

Preface

Women in Science – New Frontiers of Research

Since the International Women's Day, a global event celebrating the achievements of women, is celebrated on 8 March, the month of March has always been considered a special one for women. The day also calls for action to accelerate gender parity in all walks of life. It is therefore a pleasure to present, in this subsequent month, this special section of *Current Science* that focuses on the contributions of women scientists working in India and celebrate their achievements.

It is often asked that given the universal nature of science and scientific activity, why is it necessary to have a focus on the contributions of women scientists, and does gender parity exist in the field of science? However, even a cursory glance at the existing situation makes it obvious that women are seriously underrepresented in scientific fields, and their contributions are often overlooked. Even though women have made important contributions to science and technology over the centuries, their number remained insignificant globally as they were denied formal education until the late 19th and early 20th centuries. At this time, though some colleges and universities in Europe and the US opened their doors to women, their number remained small and their talent was often undermined. Even well-educated people find it difficult to recall the names of women scientists, other than a few Nobel laureates like Marie and Irene Curie, Rosalyn Yalow, Dorothy Hodgkin and Maria Goppert Mayer. In addition, there are well-known stories of how women scientists like Liese Meitner, Rosalind Franklin, Jocelyn Bell Burnell and C. S. Wu were denied the Nobel prize.

In India the situation is not any different. After independence, the importance of women's education was stressed and the situation has changed as the general level of education has improved. Yet, there are many social challenges when women want to make a career in science. Those who still struggle and want to flourish in their careers find that there are several hurdles and an invisible glass ceiling. Some attempts have been made by the Science Academies and agencies like DST, UGC, etc. to address this problem. A few schemes are beginning to see some measure of success.

However, very few women are recipients of awards and honours, and the general public remains unaware of their work. Most people do not even know the names of Bhatnagar awardees like Asima Chatterjee (chemistry), Archana Sharma (biology) or R. Parimala (mathematics), and no woman scientist has ever been given the Bhatnagar Award in physics. Very few people are aware of the contributions of Leela Mulherkar, who founded the field of developmental biology in India, and was an authority on chick embryology. Even though the recent successes

of the Indian Space Research Organisation (ISRO) and Defence Research and Development Organization (DRDO) have brought the achievements of their women scientists to the forefront, other than Tessa Thomas, the others remain unknown. This special section is a small attempt towards redressing this situation, by focusing on the work of young women scientists. It has been the experience of those who have been active in research and teaching, that girls and young women science students are excited to see women scientists and get inspired to take up scientific careers. We therefore hope that this attempt to showcase good scientific work by young women scientists will not only be encouraging to women researchers, but will also be seen as a good initiative to encourage and bring to the fore the work of women scientists.

This idea received enthusiastic response both from leading scientists and young women scientists from different fields working in different institutes in India. The contributions presented here also include a short paragraph 'About the Author', along with their photographs, to further highlight their career graphs.

Some of the contributions in this special section are regular research articles and some are mini-reviews. They provide a glimpse of a variety of subjects like mathematics, basic physics, applied physics, instrumentation and materials science, modelling and computational techniques in biology, pharmaceuticals, and earth sciences, where these women have made important contributions.

The first set of articles goes from gravitational scales to atomic and sub-atomic scales.

Archana Pai (**page 1353**) discusses LIGO, viz. the large interferometers employed in the recent detection of gravitation waves in the article 'Gravitation waves in an interferometric detector'. This is a timely and topical article in an area which has recently seen spectacular discoveries.

Quantum entanglement and its applications have been a hot topic of investigation during the last decade. Aditi Sen (De) (**page 1361**) has introduced the concept of entanglement, i.e. quantum correlations in her review 'quantum entanglement and its applications'. She has also discussed well-known entanglement measures, as well as the application of entanglement to communication protocols of dense coding and quantum teleportation.

The world of cold atoms is discussed through atom-photon interactions at the low photon level using optical fibres by Shrabana Chakrabarti (**page 1369**) in the article, 'Manipulating cold atoms with optical fibres'.

We have two articles on neutrinos, addressing different aspects of their properties and behaviour. The article by Vandana Nanal (**page 1375**), 'Is neutrino its own antiparticle' describes the properties of neutrinos, and the topic of neutrino oscillations is introduced by Sandhya Choube

(page 1381) in the article ‘Neutrino oscillations’, which takes us beyond the Standard Model of fundamental particles.

Nabamita Banerjee and Sayali Atul Bhatkar’s (page 1385) article ‘Non-relativistic fluid’ discusses how an effective field theory can be described by a fluid, which can then be studied for its transport properties. The results can have implications for gravity as well as low-energy physical systems such as superfluids.

The second set of articles deals with materials, their properties and the techniques to study these properties.

Chhayabrita Maji (page 1390) discusses a class of interesting newly emerged materials with applications in many modern devices/instruments in her article ‘Properties of magnetic shape memory alloys in martensitic phase’.

In recent years, a large cross-section of scientists working on the energy issue are trying to obtain efficient thermopower materials. Preeti A. Bhobe (page 1402) discusses in her article ‘A peek into the world of materials using thermopower and XAFS as investigative probes’, properties which are essential for profitable thermopower materials. She also explains how the XAFS technique is useful to understand materials in general, and how they are used to study the properties of thermoelectric materials.

Neha Hebalkar (page 1413) introduces not a new but mostly neglected and unknown class of materials, viz. aerogels, in her article ‘Development of nanoporous aerogel-based thermal insulation products: Make-in-India initiative’. These materials have been neglected due to their high production costs and rather difficult and delicate synthesis techniques, but are gaining importance now; so this article will be of interest to many materials scientists.

Mahima Makkar and Ranjani Viswanatha (page 1421) discuss recent advances in doped semiconductor quantum dots in their article on ‘Recent advances in magnetic ion doped semiconductor quantum dots’. They summarize important developments in the field of nanotechnology, with applications in spintronics.

Nandini Garg (page 1430) provides a lucid introduction to high-pressure experimental techniques as a tool to study material properties in her review article entitled ‘high pressure: one of the many tools to study material properties at extreme conditions’.

We also have three articles on important computational techniques, with applications to biological systems, molecular systems and geological systems respectively.

Sneha Menon and Neelanjana Sengupta (page 1444) present a mini-review on the computational approaches to studies of intrinsically disordered proteins, an important class of proteins in biological systems.

Debashree Ghosh’s (page 1455) article ‘Multi scale modelling: hybrid quantum mechanics/molecular mechanics as an example and some recent developments’ discusses, as the name suggests, the power of multiscale modelling in molecular systems where both time and length scales are important.

Attreyee Ghosh and co-workers (page 1463) discuss in their article, ‘Understanding deep earth dynamics: a numerical modelling approach’, how various surface phenomena can be understood by investigating the earth’s deep layer dynamics using computational modelling.

The last set of articles is varied, dealing with mathematics, manufacturing and palaeobiology.

Anisa M. H. Chorwadwala (page 1474) reveals how a branch of mathematics, viz. geometric analysis is used for shape optimization problems with some examples in her mini review ‘A glimpse of shape optimization problems’.

Mugdha Gadgil (page 1478) summarizes the ideas involved in manufacturing various drugs through her review article ‘Cell culture processes for biopharmaceutical manufacturing’.

Devapriya Chattopadhyay’s (page 1489) article ‘Predation to climate change: what does a fossil shell tell us?’, gives an account of identification of the agents of natural selection that influence the ecology and evolution of an organism using marine fossil record.

Unfortunately, here we could not cover other areas like space science, meteorology, etc. However, we hope that *Current Science* will continue to support these efforts to focus on the work of women scientists. We would like to end this preface with a tribute to our dear friend, the distinguished chemist Charusita Chakravarty whose first death anniversary falls this fortnight.

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– Guest Editors