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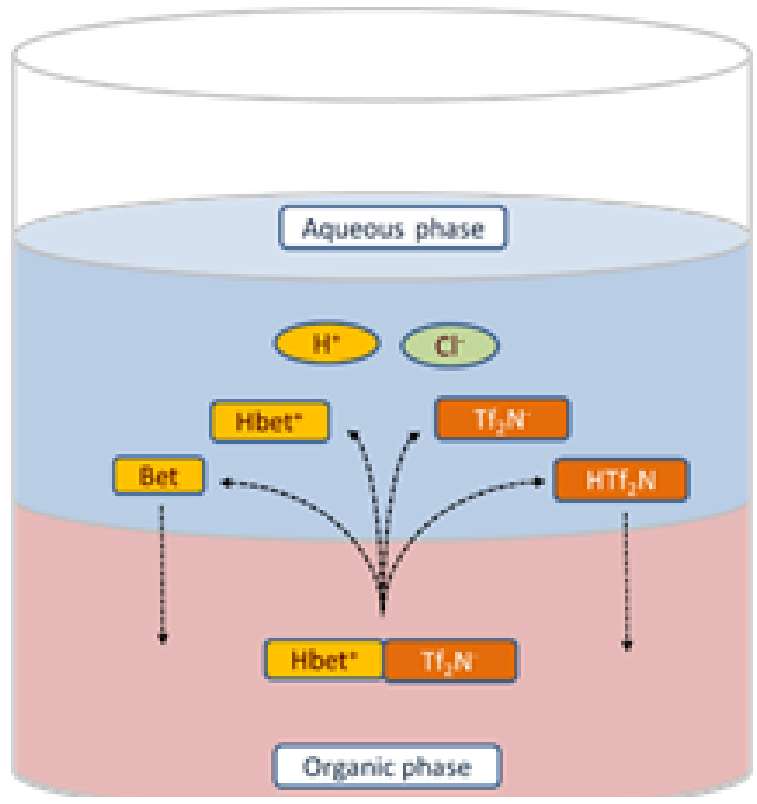
A Deeper Look Into Iconic Liquid and Water Interactions

One step closer to understanding a metal extraction mechanism into iconic liquid

THE SCIENCE
An ionic liquid is an organic solvent made entirely of ions. They have been used extensively for metal extraction, a process of transferring metallic species dissolved in an aqueous (water-based) media into an organic solvent. In principle, the aqueous and the organic phases are immiscible, meaning that they do not dissolve. However, it was found that an ionic liquid can partially dissolve into the aqueous phase and triggers some chemical interactions that lead to the distribution of ions between the two liquid phases. This process is affected by several factors. For instance, the presence and the concentration of other dissolved ions in the aqueous phase.

THE IMPACT
Understanding the chemical interactions between ionic liquids and water is paramount to explaining the mechanism of metal extraction in that chemical system. This knowledge can be used by scientists to explain the chemical form of the species being extracted and eventually to improve the extraction efficiency when necessary. Additionally, this work is the first stage in a study of the extraction of the metallic element indium, which is expected to have similar chemical properties to the superheavy element nihonium (element 113). This work contributes to developing new techniques for studying the chemistry of super-heavy elements.

SUMMARY
A betainium-based ionic liquid (commonly written as [Hbet][Tf2N]) has an interesting property because it has a functionalized carboxylic acid group that can form complex compounds with metal ions. This ionic liquid can be used to extract various metal ions, but to explain the metal extraction mechanism into this organic solvent, its interaction with water was first studied in the presence and absence of aqueous hydrochloric acid (HCl) and zwitterionic betaine (bet). Hydrochloric acid is commonly used as the aqueous media in the extraction system, while bet is the precursor of [Hbet][Tf_2N] whose presence in the aqueous phase was found to increase metal extraction efficiency. When [Hbet][Tf_2N] was mixed with water, a fraction of the [Hbet+] cations and [Tf_2N-] anions was transferred into the water phase. The presence of HCl increases the solubility of [Hbet+] but has the opposite effect on [Tf2N-]. The dissolution of [Hbet][Tf_2N] in the aqueous phase initiated other chemical reactions such as the formation and transfer of [HTf_2N] acid to the ionic liquid phase, changes in water equilibria, and partition of bet between the two phases (when it is present in excess).



Dissolution of [Hbet][Tf_2N] ionic liquid into the aqueous phase initiates chemical interactions and distribution of ions between the two liquid phases.

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PUBLICATIONS
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