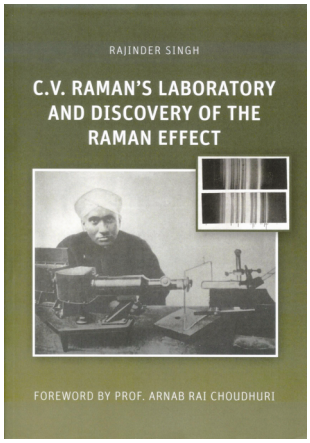

C. V. Raman's Laboratory and Discovery of the Raman Effect. Rajinder Singh. Shaker Verlag GmbH, P. O. Box 101818, D-52018, Aachen, Germany. 2018. xvi + 153 pages. Price: 21,90€. ISBN 978-3-8440-5691-4.

This is a refreshingly different book about Professor C. V. Raman, Nobel Prize Winner for Physics in the year 1930. It is written by a professional historian of science, working in the University of Oldenburg, Germany. As is appropriate in a scholarly book of this type, almost every one of the numerous statements is given a citation of the source from where the information has been collected. Thus the author is in a good position to separate the myths and the hypes from the day-to-day reality and facts, in so far as they can be taken from the original sources.

It is also clear that the author holds Raman in high esteem, in spite of being aware of his personal foibles like a lack of modesty, a touch of self-projection and a slight intolerance of opposing points of view.

The primary myth that the author wants to debunk is the oft-quoted statement that Raman's discovery of the Raman Effect was done with a ridiculously low cost equipment and a pittance of money support. This occupies about half the book. Very unfortunately we do not have any museum room with the items of the original equipment used by Raman with perhaps wax figures of the persons involved. One can only lament with the author that 'Indian men of science and technology are oblivious in preserving their heritage, in particular, in the field of science and scientific instruments'. So from the original sources the author has collected the information about the cost of the equipment and facilities available to Raman during that period. The data clearly show that the IACS laboratory was perhaps the best research institution in India at that time and possibly as good as the laboratories of the medium level universities abroad, though clearly a notch below the top level institutions. There were excellent technicians capable of fabricating intricate and delicate pieces of apparatus as well as the resources to import modest items of equipment from abroad. There were many dedicated research scholars. The cost of the equipment used to study the light scattering was clearly not a few hundred rupees, but more like a few thousand rupees. Viewed in the context of the situation in 1928 this was not a miserably small amount of money. This is not to belittle Raman's work, after all the accolade of the Nobel Prize is a fitting tribute to the quality of the achievement, but more to avoid the pitfall that if poor support is given to scientists they will work hard and do great work. Often the science managers have a tendency to quote the famous statement 'when you have no money and power, you begin to think!'. Unfortunately experimental work requires adequate infrastructure support and this costs money. The author could have further highlighted the situation by pointing out that, while the first experiment is usually a herculean task, a heroic effort and an astonishing leap of faith, the experiment can be repeated later with much less effort, cost and facilities.

A surprising omission in the book, in this context, is the reference to Raman's 1930 Physics Nobel Prize talk, which is now available in the open literature. However it does not give too much of additional information to the present problem. The 7 inch refractor lens to condense the sunlight was used in the earlier studies. Then the spectral analysis, as different from the light intensity measurements, was taken up. Raman states. 'The quartz mercury lamp was so powerful and convenient a source of monochromatic illumination that, at least in the case of liquids and solids, photographing the spectrum of scattered light was found to present no extraordinary difficulties. The earliest pictures of the phenomenon were in fact taken with a portable quartz spectrograph of the smallest size made by the firm of Hilger. With a somewhat larger instrument of the same type, Krishnan obtained very satisfactory spectrograms with liquids and with crystals on which measurements of the desired precision could be made, and on which the presence of lines displaced towards the violet was first definitely established.' It is quite possible that Raman first used a pocket spectrograph to check the scattered light and on seeing additional scattered light decided to analyse the scattering with a conventional Hilger spectrograph. This is quite plausible, given that on the fateful 28 February 1928, K. S. Krishnan came to the laboratory only in the afternoon to find Raman excited about the use of the pocket (portable) spectrograph and then proceeded to analyse the scattered radiation with the Hilger spectrograph. The first reference to a cost of Rs 200 or Rs 400 for the discovery appears only in 1948, twenty years after the discovery. Subsequently the same has been repeated by many others, without a careful search of the literature and the situation as of 1928 in the IACS laboratory. In experimental work, a preliminary indication is taken as a very valuable guide, but only a proper verification of the result is taken as the 'observation'. In Raman's case the proper verification was only with the regular Hilger spectrograph. In this context one may even recall Pasteur's famous advice that inspiration comes to the mind prepared to seize the importance of the idea and develop all the impacts and consequences. Even if Raman's effort on the 28 February 1928 did not cost much, the preparation of the mind to seize the importance of the observation must be counted in the cost of the discovery.

The next one fourth of the book is devoted to the Indian Association for the Cultivation of Science with Raman at the

Spectroscope used by C. V. Raman for the discovery of the new effect. Credit: Indian Association for the Cultivation of Sciences, Calcutta (abbreviated as IACS).

helm. The efforts to make it a vibrant research center are described at length. Good workshop facilities, bright and hard-working research scholars as well as the import of a few instruments and chemicals made IACS the premier research centre in physics in India during this period, though Raman had an ambition to take it to international levels. Again almost every statement is made with a citation of the source from which it is taken, leaving no doubt about the veracity of the remarks.

The last quarter of the book discusses the situation of Raman with reference to the Calcutta University and IACS. It must be a revelation to many that to the very end there was a very friendly atmosphere of mutual respect and support. Raman even espoused the use of Bengali language to teach youngsters, taken up vigorously later by people like S. N. Bose and others. In spite of the financial difficulties, Raman was supported to the extent possible and Raman reciprocated by crediting the University and IACS for the success achieved. Alas, Raman's outbursts on other workers, without realizing the deep hurt such remarks create, slowly made a group of people to be unfriendly. Raman's salary in 1928 was Rs 1000 p.m. and this was sought to be made Rs 1500 p.m. after the award of the Nobel Prize in 1930. There was a bitter and acrimonious debate with personal tirades in the Senate of the University and only the intervention by the Vice Chancellor enabled the salary increase. At about the same time there were feelers to attract Raman to the Directorship of the Indian Institute of Science, Bangalore, as the first Indian to be the Director. The challenge of Bangalore was tempting and tantalizing. The author clearly does not want to spend much time on this unhappy last years in Calcutta and merely quotes Raman's student, Sukumar Chandra Sirkar, 'Professor Raman was given an increment of Rs 500 per month after the award of the Nobel Prize and he was drawing altogether Rs 1500 per month at that time. The salary offered to him in Bangalore was about double this amount. He told me that he would take one year's leave without pay and during this period the work in the Association would be continued undisturbed'. Raman moved to Bangalore in 1932 and such was his unquestionable greatness that within a year he produced another world class gem from Bangalore, namely the Raman–Nath theory of diffraction of light by ultrasonic waves which explained at one stroke the bewildering changes of the intensity of the light diffracted when the ultrasonic intensity is varied and which has become the corner stone of the modern acousto-optic modulator instruments.

What else can one want? Another historian to tell about Raman's life before 1920s. The facilities of IACS and the Calcutta University were far below par and yet Raman managed to accomplish world class work in acoustics, specially the music of violin and drum (mrudangam). The article in *Handbuch der Physik* and the election to the Fellowship of the Royal Society were largely due to the pioneering work in musical acoustics. Recall that in 1924, the year he became an FRS, his light scattering work was not yet of the first quality.

History is replete with numerous examples of poets, musicians, and scholars who were living in abject poverty and yet produced work which are remembered even today as world class standing the test of time. This is a tribute to their genius. It would be terribly wrong to deduce that poverty is a necessary condition to produce pioneering work. Ramanujan was a mathematical genius. It would be a blunder to conclude that everyone who fails in the college examinations would become a great mathematician. Raman's story is similar. The conclusion to be drawn is merely that in a laboratory whose facilities were nowhere comparable to those in the top institutions elsewhere in Europe and USA at that time, a fine piece of research was produced. It is definitely not to indicate that substandard facilities in Indian institutions would somehow produce magical wonders.

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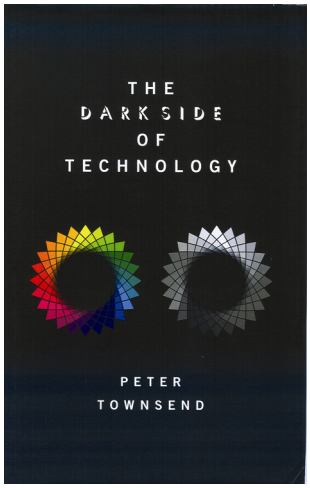

The Dark Side of Technology. Peter Townsend. Oxford University Press, Great Clarendon Street, Oxford, OX2 6DP, UK. 2016. xi + 306 pages. Price: £25.00. ISBN: 978-0-19-879053-2.

Right from the time of the Industrial Revolution it became clear that technology was not all good and that it had another side. No doubt thanks to the early technologies – textiles, iron and steel, transportation (steam engine, steam ships, railways, etc.) – productivity increased, drudgery reduced, income levels improved and rural communities were transformed into urban neighbourhoods. But, as social historians would tell us, it was only the rich and the middle class who started enjoying a better quality of life; for the working class life became more difficult. Technology also led to exploitation of labour (long working hours in poor and unsafe conditions, for example) and industrial disputes as was illustrated by the Homestead strike at the Carnegie Steel Company in Pennsylvania in 1892. The social dimensions of today's technologies, e.g. information technology and biotechnology, are far more serious than those of the earlier technologies. In this book, the author aims to show how science and medicine have altered our lives.

Take nuclear energy for example. While it is clean and it accounts for about 11% of energy used worldwide, it also has a downside. For example, disasters at Three Mile Island, Fukushima Daichi and Chernobyl caused untold suffering. Today nine countries including India possess nuclear weapons, and a mad rush of blood in the leader of any of these countries can lead to global devastation. After the recent standoff