

## Editorial\*

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*Jasjeet Singh Bagla, Associate Editor*

This issue of *Resonance* celebrates the life and work of Professor Govind Swarup. Govind was one of a kind, in a league of his own, with few people to whom he or his body of work can be compared easily. What made him unique was his ability to see the big picture, as well as, the capability to focus on the subtle aspects of a project. The combination of the ability to dream big, undaunted by the audacious scale of projects, the tenacity to see things to a logical endpoint, and a willingness to work hard through all stages ensured that the projects undertaken by him and his team were successful. He was always willing to collaborate on ventures big and small.

Govind was born and brought up in a privileged family in rural western Uttar Pradesh. He went to Allahabad University for higher education, and it is here that he developed a keen interest in physics under the tutelage of faculty members like K S Krishnan. As discussed in the article by Dhruvo Saikia, this relationship led to the move to the National Physical Laboratory and put Govind on track towards radio astronomy.

Govind used radio astronomy to study the Sun. There are several crucial results that he obtained in the 1950s. He established that the radio flux from the Sun is correlated with Sunspot activity. He demonstrated that the quiet Sun shows limb brightening (see Article-in-a-Box by Divya Oberoi). He also discovered a unique signature of bursts of radio emission from the Sun.

He returned to India from Stanford and joined the Tata Institute of Fundamental Research. He started setting up a radio astronomy group, and they set up an array of telescopes at Kalyan near Mumbai. Then came the first mega project in the form of the



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Ooty Radio Telescope. This telescope has some unique aspects as discussed in the article by S. Ananthakrishnan and V. Balasubramanian, as it used the Moon and occultations by the Moon to unravel the structure of radio sources in the east-west direction. The Ooty Radio Telescope is a 500 m long cylinder oriented in the north-south direction, and this can be used to obtain high resolution in the north-south direction. A lot of work was done by the radio astronomy group to develop a formalism to optimize information recovery from such complex observations.

The success of the Very Large Array (VLA) convinced Govind Swarup that the future of radio astronomy lies in interferometric arrays. He started a concerted campaign for a multi-national radio array. Although this did not become a reality at that time, these discussions eventually led to the Square Kilometer Array project. Meanwhile, an interest in studying galaxy formation at high redshifts led to the conceptualization of the Giant Meterwave Radio Telescope. A change in the paradigm of structure formation meant that the goal was not within the reach of the array as it had been planned and set up in the 1990s. However, a series of upgrades have made such observations feasible, and this is discussed in the article by Nissim Kanekar, Aditya Chowdhury and Jayaram Chengalur. It was heartening that the first report of such observations was presented at a conference organized in honour of Govind's 90th birthday in March 2019. Needless to say, he was pleased to see the results.

Govind placed a lot of emphasis on training, and we can read about the summer programs that he organized along with RRI in the article by D J Saikia. Discussions initiated at the time matured in the form of the Joint Astronomy Program hosted at the Indian Institute of Science: a joint graduate school for students at several institutes. During the construction of GMRT, Govind realized the need for people who are at home in a variety of subjects within sciences. This led to a series of discussions in various forums, including the Astronomical Society of India. Proposals emerging from these discussions eventually led to the formation of IISERs.

I first met Govind during the first summer program on astron-



omy and astrophysics organized jointly by NCRA and IUCAA in 1990. He was already 60 and working hard at setting up the GMRT. Bases of the first two telescopes were coming up. Govind was excited by the first results from COBE-FIRAS and made a point to catch young students to show them the spectrum observed by FIRAS displayed prominently on the notice board. I don't recall any meeting with Govind, though we met often, when he was not excited about some new scientific development. He made it a point to share his excitement with others. I hope the readers capture some of the excitement in the articles written as a tribute to the great man.

In this issue, we also have the last part of a three-part series on quantum game theory by Indranil Ghosh. Alok Kumar Singh and co-authors describe the genome editing revolution in life sciences. Machine learning in nonlinear dynamical systems is the theme of an article by Sayan Roy and Debanjan Rana. We also have three articles in the classroom section discussing topics as diverse as the four colour problem, and the upper limit of the periodic table.

