

Three Minutes, ‘The effort to understand the universe is one of the very few things that lifts human life a little above the level of farce and gives it some of the grace of tragedy’.

During the time one of us (UY) was his research associate, the group would go to the Faculty Club for lunch. Those interactions were very interesting. The group around the table would have members of varied nationalities, Chilean, Spanish, Sri Lankan, Romanian, Swedish, Japanese, British, Belgian and of course Indian. He would usually hold forth on many interesting topics in a voice that would carry and was not deterred by people from other tables telling him how much they enjoyed his ‘lecture’.

He had said ‘I plan to retire shortly after I die’. Indeed, this prophecy of his too has come to be true. He was teaching and involved in creative research till the end. Among the last publications of his on the iNSPIRE-HEP database website is one from January 2021. It is the text of a talk he gave on EFT, providing guidance to the particle physics community at large. Indeed, this is a perfect example of what he himself had said he always was trying to do: provide a point of view to the fellow physicists. It is humbling and inspiring, that the last entry in this list dated April 2021, is his latest textbook *Foundations of Modern Physics*.

As stated already, UY has had the good fortune to be a graduate student at University of Texas at Austin where Weinberg was on his thesis committee and later took him on as a Postdoctoral Associate. RG, having started her graduate studies in 1974, the year of November revolution which was the first step in establishing the correctness of the SM, is certainly the child of the gauge theory days of particle physics. She has had occasion to listen to his talks/lectures on a number of occasions. In fact, in spite of having ‘grown’ in SUNY at Stony Brook, the birthplace of Supergravity, the beginning of her journey in Supersymmetry can be traced to lectures on Supersymmetry that Weinberg gave at Austin and a paper by him on Supersymmetry showing that in a certain class of models one would have supersymmetric particles lighter than the W/Z . This latter was one of the early demonstrations of relating this mathematically beautiful and compelling theory to something that could be looked for in experiments going on at the time!! We are very sure that this is just a typical example how Weinberg’s work shaped the life of quite a few young particle physicists of the time.

A note added: This is a modified version of an obituary to appear in *Physics News*. In this version some details about physics are reduced and more details on the non-

physics aspects of his writing and opinion have been added.

Various statements and quotations attributed to Prof. Weinberg and others are taken from one of the following sources:

1. <https://home.cern/news/obituary/cern/steven-weinberg-1933-2021>
2. <https://cerncourier.com/a/still-seeking-solutions/>
3. <https://cerncourier.com/a/model-physicist/>
4. <https://grahamfarmelo.com/steven-weinberg-the-universe-speaks-in-numbers-podcast/>
5. <https://grahamfarmelo.com/remembering-steven-weinberg/>
6. <https://highprofiles.info/interview/steven-weinberg/>
7. <https://www.bates.edu/commencement/annual/y2002/honorary-degree-citations/steven-weinbergs-address/>
8. <https://www.nature.com/articles/426389a>
9. <https://www.quantamagazine.org/how-steven-weinberg-transformed-physics-and-physicists-20210811/>

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Kasturi Lal Chopra (1933–2021)

Professor Kasturi Lal Chopra was born to Jagat Ram Chopra and Chanan Devi in Chahal Kalan in Gujranwala district of Punjab on 31 July 1933. He obtained his bachelor’s degree in science from the University of Delhi in 1952 with honours and continued his study in the same university to obtain his Master’s degree in 1954. Following this, Chopra secured a fellowship at the University of British Columbia and proceeded to North America to carry out his doctoral study. He obtained his Ph.D. from the same university in 1957 working in the field of low-temperature physics. After completing his doctoral study, he joined the Royal Military College of Canada as a Defence Research Fellow to conduct post-doctoral research. After a two-year stay, he moved to Fritz-Haber Institute at Berlin, West

Germany, as a Max Planck Fellow from 1959 to 1962. He returned to the USA in 1962 as a research specialist and group



leader at Phelico-Ford Scientific Laboratory, Blue Bell, USA. In 1964 he moved to the Ledgemont Laboratory of the Kennecott Copper Corporation as a staff scientist and concurrently Adjunct Professor, North Eastern University, Boston. In 1970, he decided to return to India and joined the Department of Physics at the Indian Institute of Technology, Delhi as a senior Professor of Solid State Physics. He served as department head from 1970 to 1973.

Chopra occupied various academic-related administrative positions at IIT Delhi, as Dean, Faculty of Science (1973–74), as Chairman/Dean, Industrial Research and Development (1975–76 and 1985–87) and Dean, Post Graduate Studies and Research (1976–79). He contributed significantly to the Center for

Energy Studies and the Thin Film Solid State Technology Laboratory at IIT Delhi. After superannuating from IIT Delhi, he was invited to become Director of the IIT Kharagpur in 1987 and continued until 1997. He was appointed the Emeritus Fellow and the Chair Professor at the Indian Renewable Energy Development Agency (IREDA), a post he held until 2000. He was an Honorary Professor and adviser to the Thin Film Laboratory at IIT Delhi, Indian Institute of Technology, Bhubaneswar, Distinguished Chair Professor at Indian Institute of Engineering Science and Technology, Shibpur and an honorary Professor at King Fahd University of Petroleum and Minerals, Saudi Arabia. He was closely associated with several academic Institutes like the Jaypee University of Science and Engineering Bhubaneswar, the Budge Budge Institute of Technology, Calcutta and the Jaypee University of Engineering and Technology, Madhya Pradesh. During 1970–80, he was visiting professor at Cornell University USA. He was also a consultant to R&D Groups at IBM, Westinghouse and ARCO.

Chopra is a pioneer in thin-film research. Starting his career working on materials behaviour at ultra-low temperature, he developed techniques for the flow of liquid helium to carry out his experiments. His primary attention in the initial days was on thin films of metals and their oxides. The early work includes electrical transport properties of metals like Au, Ag and Al, including the superconducting properties of aluminium films. The ability to measure the properties of the thin films remains one of his passions throughout his life. On his return to India, his laboratory developed the capability to measure thermal transport properties and optical properties of thin films and published a series of important papers on the conductivity of thin films. He worked on the basic mechanism of thin-film growth, including field-induced nucleation and growth, besides the synthesis of novel films like semiconducting metallopolymer films.

One of the areas he looked at in considerable detail during his tenure at IIT, Delhi and contributed significantly was transparent thin films conductors. The status review he had published with his colleagues in the journal *Thin Solid Films* in 1983 attracted more than 3500 citations. He established the specular scattering of electrons in epitaxial thin film and giant photoconduction in amorphous chalcogenide thin films. His urge to implement his research results to practical applications led him to look at solar cells, particularly thin-film solar cells. A considerable portion of his attention was devoted to solar energy and its conversion from the early eighties. He was invited to be a member of the editorial board of *Solar Energy Materials and Solar Cells*. His review 'Thin-film solar cells: an overview' published in *Progress in Photovoltaic* in 2004 at the beginning of the modern solar cell revolution has influenced its future developments.

A prolific researcher, Chopra has published more than 430 research publications, including a series of opinion/policy articles in this journal. He has published ten books that include *Thin-film Phenomena* that influenced researchers all over the world. He followed this with the popular books on *Thin Film Device Applications* and *Thin Film Solar Cell*. He held six US patents and transferred eight know-how to the industry. He is also instrumental in creating two important set-ups for research in this area, the Thin Film Laboratory at IIT Delhi and Micro science Laboratory at IIT Kharagpur.

Chopra strongly believed in integrity and ethical practices in scientific endeavour. Along with fellow scientists of similar beliefs, he founded and presided over the Society for Scientific Values. Realizing the importance of Vacuum Science and Technology in thin-film technology, Chopra actively associated himself with the activities of the Vacuum Society of India and served as its president. A life member of the Materials Research Society,

he served the society as its vice president. He was also a vice president of the Electron Microscope Society of India. He served the council of the Indian National Science Academy during the period 1988–1990.

In recognition of his contributions, he was elected a fellow of the Indian National Science Academy in 1978, the Indian Academy of Sciences in 1980 and the National Academy of Science in 1988. He was also a fellow of the Indian National Academy of Engineering. Chopra is an elected fellow of the American Physical Society and the Asia Pacific Society for Materials Research. In 2008, the Government of India honoured him with the *Padma Shri*.

Chopra is a recipient of numerous national and international awards. In 1975, he was awarded the Shanti Swarup Bhatnagar Prize of the Council of Scientific and Industrial research. He received the FICCI award in 1983, the Bhabha award of the University Grants Commission and the Om Prakash Bhasin award. He received the Distinguished Materials Scientist Award of Materials Research Society, Distinguished Vacuum Scientist Award from the Vacuum Society of India and Life Time Achievement Award of the Solar Energy Society of India. He received the K. S. Krishnan Medal (1992), Prashanta Chandra Mahalanobis Medal (1996) and Aryabhata Medal (2004) of the Indian National Science Academy.

Chopra has left his legacy in training more than 100 M.Tech. students, initiating 60 doctoral students in the path of scientific pursuits and inspiring and encouraging innumerable number of scientists and technocrats to excel.

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