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SERIES 74

Dr. Sanjeev Kumar Ujjain

Series – 74

Date and Time	:	2022-05-12 (15:30 - 16:30 JST | 12:00 - 13:00 IST)
Venue	:	Zoom
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Title- Pathway for an Affordable Early-Stage Cancer Diagnosis

Imagine a basket full of tennis balls, identical in color and size, varying merely by a tenth of a gram in weight. Even with the right equipment, sorting out the heavier tennis balls would likely be a challenging and tedious work. A similar situation exists in separation of isotopes, including oxygen-16 (^{16}O) and oxygen-18 (^{18}O) or carbon-12 (^{12}C), carbon-13 (^{13}C) and carbon-14 (^{14}C) etc., due to their extremely low natural abundance and nearly identical physical and chemical properties. These isotopes are highly desirable because they can be substituted for naturally occurring atoms without significantly perturbing the biochemical properties of the radio-labelled parent molecules. These labelled molecules are employed in studies of brain disease, clinical radiopharmaceuticals and as imaging probes in the radionuclide-based molecular imaging positron emission tomography (PET) technique; for early-stage detection cancer tissues. Taking advantage of the cancer cells natural tendency to take up much more glucose than normal cells, clinicians inject a drug called [^{18}F]-labeled 2-deoxyglucose (FDG) produced from ^{18}O, which is an index of glucose metabolism and uses a PET machine to accurately diagnose the infected or cancerous tissues. However, their separation remains an immense challenge, as the established distillation-based isotope gas separation methods have a separation factor (S) below 1.05 and incur very high operating costs, highlighting the need for new separation technologies.

In this Café, I will present a novel method and an instrument we have devised for the rapid, less energy-intensive and efficient separation of ^{18}O or ^{13}C from their parent gaseous molecules. This rapid and preferential adsorption-based separation of ^{18}O resulted in a $S(^{18}O/^{16}O)$ above 60 using nanoporous carbide-derived carbon (CDC) adsorbent. Similar, high separation efficiency has also been evident for the separation of ^{13}C with $S(^{13}C/^{12}C) = 56 \pm 6$. We discovered that a cooperative or collective nuclear quantum effect (NQEs) can explain the high separation efficiency of ^{18}O or ^{13}C by subnanometer pores. The new method can facilitate production and availability of ^{18}O at an affordable cost for early-stage cancer diagnosis using PET imaging and other medical applications; saving millions of lives across the world.