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New Elegant Method for Rapid Recovery of Anti-Cancer Agent At-211

Researchers report fastest purification process for astatine-211, a promising radioactive isotope for targeted cancer treatment

THE SCIENCE

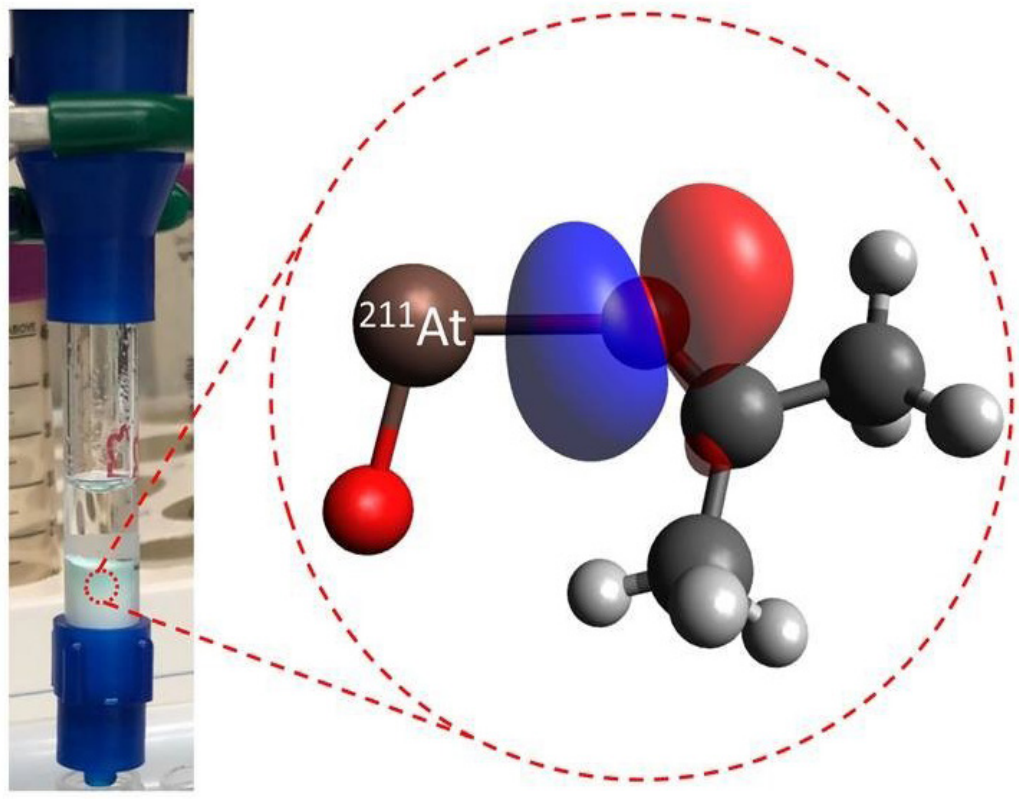
Astatine is an extremely rare element. It occurs naturally only due to the radioactive decay of other elements in the earth's crust. There are no known stable isotopes of astatine, and none of its isotopes has a half-life greater than 8 hours. This means half of the nuclei in a sample of astatine will decay every 8 hours. One isotope of the element, At-211, has shown promise in cancer treatment. However, because of its short half-life, scientists need a rapid system with high yield to recover At-211 for medical use. In this research, scientists developed a purification system based on a newly discovered chemical interaction of At-211 with a class of chemicals known as ketones. This system results in a high purity, high yield recovery of At-211 in roughly 10 to 20 minutes.

THE IMPACT

Researchers are increasingly interested in targeted alpha therapy (TAT) drugs for cancer treatment. TAT is a process that uses an atom that releases alpha radiation capable of causing large amounts of damage at a short range. This atom is attached to a molecule targeted at cancer cells. At-211 is of particular interest for TAT because it emits one alpha particle and has a moderately-short half-life of 7.2 hours—characteristics that help doctors control damage to the patient's body. Although At-211 is not widely available, researchers have used the isotope in a number of clinical trials. The trials include treatment of malignant brain tumors, ovarian cancer, and a current study treating advanced blood and lymph system cancers. The new purification method results in high yields of At-211 faster than previous methods.

SUMMARY

Making At-211 requires a nuclear reaction resulting from bombarding a metal plate of bismuth with alpha particles using a particle accelerator such as the Texas A&M K150 cyclotron. The At-211 is trapped in the bismuth target and must be extracted through a chemical process. Of the two approaches generally used to recover the At-211, completely dissolving the target followed by chemical processing results in a more consistent At-211 yield. Researchers have found using ketone solvents in the wet chemical process improves the overall amount of At-211 purified. The biggest challenge of recovering purified At-211 is the amount of time it takes and the need for sophisticated equipment that runs continuously. To overcome this challenge, scientists explored the use of chromatography to extract At-211. Chromatography is a process of breaking down a solution into its various parts in a single step.Using this method reduces the time and resources necessary to extract At-211. The extraction chromatography system used in this project is based on a chemical called 3-octanone. The results indicate that this process produces high-quality At-211 in about 10 to 20 minutes using minimal resources and mild chemicals, which should be compatible with human use. This streamlined process can improve availability of this potentially useful isotope, increasing its availability to the medical research community through the DOE Isotope Program's National Isotope Development Center.



At-211-ketone interaction within the chromatography column.

Jonathan D. Burns

Evgeny Tereshatov

PUBLICATIONS

Burns, J.D. et al. "Astatine partitioning between nitric acid and conventional solvents: indication of covalency in ketone complexation of AtO +," Chem. Commun. 56, 9004–9007 (2020).

Burns, J.D. et al. "Rapid recovery of At-211 by extraction chromatography," Sep. Purif. Technol. 256, 117794 (2021).

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ABOUT THE CYCLOTRON INSTITUTE: *Dedicated in 1967, the Cyclotron Institute serves as the core of Texas A&M University's accelerator-based nuclear science and technology program. Affiliated faculty members from the Department of Chemistry and the Department of Physics and Astronomy conduct nuclear physics- and chemistry-based research and radiation testing within a broad-based, globally recognized interdisciplinary platform supported by the United States Department of Energy (DOE) in conjunction with the State of Texas and the Welch Foundation. The facility is one of five DOE-designated Centers of Excellence and is home to one of only five K500 or larger superconducting cyclotrons worldwide.*