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EDITORIAL

NUCLEAR CHEMISTRY RESEARCH : PAST, PRESENT AND FUTURE

Madam Curie predicted two new elements, Po and Ra in 1898 but only in the year 1910 she could able to isolate tiny amount of radium from tons of pitchblende. She was awarded her second Nobel Prize in chemistry in 1911in recognition for the discovery of new elements radium and polonium and for the isolation of radium in its pure metallic state. In fact, "isolation of radium in pure metalic state" gave birth of a new subject "Nuclear Chemistry" or "Radiochemistry". The Nobel Committee in their citation said that by the discovery of Madam Curie science acquired numerous points of contacts with many other natural sciences. The Nobel Prize in Chemistry in the year 1935 was again awarded jointly to Frédéric Joliot and Irène Joliot-Curie "in recognition of synthesis of new radioactive elements". Since the successive epoch making discoveries of Curie family, nuclear chemistry is working in many splendors of life and knowledge. This discipline of science became contact points of physics, chemistry, biology, medicine, etc. The nuclear chemistry is also working on discovering new isotopes and new elements.

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Science and Culture proposed to publish a special issue on this dynamic subject "Nuclear Chemistry". One of the SINP-DAE 12 five-year plan project, TULIP (Trace, Ultra-trace Analysis and Isotope Production) is committed to the society and on the dissemination of knowledge to the public in general. Therefore when editor-in-chief proposed to publish this special issue, the director, Saha Institute of Nuclear Physics (SINP), readily agreed to support this issue, especially when the nuclear chemistry research in this institute has long-heritage.

The Institute of Nuclear Physics was established under the dynamic leadership of Professor Meghnad Saha and formally inaugurated by Nobel Laureate Professor Irene Curie-Joliot, on January 11, 1950. In the Institute, Professor Saha initiated academic activities broadly in three major fields, namely, Accelerator Physics, Nuclear Physics and Nuclear Chemistry, and expanded later in other branches of scientific research of contemporary interest. The Institute of Nuclear Physics was later renamed as Saha Institute of Nuclear Physics. During the period, B. C. Purkayastha who was associated with Professor Paneth in England as a nuclear research chemist published two highly acclaimed reviews on nuclear fission in Nucleonics. Professor Saha realized the importance and intricacy of chemistry in nuclear science and entrusted B. C. Purkayastha, the first nuclear chemist in India, to organize the nuclear chemistry division in the Institute. In fact, the Institute is the pioneer in introducing research in nuclear chemistry in India under the leadership of the first nuclear chemist of our country.

In this long period of over sixty-five years, nuclear chemistry research in Saha Institute of Nuclear Physics has

been proliferated into the diversity encompassing many areas of sciences. Many "first" is associated with the nuclear chemistry group of SINP. Below a glimpse of the current trends in nuclear chemistry research in SINP is given.

This group introduced for the first time heavy ion projectiles for production of radioisotopes using medium energy accelerators and studied in depth their separation chemistry from the target material. The introduction of heavy ion beam made easy access to the neutron deficient short-lived radioisotopes and expanded the horizon of clinically important radionuclides. The nuclear chemistry group of Saha Institute of Nuclear Physics first time combined radiotracer technique with "Green Chemistry" experiments and successfully synthesized first "radioactive gold nanoparticles". The team also developed separation methods of minuscule amount of supernova produced radionuclides ^{53}Mn, ^{146}Sm and ^{182}Hf from the billion times abundant interfering stable isobars ^{53}Cr, ^{146}Nd and ^{182}W respectively. These separation schemes would bring new dimension to cosmochemistry and a step forward to solve astronomical puzzles.

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The nuclear chemistry research in India is very strong compared to the world scenario. Bhabha Atomic Research Centre (BARC) is taking lead role in all front line areas of nuclear and radiochemistry research including isotope production for beneficial use of mankind, synthesis of suitable radiopharmaceuticals, reactor based research, separation of important radionuclides from fission products and in many other areas. Indira Gandhi Centre for Atomic Research (IGCAR), Kalpakkam, is also engaged in reactor based program in nuclear and radiochemistry. Accelerator based pioneering researches in nuclear sciences are carried out in three main accelerator centers, namely Variable Energy Cyclotron Centre (VECC), Kolkata, Bhabha Atomic Research Centre-Tata Institute of Fundamental Research (BARC-TIFR) Pelletron, Mumbai and Inter University Accelerator Centre (IUAC), New Delhi. Accelerator based material and biological sciences are also carried out with equal interest in all of these centers. Besides various institutes of national importance, many universities in India are also practicing nuclear chemistry in their limited capacity. University of Burdwan, Mizoram University, Panjab University, K.C College, Mumbai, Indian Institute of Technology Roorkee, Nagpur University, Amity University, New Delhi, etc., are some examples.

The nuclear chemistry is now engaged in some pioneering experiment world wide along with other branches of sciences. For example, the limit of chemical element is an important question. An international team of scientists, physicists, chemists, engineers, gathered in GSI, Darmstadt, Germany and constructed world's most powerful recoil separator called TASCA (TransActinide Separator and Chemistry Apparatus) to study superheavy elements. In 2011 and 2012 they had six months long beam time in each year to synthesize new element 119 and 120. Element 120, would be long-predicted "island of stability in the ocean of instability". Though both the experiments failed to get a single event of 119 and 120 but got an insight in the upper region of the radionuclidic chart and on the way the group independently confirmed new element 117. It is noteworthy to mention that SINP nuclear chemistry group is part of this international collaboration. RIKEN and JAEA (Japan Atomic Energy Agency) are taking lead role in front line areas of nuclear chemistry in Japan. Recently they reported in nature experimentally determined first ionization potential of lawrencium, element 103. The neutrino mass determination is one of the fundamental problems till unsolved. One of the approach is direct kinematic measurement through some ideal radionuclides like ^{163}Ho who decays only by electron capture and no other decay mode. However, this attempts

require ultra pure cyclotron produced ^{163}Ho free from any stable, radioactive isotopic or non-isotopic impurity. The nuclear chemists from different institutions like JGU, Mainz, Atomki Hungary, PSI Switzerland, SINP, India have gather around the micro calorimetric group of Heidelberg University in Germany so that required amount of ultrapure ^{163}Ho is available, which is a highly tedious job. CERN is best known for LHC, ATLAS, for discovery of Higs Boson, and so many problems of fundamental sciences. Recently CERN has taken a project called CERN-MEDICIS for production of huge quantity of clinically important radioisotopes, naturally lots of radiopharmaceutical and nuclear chemistry research is going on around this facility. Similar facility is also planned in SCK-CEN, Belgium, MSU, USA. In USA nuclear chemistry became integrated with sustainable reactor research, Accelerator Driven systems (ADS), etc. In nutshell century old nuclear chemistry is rejuvenated and coupled with many facets of modern days sciences.

Nuclear Chemistry is the contact point of many disciplines and it keeps an eye to the all round development of nuclear sciences all over the world. It would be nice if we could add glimpse of all aspects of nuclear chemistry in this special issue of Science and Culture. However, journal page is limited which also limits our capacity. Therefore few handpicked articles have been selected in this issue over a wide variety of modern and forthcoming issues, starting from the history of nuclear chemistry, application of radioisotopes in nuclear medicine and green chemistry, state of the art research in superheavy elements, upcoming radioactive ion beam facilities in India, and on Facility of Antiproton and Ion Research (FAIR) – a facility for the future where India is playing an important role in building up this multinational facility.

Finally, I would like to record my personal thanks to Professor Suprakash Roy, Editor-in-Chief, Science and Culture for thinking of a special issue on Nuclear Chemistry and also for inviting me to serve as guest editor of this special issue.

Hope readers will enjoy this issue. ❐

Susanta Lahiri
Saha Institute of Nuclear Physics,
1/AF Bidhannagar, Kolkata 700064, India
E mail: susanta.lahiri@saha.ac.in

Professor Susanta Lahiri is Senior Professor in Chemical Sciences Division of Saha Institute of Nuclear Physics, Kolkata. Over last two decades, he has earned international reputation through outstanding accomplishments in Nuclear and Radiochemistry and for which he was awarded most coveted international recognition, "Hevesy Medal Award-2015". In fact he is the first winner of this award from India since its inception in 1968. His main interests are chemistry and physics of accelerator produced neutron deficient radionuclides, radiotracer technique, physics and chemistry of converter targets, superheavy elements, green chemistry, etc. While he carried out most of his research work in India using medium energy accelerators, but at the same time he also initiated collaboration with well known international institutions as CERN-ISOLDE; TASCA group, GSI, Germany; Electron Capture of Holmium neutrino (ECHo) collaboration, Heidelberg University, Germany; IMP, China; TU Munich, Germany; etc. He has more than 180 publications in international peer reviewed journals, about 240 reports in international and national conferences. He has guided more than 10 Ph. D students. He was offered Third World Academy of Sciences (TWAS)-Associateship twice in the year 2000 and 2004.

Editor's Note : *We congratulate Prof. Susanta Lahiri of SINP for being the First Indian to have bagged the International Hevsey Medal 2015 for his lifetime achievement in nuclear chemistry. To understand the importance of his work, we have presented brief scientific activities of Prof. Lahiri under our newly introduced section 'News Flash' (p.277) where we plan to publish important scientific discoveries and breakthroughs.*

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