Jour. Geol. Soc. India (2022) 98:1765-1767
https://doi.org/10.1007/s12594-022-2249-x

BOOK REVIEW

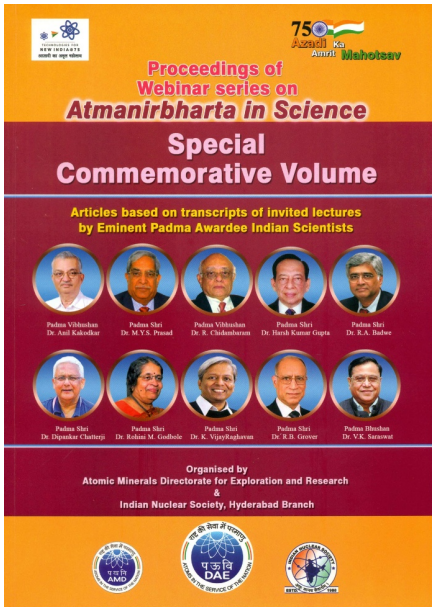
SPECIAL COMMEMORATIVE VOLUME – PROCEEDINGS OF A WEBINAR SERIES ON ATMANIRBHARATA IN INDIA. Atomic Minerals Directorate for Exploration andResearch, Department of Atomic Energy, Government of India. 134p.

T. M. Mahadevan
Sree Bagh Ammankoil Road, Kochi - 682 035, India
E-mail: *tmm154@gmail.com*

Received: 29 October 2022 / Accepted: 5 November 2022

The Atomic Mineral Directorate for Exploration and Research on the occasion of '*Äzadi Ka Amrit Mahotsav*', has brought out a Special Commemorative Volume containing articles based on transcript of ten invited lectures from eminent Padma Awardees who are leaders of Indian science in different fields.

These ten lectures were part of a webinar series and were web-cast live in virtual platforms (Webex and YouTube) and provided an opportunity to large audience of scientists, academicians, researchers and students from various disciplines. The articles have been reviewed



and approved for publication by the respective speakers. The volume now published is expected to "serve positivity and inspire young aspirants with the culture of basic and applied sciences". In the Preface to the volume Dr. D.K. Sinha, Director AMDER and Chairman of Indian Nuclear Society, Hyderabad branch has summarized the contents. These papers are briefly reviewed here:

(I) Padma Vibhushan Dr. Anil Kakodkar : "Atmanirbhar in Atomic Energy to Atmanirbhar in Clean Energy"

This paper emphasizes the need to have a fivefold increase of energy consumption, so essential to improve our quality of life. But effecting such increase keeping control and limiting carbon emission calls for an overhaul of the energy basket, depending more on nuclear, solar and wind power, whose contribution should go up by a factor of 120-140. Considering the limitation of solar and wind sources of energy, self-reliance (*Atmanirbharata*) demands dependence on use of nuclear energy, harnessing the vast experience gained by the country in PHWR technology. Nuclear power can be exponentially increased. "Government of India's approval for the construction of Made in India 700 MW PHWR reactors in fleet mode is a significant step towards enhancing the foot print of low tariff, zero carbon consumer friendly and reliable nuclear power". The 70 M W PHWR is a globally competitive workhorse for generating the nuclear power programme. It is suggested that India should complete three (03) more fleets by 2050 to attain the goal of net zero emission. Emphasis is laid on the 3-stage programme that will enable us to use our large thorium resources and on fabrication of Small Modular Reactor units (SMR) for retiring coal plants. The article highlights the importance of decarbonization and Carbon Capture and Utilization (CCU), outlines the global prospects of CCU and its status in India. The paper concludes by suggesting that we need to aim at India being the world leader in energy generation by 2050 so that our citizens enjoy the best quality of life and contribute to the survival of the planet.

(II) Padma Shri Dr. M.Y.S. Prasad: "Development of Space Activity in India Since 1960".

After a brief reference to the great inspiration that space research received from Prof. Vikram Sarabhai, the visionary leader of Indian space and from Prof. Sathish Dhawan, the institution builder, the author outlines the phased growth of Indian space programme. It started with a concept phase followed by an experimental phase that involved design and development of indigenous communication / remote sensing satellites, launch vehicles, pay loads and application interface methodologies. The next phase of operational phase saw the launching of INSAT, IRS, PSLV and GSLV programmes. National operational coordinating systems were introduced, creating an industrial base for space programmes. Chandrayan I marked the beginning of the exploration phase.

The major activities by the space programme include launch vehicle activities, space craft building, Pay load activities and applications related to communications, remote sensing, meteorological navigation and synergy applications. These are described in detail individually. Notable applications in remote sensing includes food security and disaster management. The paper highlights the Science Mission of ISRO which includes the Chandrayan I and II , Mars Orbit Mission and Aerosat. The numerous space centers and units in India are outlined. The paper concludes by referring to the commendable management model of ISRO and the sound philosophy that leads to good culture and good management.

(III) Padma Vibhushan Dr. R. Chidambaram: "The Many Dimensions of Nuclear Energy"

This paper initially makes a brief reference to the great Indian traditions in Science and Technology, and recalls the contributions of Aryabhatta and Bhaskaracharya in the olden times and in the 20th century Nobel Awardee Sir C.V. Raman and a few others. He refers to Indian dreams to eradicate poverty, provide good health and well living etc, sharing the goals of the United Nations.

He recalls the great vision of Dr. Homi. J Bhaba of long-term energy security. Dr Bhaba conceptualized the comprehensive three stage NPP of India and the need to build up the closed nuclear fuel cycle, involving re-processing and recycling of fuel material back into the reactor, aiding the utilization of plutonium, along with uranium. The three-stage programme also helps the conversion of thorium, of which India has abundant resources, to U-233, that in a fissile reactor material, that can be used in the reactor.

Discussing the importance of Indian nuclear power to counter the threat of climate change, it is pointed out that importance of renewable energy sources (RE) is globally recognised and India has progressed considerably in generating power from RE. However, large installation area are required and energy storage for RE have limitations. Nuclear energy utilities have an average capacity factor of 90% while solar and wind power have 20 to 30 %.

Discussing the Nuclear Detergence in India and aspects of national security, the thermo-nuclear testing conducted in India in 1974 (Pokran I) and 1998 (Pokran II) are cited as major landmark events in Indian NPP. The execution of the tests are briefly reviewed. These provide the "capability to confidently design and build nuclear weapon from low yields up to around 200 kilo tones". A parallel development in DAE is the generation of super computers made indigenously in the past 30 years.

Harnessing the spin-off from the NPP, DAE has contributed to its application in several fields. These include the field of agriculture, health care sector, radio-isotopes, radio-pharmaceuticals, radio immuno array (RIA) and immuno radiometric array (IRMA). Nuclear application have helped in water resource management and variety of other fields.

DAE's international scientific collaboration include (i) the construction of the Large Hardon Colliderc (LHC) and (ii) international collaboration in the international thermo-nuclear experimental reactor coming up in France, an experimental machine designed to harness the energy of fusion.

Another dimension to nuclear energy development is the relevance of artificial intelligence and machine learning based on different expert systems for cyber security in the NPP.

The article concludes that to be a global technology leader, India should aim to be the first introducer of new advanced technologies, make itself immune to technology control regimes in all high technology fields and keep improving the techniques.

(IV) Padma Shri Dr. Harsh Kumar Gupta : 'Developing Tsunami Early Warning System for Indian Ocean'

This paper highlights Indian achievements in generating its own Tsunami Early Warning System (ITEWS) in the Indian National Centre for Ocean Information Services (INCOIS), Hyderabad. This has been achieved without any foreign collaboration. Different Indian organizations collaborated in designing and setting up the ITEWS which includes, The Department of Space (DOS), Department of Science and Technology (DST), Council of Science and Industrial Research (CSIR), Survey of India(SOI) and National Institute of Ocean Technology (NIOT). A brief introduction is provided to earthquakes, their distribution magnitude and energy release; oceanic faults and movements that generate tsunami; their heights and movements and manner of transmission of ocean waves that causes the tsunami. The paper then presents an account of the major components of ITEWS. The computational and communication infrastructure of ITEWS that enables reception of real time data from all the sensors, analysis of data and generation and dissemination of tsunami advisories are outlined. A number of events detected by the system are reviewed that led to timely advisories to affected areas. It is noteworthy that there have been no false alarms till date since the inception in 2007.

(V) Padma Shri Dr. Rajendra Achyut Badwe, DAE: "Advances in Cancer Therapy – A DAE Contribution"

This paper presents an overview of cancer trends in India and other countries, cancer mortality, cancer care and control in India. Preventive measure for cancer and effective ways of streaming and detection are discussed. The article highlights Tata Memorial Center's noble initiative of communicating the benefits of healthy lifestyle and personal hygiene which has ensured that cancer prevalence in India is less than one third of western countries. The introduction of tele-medicine, web-based engine Navya service and establishment of National carrier grid have facilitated easy and affordable access to cancer care. The article concludes that considering the medical infrastructural developments in cancer care and the availability of cheaper drugs, India is probably the top country in the world by virtue of low incidence compared to western countries.

(VI) Padma Shri Dr. Dipankar Chatterjee: 'Post-Independence Development in Indian Science Programme for Student Community in India: The Road To Atmanirbharata'

This paper outlines that "Chance and Necessity" are the two factors that have led to the growth of science and cites the examples of discovery of the principles of vaccination and the discovery of penicillin. He suggests our students must be given sufficient chance to lead them to success. He cites platforms offered for interaction of undergraduates, PhD students and researchers in the Nobel Laureate meetings conducted annually in Lindlar, Germany and cites the need for such interaction in India.

Outlining Indian efforts to foster scientific temper he cites establishment of the CSIR that has today dynamic network of 37 national laboratories, 39 outreach centres, 3 innovative complexes and 5 units of Pan-India presence and establishment of atomic energy programme. He refers to the contribution of eminent scientists like Nobel Laureate C.V. Raman, M.S Swaminathan and the Nobel Laureate Venki Ramanathan all of whom have helped in fostering the scientific temper. The Indian National Science Talent Search Programme and the *Kissan Vaigyanie Prothsahan Yojana* (KVPY) of the DST have promoted generation of scientific man power. He discusses in detail several aspects of the research and academic expansion in India, expansion of the biotech industry and development of molecular biology. In this regard the author makes a pointed reference to the contributions of professor G.N Ramachandran, from the University of Madras (1922-2001) and the less known Dr. Sambu Nath D C (1950) a doctor in Nilratan Sarcar Medical College Calcutta.

In conclusion, it is pointed that modern India has a strong focus on Science and Technology, a key to economic growth. This has been proved by achievement of developing two vaccines for meeting the COVID Pandemic and inoculation of more than a billion people. India has done enough to show that *Atmanirbar Bharath* is not just a mere slogan.

(VII) Padma Shri Dr. Rohina M Godvole: "Mega Science Projects: Relevance of and for India"

This paper deals with India's progress in science has been insured by the establishments of organizations like the Department of

Atomic Energy (DAE), Defense Research and Development Organization (DRDO) and Indian Space Research Organization (ISRO). This initiative has lead to the international collaboration in Global Mega Projects, that are crucial to basic sciences. The paper outlines five such projects and discusses their scientific reach. These include (i) the Large Hadron Collider (LHC) accelerator at the European organization for Nuclear Research (CERN) (ii) the indigenous Indian Neutrino Observatory (INO), (iii) The Laser Interferometer Gravitational-Wave Observatory (LIGO) and (iv) The Square Kilometer Array (SKA) Radio Telescopes. The scientific content and target of these projects, their benefit to science and technology gains are discussed in detail and India's role in each of these. In conclusion it is pointed out that both the "Blue Sky" research and applied research are part of a virtual circle and we have no option but accept the both. Indian discussion on budget includes consideration of the mega projects and we are proceeding in the right direction. The future of basic researching in India seems to be bright.

(VIII) Padma Shri Dr. Vijaya Raghavan: "Science and Technology: Directions for the next three decades"

This paper outlines the Indian traditions in science and technology, in Astronomical and other sciences. The paper focuses on the need to analyze big data and the world's emphasis on artificial intelligence (AI) and machine learning (ML) techniques for gaining predictive modeling and other advanced analytical applications. The article concludes that in a world where science and technology has expanded at an enormous scale, going forward, with a mission of sustainable development over next three decades is very challenging.

(IX) Padma Shri Prof. R.B Gover: "Relationship between Science and Technology'

This paper explains that in the 13th century, science and technology followed parallel trajectories, but by 19th century technology became the mirror image of each and now the two are fully intertuned. The article outlines the multi-faceted relationship between the two (science and technology) and a conceptual relationship between the two exist, the two being inter tuned. There is a need to evolve institutional interactive environment where academic and post-academic research can co-exist to nurture a spirit of innovation to address real life problems.

(X) Padma Bhushan Dr. V.K Saraswat: "The Nuclear Power in Energy Transition to achieve Net Zero Carbon by 2070"

This paper presents a wealth of data on : (i) Operational Nuclear Power Plants in India and those under construction. (ii) An overview of different types of Generation-IV nuclear reactors (iii) Types of Small Modular Reactors (SMR) developed world wide and (iv) Contrasts: Large Generation III and III+ vs smaller generation IV reactors.

In the background of this information the author explains the role of nuclear power in energy transmission in India, keeping in view the aspects of resource efficiency, reliability, low foot print, safety and the lowest average life cycle of carbon dioxide emission of nuclear power. It scores over solar and wind energy. Nuclear energy, thereby holds the answer to meet the carbon emission problems. As to the gaps in the targeted nuclear energy generation and actual achievement, the author suggests that private participation in nuclear energy generation may be encouraged. Further a mix of nuclear power and green energy sources and adapting SMR technology may be a long-term strategy for advancing net zero carbon by 2070.

Concluding Remarks

The ten articles from outstanding leaders of science and technology of India provide a synoptic view of the grand path of the growth of Indian science and technology in the last 75 years, after independence. Several papers recall early traditions of scientific and technological achievements that has helped to build a tradition in science and technology. The publications provide a synopsis of the past, present and future of Indian science. There is no doubt that these publications, in fact the publication as a whole will be an aspiration to current and future scientists and technologists and is indeed a tribute to *Atmanirbharta* (Self Reliance) in Indian science and technology.