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S. Ramaseshan, the teacher*

Prof. Ramaseshan started his career in physics as a student of C. V. Raman. Like most of Raman's students he also was infected with *optics*, a subject that he loves even to this day. In retrospect we can say that his association with Raman had a lasting impact on his tastes in science in general and physics in particular. Anything in optics interests him and everything else in physics he tries to translate into the language of optics. What is more, he has managed to pass on this infection to a few of his students. And we are amongst that fortunate few. It is probably not an understatement if we say that his entry into the domain of crystallography was again through optics, in particular through optical diffraction. But it was only a sojourn in crystallography and not a migration to it. When we joined as Research Fellows he was already a renowned crystallographer. But when crystallography became an industry to determine crystal structures he chose to phase out of it. It was during his withdrawal phase from this area that we were with him as his students. Only we knew that he was undergoing a 'phase' transformation. This period also coincides with his move from an academic institution to a laboratory dedicated to scientific and industrial research. We did academic research in an environment charged with applied research.

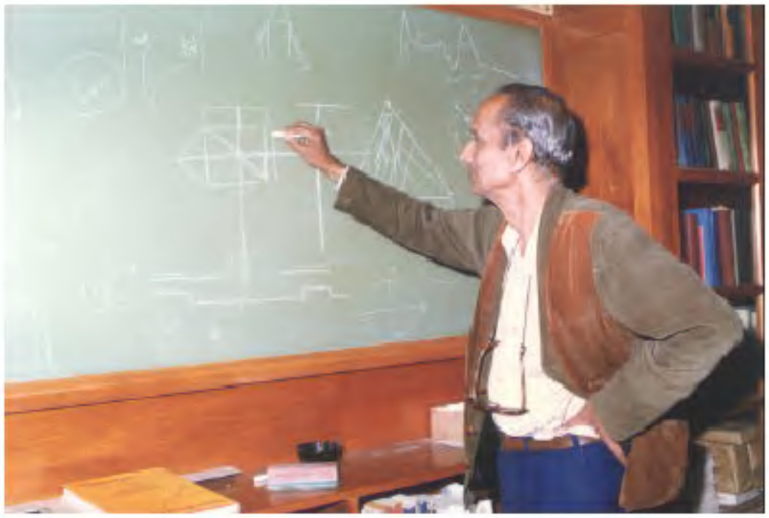
We briefly sketch here the personal recollections of our association with Ramaseshan during his stay at the National Aerospace Laboratories (NAL), Bangalore. Those days it was called the National Aeronautical Laboratory. He had moved in a few years earlier to build and develop its Materials Science Division. Here, he was involved in both pure and applied research. In scientific (pure) research he was occupied with problems in crystal physics, high pressure physics, piezo-optics, neutron-optics, disordered structures and scattering processes in metallic and magnetic systems. Of course he had not completely given up formal crystallography. In industrial (applied) research his interests were in stress analysis of air-frame structures, corrosion in metals and alloys, electrochemical machining, composites and opto-electronic materials. We were surprised at his wide spectrum of research interests and even wondered how he kept track of all these activities. This was all the more an enigma since he always met daily each one of us and spent enough time on the research problems that we were working on. When the problems that we were occupied with reached an exciting stage he would always meet us many times a day and this would go on for days. A meeting with him would often go beyond the problem on hand. Being an excellent teacher he could enthuse the student in related topics as well. Thus we learnt lot more than what was necessary for a mere paper or a problem. He would repeatedly stress that physics was like cheese and that one could enter it anywhere and get out of it anywhere else. This is probably why

S. Ramaseshan (circa 1960s).

*Dedicated to Prof. S. Ramaseshan on his 80th birthday.

we find many of his students being interested in and have often contributed to a variety of topics. He strongly advocated a first order change in the research topic after one's thesis work. He despised narrow specialization and abhorred professionalism in research.

It will be unfair if we do not at least briefly comment upon some the specific areas of research that we were involved in when we were his students. Some of the topics of research were: Effect of mechanical stress on natural and magnetic rotation in single and polycrystals; optical diffraction in chiral, periodic and random media; anomalous scattering of X-rays and neutrons in disordered systems; stress-induced dichroism in absorbing systems; neutron optical rotation in heli-magnetic structures, electrical resistivity of metals, alloys and liquid metals; high pressure studies in metals, alloys and spin systems. In many of these topics, optics played a role, one way or the other. To do optics and not to know the Poincaré sphere was alien to him. In addition, he repeatedly emphasized the usefulness of Jones' matrices in optical calculations. As his associates we also got infected by both the Poincaré sphere and Jones' matrices. Thus we often ended up playing with the Poincaré sphere and employed Jones' matrix method in our calculations. In a similar vein, we picked up Fourier optics too. Another area to which he turned his attention was lattice dynamics and structure of non-crystalline materials. With K. S. Viswanathan (of the Mathematical Science Division of NAL, who as a student of C. V. Raman had become an expert in lattice dynamics) he established the breakdown of Friedel's Law in inelastic neutron scattering. Later on, one of us (TGR) collaborated with him on this problem and showed that the initial phase of the elliptic motion corresponding to a complex polarization vector can be got again from anomalous scattering. It was also shown that the static displacements of atoms in a binary system could be obtained from diffuse anomalous scattering. In a similar vein, multi-wavelength method was proposed for separating the partial structure factors in liquids. The method of partial waves employed in the quantum theory of scattering along with the 'optical' theorem of Bohr, Peierls and Placzek led to the development of a unified approach to the theory of anomalous scattering of X-rays and neutrons. It was around this time that Ramaseshan invited the high pressure physicist A. Jayaraman of AT&T Laboratories (Bell Laboratories at that time) to set-up a high pressure facility at NAL. Jayaraman's work on caesium became an inspiration for the 'two-species' model developed for understanding the effect of pressure on the electronic behaviour of liquid caesium. All the main features of the resistivity behaviour could be explained on this model within the framework of Krishnan–Bhatia–Ziman theory of liquid alloys. This model also led to some interesting results in the pressure dependence of the thermoelectric power of liquid caesium.



Ramaseshan lecturing in the early 1980s.

In today's environment, it seems improbable that Ramaseshan could have built a group of research students working on basic physics at the Materials Science Division at NAL. He often attracted young students through talks. One of us (RN) was lured by his two lectures on 'Waves' at the Theosophical Society and one on the 'Fourth State of Matter' at the Vivekananda College, Madras. In fact, the second author (TGR) took to research and became his student after hearing his illuminating lectures on the strength of materials, at the Physics Department of the University of Mysore, Mysore. He delivered his talks in his intense, almost charismatic style, and he would finish with an account of what his students and colleagues, all mentioned by name, were doing. To many, his broad physics perspective together with exciting research was irresistible.

Any new entrant to his group would spend time in four or five labs of his younger colleagues, getting exposed to stress measurement by X-rays, by polarized light, with mechanical methods, and in composites. A young research scholar took for granted the prevailing congenial atmosphere for research, only to realize decades later how much thought, effort and leadership had gone into creating such an atmosphere. The first few years of research are surely as formative and important as those of childhood, and we remember vividly some of the highlights. The scientific atmosphere that prevailed during Ramaseshan's stay at NAL was truly outstanding. We were always encouraged to interact with other groups and with visitors, some of whom were very distinguished. We have fond memories of interacting and discussing our research problems with such distinguished physicists as Ashcroft, Bardeen, Bloembergen, deGennes, Fisher, Goodenough, A. Jayaraman, Kapitza, G. N. Ramachandran and Ziman, to name a few. At least three of them got the Nobel prize – after their visits to NAL which were a part of their visits to Bangalore. Again, we took it for granted then that such visitors would be found in other places as well. But now we realize that this was a result of the special regard they had for him.

As students, our own reading was gently pushed towards classics. Nye on symmetry and crystal properties, Born or Sommerfeld on optics. Ramaseshan felt that Wolf's elaboration of Born's book had not really clicked. When it came to crystallography or advanced optics, there were of course the books and articles by G. N. Ramachandran and him. But these were just sources and the various topics

really came alive during discussions with him. These discussions were not particularly planned. Like a surgeon in a hospital, he would go on his rounds, and drop in where we sat at some time almost everyday, asking quite simply, 'what is new?'. He would have asked us the same question a few weeks earlier and it symbolizes the basic purpose of research which is so easy to forget—to produce something new. In this game of producing something new, we all had a fair chance of trying out our ideas.

The barrier between experimental and theoretical work was not very strong, and the same people could be seen doing both. Likewise, the barrier between pure and applied science was even weaker. One of us (RN) got roped into a role in a project to build a geodesic dome from composite materials. If there was a conference or a school on liquid crystals at RRI, or interesting lectures at IISc, it seemed totally natural that we should go. His name opened all doors! He often described the work of other colleagues in the country with great enthusiasm and appreciation. Later, we would learn that some of it had defects, which he was fully aware of, but he felt that the positive way of looking at people meant that we could benefit from interactions with a very wide group of scientists.

NAL was of course only a late phase of Ramaseshan's career, and he had very eminent students from earlier epochs. To count ourselves as members of this large group, carrying related academic genes, is indeed a privilege.

We greet him on his eightieth birthday.

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