Ion Hydration and Association of Aqueous Eu³⁺ Salt Solutions

[Collaborative project with the Institut für Nukleare Entsorgung (INE) at the Karlsruhe Institute of Technology (KIT)]

In aqueous electrolyte solutions increasing salt concentration generally leads to the formation of ion aggregates, especially ion pairs. The latter can be distinguished into contact ion pairs (inner-sphere complexes) and outer-sphere complexes where one or two hydration shells remain intact, so-called solvent-shared and solvent-separated ion pairs [1].

For the appropriate thermodynamic description of aqueous salt solutions and their interactions with surfaces it is adamant to take all relevant solution species into account. Inaccuracies in speciation severely hamper the development of chemical and thermodynamic models and deteriorate quantitative predictions. Thus, speciation models of relevant systems should be verified with various experimental techniques yielding complementary information on the nature and concentration of the various solution species present. Whereas most spectroscopic techniques (e.g. x-ray absorption or laser fluorescence [2]) primarily yield information on inner-sphere complexes, dielectric relaxation spectroscopy (DRS) is also sensitive to both outer-sphere complexes [3]. A combination of the above methods thus yields a better understanding of the chemical processes involved, helps in the development of accurate chemical speciation models and leads to an exact and comprehensive thermodynamic description of the studied system.

In the proposed project, a collaborative study between AK Buchner (Uni Regensburg) and INE (Karlsruhe), such a combination of experimental methods should be used to investigate aqueous Eu³⁺ solutions as a model for trivalent actinides. The anions used will be Cl⁻, ClO₄⁻, NO₃⁻ and SO₄²⁻. Centerpiece of the project will be DRS measurements performed in Regensburg. Supporting x-ray absorption (mainly EXAFS) and time-resolved fluorescence studies should be performed in the framework of a short-term research stay of the student at the INE of KIT in Karlsruhe. Adequate introduction to the different techniques and the associated data analysis will be given. Appropriate supervision will be provided during all stages of the project.

