Liquid-liquid Extraction of Vanadyl as a Probe of Vanadium's Suitability as a Surrogate for Astatine

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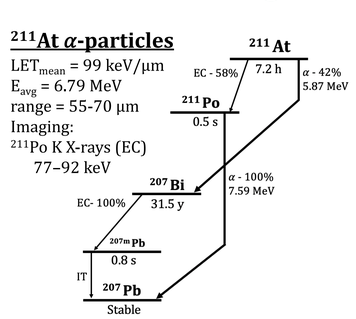
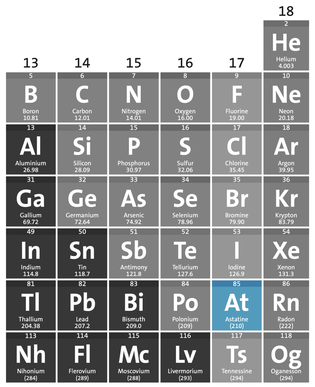
Abstract:

The rapidly growing field of radiopharmaceuticals, specifically Targeted Alpha Therapy (TAT) agents, has necessitated the development of new radionuclides to treat various types of cancer. One promising isotope is ^{211}At, currently of interest due to its simple decay scheme, stable granddaughter nuclei, and short half-life (roughly 7.2 h). Inquiry into At chemistry has been complicated by the lack of a stable, or long-lived isotope, where ^{210}At is the longest lived ($t_{1/2}$ 8.1 h). This requires not only very efficient systems for separation and purification, but also that studies occur near facilities capable of synthesizing ^{211}At. Along with its halogen-like properties, At also possesses metallic character, forming the unique oxocation AtO^+ in acidic conditions. Knowing this, a non-radioactive chemical surrogate would allow for separation systems to be more extensively screened; the vanadyl cation, VO^{2+}, has a similar geometry to that of AtO^+, while only having metallic properties, as its frontier orbitals are *d*-orbitals compared to the *p*-orbitals of AtO^+. This project looks to probe the suitability of VO^{2+} as a surrogate for AtO^+ by comparing the extraction behavior of both oxocations into either 1-octanol or 3-octanone from either nitric or hydrochloric acid.

Background ^{211}At:

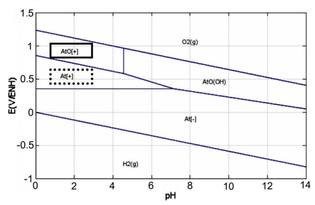


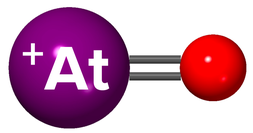
Adapted from Zalutsky, M. and Pruszynski M. *Curr. Radiopharm.* **2008**, *1*, 177–196.



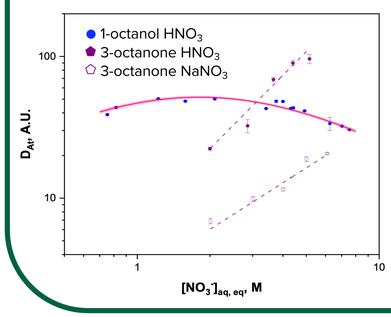
Determination of stability constants between complexing agents and At(I) and At(III) species present at ultra-trace concentrations

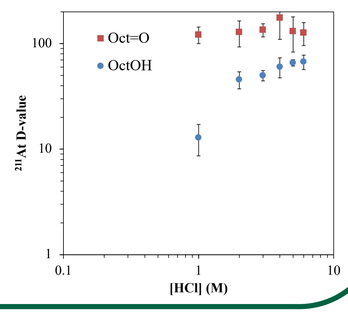
J. Champion [a], C. Alliot [b], S. Huclier [a], D. Deniaud [a], Z. Asfari [a], G. Montavon [a,*]





$$D = \frac{C_{Org}}{C_{Aq}}$$



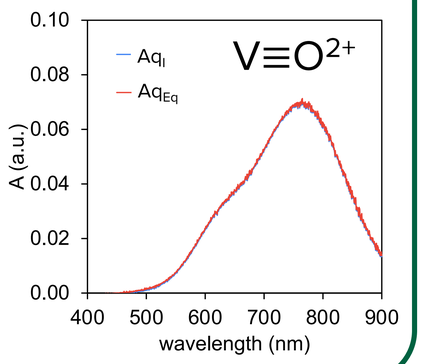


Studies with Vanadyl:

Vanadyl is the only other stable monoxide molecular cation in aqueous solution on the periodic table

$D_{VO^{2+}}$ into 1-octanol

	HNO_3	HCl
1 M	<0.01	<0.01
2 M	<0.01	<0.01
3 M	<0.01	<0.01
4 M	<0.01	<0.01
5 M	<0.01	<0.01
6 M	<0.01	<0.01
7 M	<0.01	<0.01
8 M	<0.01	<0.01



Conclusion:

- Vanadyl does not appear to be a good surrogate for $^{211}AtO^+$ in liquid-liquid extraction systems

Future Work:

- Examine vanadyl utility as a surrogate for $^{211}AtO^+$ in ion exchange systems

Acknowledgments:

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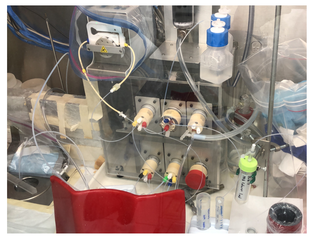
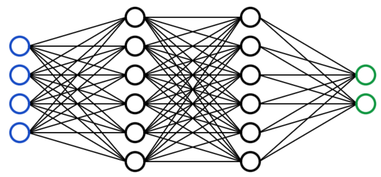
Michael's HIPPO Experiences:

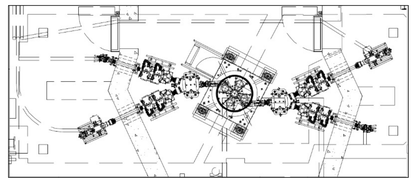
June 6–10: Involved in ^{211}At experiment at The Texas A&M University Cyclotron Institute



June 13–17: Attended TAMU HIPPO Campus



June 21–24 Attended UAB HIPPO Campus



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