization. He was always worried that 'the universities are not strong enough to bear the burden of free India'. Thus, in the Convocation Address just referred to, he said:

Let us try to make our universities the best – we should not be satisfied with anything less than the best. What will be the result? Instead of a great many of our young men going out of the country, they will remain here and strive to advance our reputation and that will make us strive for more good things.

Raman then added amidst loud cheers,

If we want our institutions to be great and rise to eminence, we must lay aside the belief that our scientific Chairs and Academies are inferior and refuse to accept the proposition that Calcutta, Madras or Allahabad is inferior to Oxford or Cambridge or any other university in the world.

Development of universities necessarily calls for money, and Raman knew very well that the Government would be least interested in such vital investments. Thus, citing the example of American philanthropists, he again and again appealed to the princes and the rich businessmen of India to contribute liberally for the cause of education. Reinforcing his appeal, he once declared¹⁷:

Has it not been truly said that he who gives for learning will be remembered long after kings and emperors are forgotten? There is no greater gift a man can make than a gift in the cause of learning.

Raman always took a holistic view of education, not regarding it as a mere channel for the production of budding scientists. Echoing this opinion on the occasion of Fraternity Day of the Islamia College in Vaniyambadi in March 1947, Raman observed that education must inculcate a proper sense of values that would make life worth living. It must lead to self-expression and self-refinement, creating refined tastes in music and the various fine arts, besides of course the sciences. India which always had been a centre of culture, now

had the opportunity to be a leader not only of Asia but of the whole world; incidentally, these remarks were made on the eve of the Inter-Asian Conference convened by Nehru even as the country was getting ready for Independence¹⁸.

Education, Raman felt, must be imparted in the right ambience. Thus he repeatedly pleaded that universities should be located in picturesque rural settings, far from concrete jungles. In an interview given in Bombay in 1950, Raman said¹⁹:

The countryside is the best laboratory you can have. It provides far better scope than big institutions costing thousands and lakhs of rupees.

Roughly ten years earlier, speaking at the Kumbakonam College, Raman struck the same note²⁰. After describing how great civilizations of the past invariably took root near great rivers, he hoped that India, like Germany, would invest more in rural centres of education because most of India lived in the villages. As he once reminded students of the Presidency College Madras, in the cities, one forgot that Nature was full of wonderful things, and also the fact that Nature is a great teacher. One's education was imperfect, unless one taught oneself to resonate with Nature and respond to her beauty. Beauty was the capacity to see and understand, and unless one had this capacity, one was essentially uneducated²¹.

Raman was in raptures when he visited the campus of IIT Madras in 1966 for delivering the Convocation Address. In the Address he said¹⁰,

I have been on a joy-ride through the Campus and was thrilled to see the wonderful old Banyan trees, the wild grass, the thorns here and there, and the occasional buildings. Study, lectures, books and examinations constitute a small part in a man's or woman's education. The greatest teacher of all is Nature herself – the supreme artist who creates forms of beauty, loveliness and colour that have been unsurpassed since the beginning of time. She has been the inspiration not only of artists, painters and sculptors but men of Science as well. Life is not merely a matter of getting food, clothes and shelter. Its

finer aspects are to be found in music, flowers, colour and beauty and the aesthetic sense and satisfaction that are derived from the enjoyment of all these.

It must be appreciated that Raman passionately advocated rural and natural settings for universities and colleges not merely because he desired a beautiful ambience but so that the environment itself would mould and influence the individual, inspiring him or her to nobler thoughts and feelings. For Raman, character was supreme and a *sine qua non* for any civilized activity, especially the pursuit of science. Character, he declared in his Convocation Address in 1961 to the graduates of the Mysore University, must go hand in hand with a balance of mind, as enjoined in the *Gita*²².

Raman the humanist

Given Raman's enlightened and progressive views on all matters, it should not come as a surprise that he strongly espoused the cause of women. For example as far back as 1941, he said in an address to the Patna University²³:

I have a feeling that if the women of India take to science and interest themselves in the progress and the advance of science as well, they will achieve what even men have failed to do. Women have one quality – the quality of devotion. It is one of the most important passports to success in science. Let us therefore not imagine that intellect is a sole prerogative of males only in science.

The perfectionist that he was, Raman often admired the craftsmanship of the ancients. He frequently lamented that the advent of the machine-age had killed, at least in India, the pride and the joy of making things. Sloppiness in work in turn led to shoddiness in products with which we seem to be fully satisfied. We are quite content, he complained, with the production of inferior things²⁴. This was back in 1945; since then, things have hardly improved despite Independence and the passage of over half a century!

Raman was a humanist to the core, and naturally he abhorred wars, the

atom bomb, etc. Delivering a lecture in Patna in 1941 on Science and War, he traced lust, greed and racial hatred as the three important causes of human conflict²⁵. In a message to a conference of American Nobelists (to which he had been invited), Raman pleaded for mutual understanding between nations and an effort to settle differences by peaceful means²⁶. At the same time he was quite clear that aggression must be given a fitting reply.

Raman always prided himself on being a patriot. During the Nobel Award Ceremony in 1930, Raman, while returning to his seat after receiving the Medal and the Citation, was choked with tears. They were not tears of joy but of sorrow, sorrow because the flag next to his chair was not the flag of India but of colonial masters. However, Raman's patriotism was not of the jingoistic variety. Patriotism, he asserted, did not flow from singing *Jana Gana Mana* or *Vande Mataram*. True patriotism, was in the last analysis, 'love of the earth that bore us, feeds us and sustains us'²⁷.

Where his own research was concerned Raman was very much an ivory-tower man but where Society and the Nation were concerned, he discharged his obligations in the fullest measure. As I have described in my biography of Raman, he offered consultancy to the Railways, and himself set up a few small-scale industries. You might also be interested to know that Raman served for a while as India's representative on the Advisory Council of the World Bank.

Raman and Gandhi

Raman was always a great admirer of Gandhi and an ardent believer in the Gandhian philosophy of simple living and high thinking. Soon after Gandhi was assassinated and people were making all kinds of plans for garish monuments, Raman declared in an interview²⁸:

The best way of perpetuating the memory of Mahatmaji is to inculcate into the minds of the coming generation the best teachings of Gandhiji. Each boy and girl from the primary standard to post-graduate course must be made to read the best say-

ings, these sayings being selected suitably, according to the intellectual standards of the pupils. Each textbook must contain as frontispiece a portrait of Gandhiji and there must be lessons containing the sermons of Gandhiji from Sabarmati and the Birla House. This would be the best and the most potent way of offering homage to the memory of the world's greatest man and the Father of the Indian Nation, and is better than building memorials and erecting statues.

Five years later, speaking to college students in Ahmedabad Raman said²⁹:

His [Gandhi's] teachings stressed the supreme virtue of the human spirit, utterly indestructible and unconquerable. India can never hope to find a place in the sun, unless it upholds the value of the human spirit.

While upholding basic Gandhian values, Raman was at the same time pragmatic enough not to totally decry technology and all that goes with it. Thus, speaking once to students in a light vein, he advocated a golden mean between what he called the Gandhian way and the cinema way!³⁰

To many, Gandhi and science might seem far apart and the affinity that Raman felt for Gandhi might therefore appear strange. However, there is an explanation. Gandhi who lived by the *Gita*, intensely believed in the spiritualization of life. For Raman whose entire life revolved around science, scientific investigation was a spiritual quest for what Plato described as Truth, Goodness and Beauty, and what our ancients referred to as *Sathyam, Sivam, Sundaram*. Thus Raman and Gandhi, each in their own respective way, tread the path of *Karma Yoga*. To honour Gandhi, Raman instituted the Gandhi Memorial Lecture, which, as long as he lived, he unfailingly delivered on 2 October. It is pleasing to note that the tradition of the Gandhi Memorial Lecture continues to be maintained by the Institute.

The spiritual side of Raman

It is often assumed that Raman did not believe in God and I too shared this

belief, till I started researching for this talk. I then discovered that while Raman did not care for rituals or institutionalized religion, he did, in the tradition of the *Bhagavad Gita*, believe in the intrinsic Divinity of the Soul and further that Nature is a manifestation of God. Delivering the Rectorial Address in the Madura College on the occasion of its 58th Anniversary, Raman declared that the true purpose of science was to comprehend Nature³¹. He could not conceive of any more supreme joy than to come face to face with Nature. And what was Nature, he asked, but the expression of what might be called the Divine Spirit? 'If there is a God, that God is in the Universe', he declared. Dealing with the same theme in his Convocation Address to the Utkal University in 1950, he said³²:

What is science in the last analysis but the study and the love of Nature, displayed not in the form of abstract worship but in the practical form of seeking to understand Nature? ...The more I pursue science, the more I am impressed with the infinite loveliness and wonders of the world. I have often gone further to give expression to this whenever I was asked whether I believed in God. I tell you, if there is a God, He is in this world before us.

If God lives in the world, then does He also live in us? Indeed He does, as the *Gita* asserts, and as Christ also reiterated. Echoing this sentiment while speaking at a *Bhoo-dan* function in Bangalore in 1955, Raman observed³³:

God lives in us. See God in your own soul and heart. The human soul is the repository of the Divine. Never shall we lay aside that feeling of devotion, which has been India's standard through the ages.

Raman never subscribed to the view that modern science was a new wisdom that had come to displace the old. Speaking once at a school prize-distribution function, he deplored the notion that 'a study of science makes *nastikas* of us all'³⁴. Calling attention to the legacy of imperishable value bequeathed by such great ones as the Buddha, Christ, and the sages of yore, he cautioned that there could be no greater fallacy than to imagine that science had

rendered unnecessary the treasures of ancient scriptures.

Raman did not see science as being distinct and standing apart from the strands of ancient Indian philosophy. In the Rectorial address already alluded to, he declared that the ultimate objective of modern science was in the same spirit as that of our sages, and added³¹:

One aspect of Indian culture was its profound understanding of Nature. Much of India's philosophy related itself to the understanding of the rationale and the meaning of the phenomena of Nature.

Raman did not interpret Nature as meaning something apart and distinct from man. Thus, to him, understanding Nature also meant man trying to understand himself. Speaking to a body called the Friends of Truth in Bangalore in 1956 Raman said that the human mind was the most wonderful thing in the Universe³⁵. Man had almost reached the stage of God in his powers of penetration into the mysteries of Nature, and perhaps there would be nothing unknowable to the human mind. But man had to learn to control himself. Such control comes from paying heed to the humanist traditions of the past. True religion, Raman said, was humanism and the recognition of the value of the human personality. This had been the approach of all great religious teachers like Christ, Buddha and Gandhi. Raman particularly extolled Buddha for his compassion and for his profound teaching that service to humanity was the greatest religion. The devil in man, Raman once said, could be eliminated by religion as conceived by the great humanists³⁵.

There is, at the present time, a strong tendency in scientific circles to regard anyone who talks of religion and God as scientifically illiterate – this is the description that Richard Dawkins uses, I believe. We must remember, however, that Raman belonged to that crucial generation that provided the first major link between our hoary past and modern times. His life overlapped with that of great thinkers, enlightened men and visionaries like Ishwara Chandra Vidyasagar, Ramakrishna Paramahansa, Vivekananda, Rabindranath Tagore, Aurobindo, Jamshedji Tata and Mahatma Gandhi, to name a few. Thus,

Raman always stressed our looking to the future without forgetting our past, as for example in his address at the Andhra University, on the occasion of the sixtieth birthday of its Vice Chancellor, C. R. Reddy³⁶. The need of the hour, Raman said, was to reconcile and blend the modern spirit with the ancient ideals of the country, in the tradition of Sir Asutosh Mukherji, Pandit Malaviya and Sir S. Radhakrishnan. At a personal level, Raman himself achieved this wonderful blend. He was second to none in his advocacy of modern science; yet, at the same time, he was not ashamed to wear the turban – in fact, he was quite proud of it! More important, he was not afraid to declare his firm belief in the values preached by Buddha, foremost of which was compassion. Today, in our immense preoccupation with science, we tend to overlook basic human values, which is why Victor Weisskopf recently warned: 'Knowledge without compassion is inhuman'.

Raman's values and today's society

Having presented a broad-brush profile of the man and his spirit, I would at this stage like to reflect, if I may, on the relevance of the values that Raman held dear, to our present situation with respect to Science and Technology. In the fifty years since Independence, we have certainly made substantial and impressive progress in the basic sciences as well as in certain strategic technologies. Yet, as we look ahead into the new century and indeed into a new millennium, all is not well and there is no room for complacency. Our progress thus far is the result of three factors.

- (i) The vision and the spirit of pioneers like Raman, Bhabha, Bhatnagar and Sarabhai.
- (ii) Strong and spirited support from towering political leaders like Jawaharlal Nehru and Indira Gandhi.
- (iii) The strength of our educational establishment, both in terms of basic values as well as academic quality.

Today, however, there is deep cause for worry concerning all these aspects.

Let me start with the education scenario. It is not merely depressing but positively alarming. Politics has perched itself firmly in several of our campuses and in its wake, criminal forces have made a brazen entry. In many of our Universities, the Vice Chancellor cannot move about without security protection. Cheating in exams is not only overlooked but, in many States, even aided and abetted by the law. Instances are not unknown of candidates coming to the examination hall with weapons or accompanied by fierce dogs. A disastrous situation has been created by the so-called reservation policy, and sometimes I wonder if the reservation percentages do not add up to more than a hundred percent! Where language is concerned, there is an awful mess. In many States English has been more or less driven out, and the teaching of English in schools has been completely stopped. Whether we like it or not, today English is the *lingua franca* of science. Even the French (known for their linguistic chauvinism) and the Germans, are now publishing to a substantial extent in English. In addition, more and more Russians, Japanese as well as Chinese are turning to English. In this situation, we who have thus far enjoyed a tremendous advantage with respect to the English language, are now trying to put the clock back and recede into the stone age.

Next there is the problem of textbooks. Raman learnt his basics from classics by Euclid, Helmholtz, Lord Rayleigh, and people of a similar stature. Even when I was a student, good textbooks were affordable. Besides, people like Saha took time off to write for our students. Today, all that has changed. Books published abroad are beyond the reach of our students, sometimes even of our libraries. To make matters worse, most of our eminent scientists have no time for textbook writing, throwing our students at the mercy of pulp writers. I wonder how many of you have seen the textbooks today's students have to cram from. If you did, you would be horrified. Barring a few exceptions, most of them are of poor quality. I doubt whether even a genius like Raman can learn anything from such books.

As if all this is not enough, there has recently been an ominous development

which has attracted hardly any attention. In May 1997, the Department of Economic Affairs of the Ministry of Finance of the Government of India brought out a 'Discussion Paper' (White Paper) on the subject of Government subsidies³⁷. As all are aware, there is much concern about the drain on the Exchequer via subsidies granted to all sorts of items. Attempting an analysis of when and where such subsidies ought to be given, the paper classifies all economic and social activities into two primary categories: (i) 'merit goods', and (ii) 'non-merit goods'. The paper argues that the grant of subsidies to merit goods is acceptable because the overall benefit to Society far exceeds the benefit accruing to individuals actually receiving the subsidy – inoculation services provided by Public Health Departments is an example of merit goods. Inspired by the World Bank, the paper then argues that higher education belongs to the category of non-merit goods! The paper states³⁷:

Most subsidies to higher education accrue predominantly to the better-off sections of society ... A significant portion of subsidies in higher education is appropriated by the middle to high-income groups, ... Admission is by quality-based entrance examinations, interviews, group discussions etc., where the poorer sections of society are easily competed out.

Thereafter, the paper goes on to recommend cuts and this was just the type of advice that the Mandarins of Delhi desperately needed when they met to consider IX Plan allocations. Result: Huge cuts on the outlay proposed by the UGC. Raman wanted our universities to bear the burden of Independent India; perhaps the Finance Ministry wants to relieve our universities of that burden!

No one questions the need to prune, the desirability of being frugal, and the virtue of prioritization. But does that mean one must blindly toe the line of the World Bank and indulge in reckless actions that are injurious to national interests? If money is so scarce, then why not eliminate bureaucratic waste, slash the useless expenditure on VIP security, and so on? Nobody seems to be bothered about this grave threat to higher education, barring a few agitated Vice Chancellors. Contrast this with

what would happen if the subsidy dear to a particular influential lobby is touched. Surprisingly, scientists are by and large silent on this issue. We articulated vigorously when threatened by an NRI-sponsored Science University; but here is a greater threat and nobody is raising his or her voice. How can science in this country survive in the future, if higher education is going to be throttled?

Many other disturbing tendencies are becoming apparent amongst us scientists and indeed also in the various Science Academies. Sometime ago I was aghast to see one of our Academies stipulating that nominations for Fellowship should be accompanied by Citation Index particulars relating to the candidate. I readily concede that Citation Index provides a measure of impact, and that it might even be useful in certain societies. But does that mean that we also have to adopt the same yardstick? Let me illustrate my point by considering the case of G. N. Ramachandran, one of the very distinguished scientists produced by this country and an illustrious student of Raman as well. I do not have to tell you about GNR's discoveries and scientific contributions – they are sufficiently well-known. But does his contribution stop with his papers and publications? Has he not made a monumental contribution by establishing thriving schools in crystallography and molecular biology? Will GNR's Citation Index reflect this contribution? Are these contributions not important for Indian science? It might be argued that the Selection Committees of the Academies are not blind and they will surely not miss such contributions. Yes, the Committees will certainly take note, provided the candidate is already established. But what about a young unknown with no powerful godfather, who is knocking on the doors of Fellowship? Will the Committees care to look beyond the Citation Index in such cases? Once criteria like the Citation Index are allowed, the Committees would start playing safe, bowing to statistics. In turn, this would give an edge to manipulators, of whom there is no shortage, who inflate their publication list by attaching their names with impunity to the work of talented juniors. And no one would care to ask how a person who is always so busy travelling, is able to

publish papers on such a wide spectrum of scientific topics. I make particular mention of this point because old-timers here know how Raman used to make his selections.

There is another issue that is more important, since it is of great National concern. Science, it is often said, is international. Very true. However, it is prudent to appreciate the fact that the science policy pursued by a given country often reflects its own national priorities, political compulsions, etc. Indeed, raids on gene pools, brazen attempts to grant patents to neem, turmeric and basmati, raising a rumpus about IPR, etc. are all the direct result of such policies, and it would be utterly naïve for us to shut our eyes to this practical reality. For instance, during the invasion of Afghanistan by the erstwhile Soviet Union, The National Academy of Sciences in America suspended its ties with the USSR Academy of Science. Similarly, after Pokhran II, many Indian scientists working in the laboratories of the US Department of Energy were asked to leave. Such things are to be expected, and there is no point in complaining about them.

People fuss about visa cancellations but none of us complain about technology embargo. In fact, few know how serious this problem is and how cunningly it is operated. For example, an Indian Company, acting as an agent for a foreign company, will decide that it will sell a sophisticated signal processing equipment to a particular laboratory but not to another because the latter is on the hit list of a Western power. Even while selling the equipment to a lab not on the hit list, an end-use declaration would be demanded. Imagine that! An Indian Company acting at the behest of foreign powers demands certificates the like of which is not asked for in any other country. It is our money, given to our laboratories by our tax-payers. Yet we have to declare to others, how we plan to use equipment bought with that money. I do not complain about America asking for such certificates, but I do worry that we readily sign on the dotted line without any consideration for National pride, dignity and self-respect. People sign such end-use certificates without batting an eyelid giving their own private rationalizations, but few care to reflect on the fact that by this

process, the powers that be are able to quietly divide and split our scientific community. Thus, when pressure was applied on certain countries not to sell cryogenic rockets to India, there was not even a whimper of protest from our scientific community. Perhaps the feeling was: 'Why bother? It is after all, ISRO's problem'.

Everyone knows that the scientific programme of ISRO is entirely committed to peaceful activities and further that cryogenic rockets which take days of preparation for launch, are militarily useless. Yet, ISRO is being squeezed. Nearly two decades ago when I was in Trivandrum to attend an Academy meeting, Dhawan and I had a conversation. I don't know if Dhawan recalls this conversation but I remember it very well – we were then walking on the airport tarmac to board a plane to Bangalore. In the course of our talk, Dhawan said: 'Wait till our Space Programme becomes commercially viable and competitive. They will then slap all kinds of embargoes which are now being applied to the Department of Atomic Energy.' His words have proved remarkably prophetic. That, ladies and gentlemen, is the **real reason** behind much of the technology embargo. Recent events have demonstrated that whenever we become a commercial threat, be it in garments, or shrimps or medicinal drugs, some excuse or the other is concocted to throttle us. Technology embargo is just one of the weapons used. Is this not a matter of concern for the Nation and therefore also for all of us, especially since issues related to science and technology are often involved?

I bring this point up not merely to lament the indifference of our Academics to the difficulties faced by their colleagues involved in Projects of National importance but also to contrast with what happened in the USSR when Ronald Reagan banned the export of PCs to that country. The scientists of USSR rose up as one person to build their own PCs and to establish a PC industry. Some years later when the coolness between the two superpowers thawed, an American scientist visiting the high-energy lab in Dubna was told, 'Please thank your President for the ban. Otherwise, we would never have built our own PCs!' Sadly, such solidarity and

defiant spirit are missing in our environment. Indeed, there is not even an adequate appreciation of how technology embargo ought to be combated. In this context, it is pertinent to quote what Raman said way back in 1948. In his reply to the felicitations offered by G. D. Naidu, a lecture to which I have already made a reference earlier, Raman observed³:

I have come to realise that if I want support from the country, I have to give something in return. It is my desire that this new Institute that I am setting up would help the industries of South India, besides being engaged in research. ... I have a desire for a workshop where I can fabricate my equipment, to teach my people not to rely on Europe.

While on the subject of instruments and scientific equipment, I would like to make a passing reference to a terrible skew prevailing in the country. We launch polar-orbital satellites, we build tokomacs, and we make lasers that can cut through several inches of steel. Yet, if one wants a simple, common-garden 1.5 mW He-Ne laser for teaching optics in colleges, one has to import. Ninety years ago, Kammerlingh Onnes discovered superconductivity using a home-built resistivity-measuring apparatus. Today, even though it is quite feasible for us to make a four-probe measuring device, we import it for our superconductivity studies. One can go on and on. It would be sobering to reflect on how much of our science budget goes to pay for the import of scientific equipment and instruments.

As I remarked earlier, Raman warned repeatedly that while pursuing science avidly, we should not become camp-followers of the West. Unconsciously or otherwise, that precisely is what seems to have happened. Today, we appear to be guided by fashions, tastes and priorities prevailing elsewhere rather than those relevant to our Society. Take the case of the Academy journal *Pramana*. After completing twenty-five years of existence, it is continuing to look thin and anemic. Not many Fellows patronize it; if at all they do it is only occasionally, and that too somewhat grudgingly. Some argue that their readership is overseas and that is why they publish in foreign journals. No doubt

there is merit in this argument but one wonders if personal considerations alone should dominate. If we want young students in our colleges to be inspired and choose science as their career, then should we not reach out to them in some manner or the other? Raman went up and down the country lecturing to college audiences whenever he could. And when he could no longer travel freely on account of his health, he arranged for the young to come to this campus so that he could be with them. Today, we have no time to deliver lectures like that. Nor are we prepared to publish in our journals which are inexpensive and therefore within the reach of our colleges. In many cases, professors and research guides are too busy with their foreign tours to find time for their students. Not surprisingly students turn cynical, describing their seniors via terms such as non-resident Professor, non-resident Director, etc. Once a visiting Russian Academician complained to me that whenever he came to India, he was never able to meet his Indian collaborator because the latter was always abroad. I was most embarrassed, although I had nothing to do with this collaboration. As a member of the Indian scientific community, I felt ashamed. It is not realized that such stories easily spread in the student grapevine, possibly turning many of them off. And yet, we expect the young to come in large numbers knocking on the doors of science. How is that possible? What worries me is that by such neglect we would be inviting the Mandarins to take a shot next at the science budget itself. They might well declare scientific research to be of the non-merit type, bringing satisfaction only to the researcher. We know that such an argument is patently false but finance officials can easily get away with it since the politicians of today have not the foggiest idea of what science and technology are all about. To make matters worse, our Industry has a dim opinion of our science and to cap it all, public perception of our contributions is not always favourable.

Concluding remarks

I am afraid we have a lot of homework to do regarding damage control and it does not behove us to claim ivory-tower

insularity, turning a blind eye to what is happening in the country. Selfishness has become a way of life, with people in high places seldom bothering about what happens to the Nation. Reflecting on this unhappy situation, Nani Palkhivala once wryly remarked: 'I don't know why they chose the peacock as the national bird. Truly speaking, our national bird should be the ostrich!' While politicians and bureaucrats might behave in an ostrich-like fashion, I believe that scientists being intellectuals have a higher duty to perform. Lest you think I am unnecessarily pontificating, I would like to point out that according to Raman our first and deepest loyalty must be to our own country and people.

Against this background, I would next like to quote from a letter I received a few years ago from a young science teacher, working in a village school in West Bengal. This is what the teacher wrote³⁸:

My purpose of writing is to draw your kind attention to how, we villagers, are receding from the benefits of science and technology day by day. There is a gap between vision and reality even after 45 years of Independence. Does science and technology benefit the rural people? Does it provide sufficient help to them? ...

I am a science teacher living in a village in a very interior part of the country, working on the popularization of science. Today, S&T books, kits, simple instruments are so costly that these are beyond the capacity of the rural pupil. We are slowly taking away from the thoughts of modern science and technology. Generally speaking, we do not know how much our country has progressed or how our reputed scientists are working

As a Member of the Editorial Board of *Current Science*, I forwarded this letter to the Editor who most kindly published it in the journal. I was hoping for some spirited correspondence from our scientists but the letter faded away without even a whimper! So much for our social consciousness today. A certain event that took place in the mid-fifties stands in marked contrast, and I would now like to refer to it.

On 15 August 1954, Raman's name appeared in the Independence Day Hon-

ours List—he had been awarded the Bharat Ratna. One of the first to congratulate him was Indira Gandhi—at that time, she had not yet entered politics, and was staying with her father in Teen Murthi House. Writing on the very day of the announcement and in long hand, Indira Gandhi said³⁹:

As you know, I have been an ardent admirer of yours since that journey to England in 1937 [when they met on the boat], and have regarded you as the 'Rathna' of India. I am happy to learn that now you are officially a Bharat Ratna. It is a title that you richly deserve.

Raman promptly responded, conveying his profuse thanks to Indira Gandhi for her message. On 19 January 1955, Raman received a telegram from Rajendra Prasad, the President of India. The President said³⁹:

I shall be glad if you stay in Rashtrapathi Bhavan as my guest, when you come to receive your Bharat Ratna Award (stop) Kindly let us know your mode and date of arrival for reception arrangements.

Raman sent a reply to the President on 20 January. In his reply, Raman said³⁹:

My dear Dr. Rajendra Prasad,

I was greatly touched by your very kind telegram received last night, inviting me to be your guest at 'Rashtrapathi Bhavan' for the Investiture Ceremony on the 27 January 1955.

Immediately on receiving the official invitation to the Investiture, I wrote to the Military Secretary and to the A.D.C. in waiting explaining that I find myself unable to come up to Delhi for the function. Even ordinarily, my work here is all-engrossing and prevents me from accepting assignments which call me away from Bangalore. At the present time I am firmly tied down here to enable one of my students to complete his Doctorate thesis which the Regulations require

him to submit to his University before the end of January. Thus my duty as a teacher has to take precedence over my own personal affairs. I feel fully confident that you will appreciate the compelling nature of the circumstances which prevent me from accepting your kind and gracious invitation to come to Delhi.

*Yours sincerely
C. V. Raman*

Raman stayed back in Bangalore to fulfil his obligations to his student, skipping the glamour, the glitter and the limelight of Delhi. Later, the Bharat Ratna medal and the Citation were routinely hand-delivered at his residence by an ordinary messenger of the Mysore Government. That was the way Raman received the Nation's highest award—no one to cheer, to stand up and applaud, or even to congratulate. This one incident alone speaks volumes for the founder of this Institute, a tall man and a spirited giant.

I would like to end by quoting in part from a poem by Wordsworth, written in honour of Milton. Wordsworth says:

*Milton! Thou shouldst be living at this hour;
England hath need of thee...
...We are selfish men;
Oh! raise us up, return to us again;
And give us manners, virtue, freedom and power.
Thy soul was like a Star, and dwelt apart;
Thou hadst a voice whose sound was like the sea; ...*

Ladies and gentlemen, need I say that these lines, with minor changes, apply equally well to Raman? Thank you!

1. Venkataraman, G., *Journey into Light*, Indian Academy of Sciences, Bangalore, 1988.
2. Jayaraman, A., *Chandrasekhara Venkata Raman – A Memoir*, Affiliated East-West Press, New Delhi, 1989.
3. Unpublished document containing the welcome address of G.D. Naidu during a reception given in honour of Raman on 24 March 1948, and Raman's reply. Ar

chival papers of the Raman R Institute.

4. *The Hindu*, 3 February 1949; *Free Journal*, 3 February 1949.
5. *Pioneer*, 29 October 1950.
6. *Amrita Bazar Patrika*, 30 October 1948.
7. *The Hindu*, 1 March 1948.
8. *The Statesman*, 11 December 1950.
9. *Deccan Herald*, 25 August 1954.
10. Convocation Address, IIT, 1966. Archival papers of the Raman Research Institute.
11. *The Hindu*, 29 December 1947.
12. *The Hindu*, 28 November 1942.
13. *The Hindu*, 2 January 1948.
14. *Curr. Sci.*, June 1943, p. 175.
15. *The Hindu*, 28 November 1942.
16. *The Hindu*, 7 January 1949.
17. *The Mail*, 28 November 1942.
18. *The Hindu*, 14 March 1947.
19. *Bharat Jyothi*, 15 January 1950.
20. *The Hindu*, 12 March 1941.
21. *The Hindu*, 13 March 1949.
22. *Deccan Herald*, 18 January 1961.
23. *The Hindu*, 30 November 1941.
24. *The Hindu*, 10 September 1945.
25. *The Hindu*, 1 December 1941.
26. *The Hindu*, 11 January 1958.
27. *Amrita Bazar Patrika*, 30 October 1948.
28. *The Hindu*, 19 February 1948.
29. *The Times of India*, 28 December 1945.
30. *The Hindu*, 10 September 1945.
31. *The Mail*, 24 October 1946; *The Hindu*, 25 October 1946.
32. *The Hindu*, 12 December 1950.
33. *The Hindu*, 6 August 1955.
34. *Deccan Herald*, 10 April 1960.
35. *The Hindu*, 1 May 1956.
36. *The Hindu*, 14 December 1940.
37. For extracts from this paper and comments on it, see *The U. News*, volume 36, issue of 1 1998. This is a weekly journal of the Association of Indian Universities published from New Delhi.
38. *Curr. Sci.*, 1993, **64**, 545.
39. Archival papers of the Raman Research Institute.

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