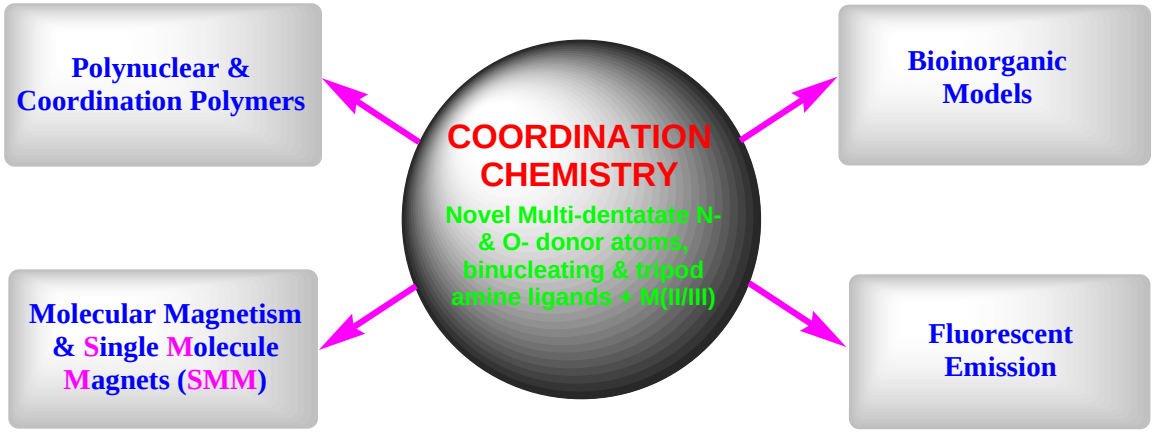
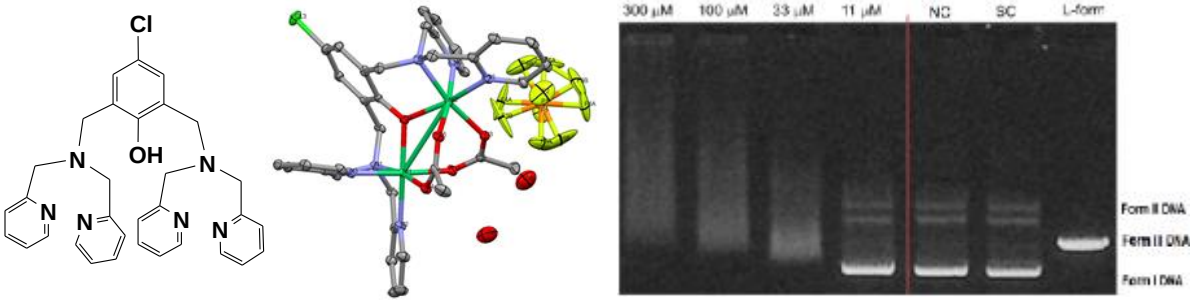
Coordination Chemistry/Bioinorganic Models/Material Sciences

Current Projects

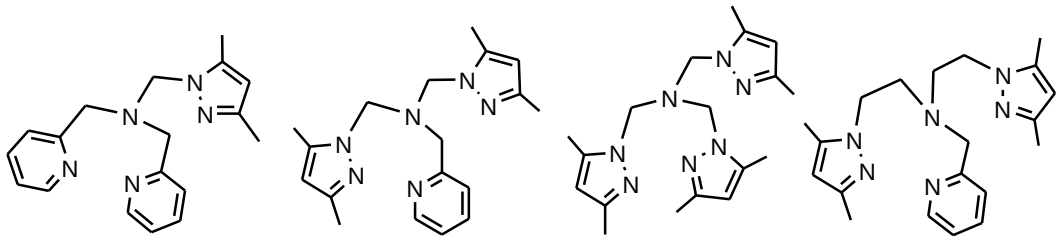
Dr. **Massoud's research** focuses on the synthesis of novel transition metal complexes relevant to biological systems and polynuclear and polymeric coordination compounds that may exhibit **S**ingle **M**olecule **M**agnetic (SMM) properties and slow magetic relaxation as well as compounds that may show fluorescene emission properties. Five research topics we are currently working on now:



1. **DNA Cleavage**. DNA has a remarkable stability towards P-O hydrolysis ($t_{1/2}$ for the hydrolysis of DNA was estimated to be ~ 130,000 years under physiological conditions) which is essentially required for the survival of life on Earth. Designing *efficient artificial nucleases*, capable of competing with natural enzymes, for DNA cleavage is a challenging topic. One of the main project we are working on now is synthesizing highly reactive artificial nucleases that can rapidly and effectively catalyze the cleavage of P-O bonds in DNA, under physiologicl conditions, and the hydrolysis of phosphodiester compounds. Novel mono-nuclear cobalt(II) and copper(II) based on tripod amine ligands and dinuclear metal(II) complexes derived from polyaromatic hydrocarbons, triazine and bicompartmental phenolate compounds are synthesized and their catalytic efficiencies in promoting DNA cleavage and phosphodiester hydrolysis are investigated. Correlating and understanding the structural parameters inhered in the complexes and other factors such as synergistic effect, cooperativity, steric effect imposed by the coordinated ligand and the electronic nature of metal, to the reactivity of the complexes is the main goal to achieve in this study.

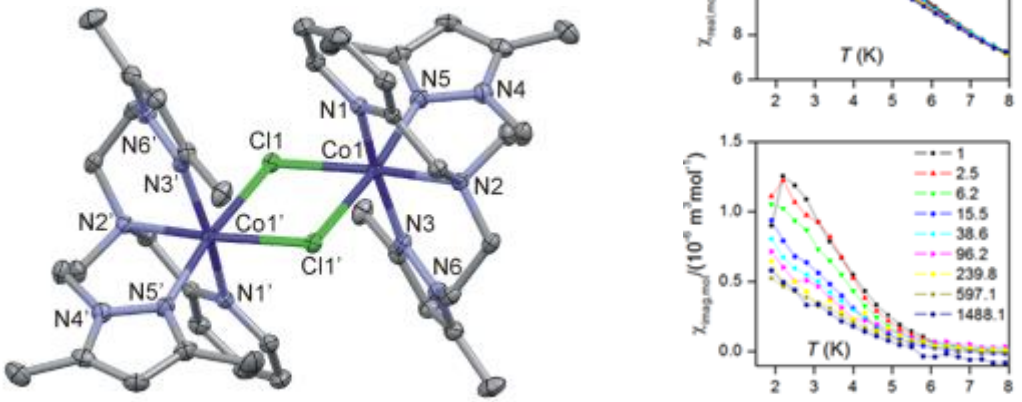


2. **Anticancer compounds**. The search for an effective therapeutic anti-tumor compounds requires lowering the therapeutical dosage of the drug and also reducing its toxicity. To achieve these targets, Cu(II) complexes based on different tripod amines that derived from heterocyclic bases such as pyrzolyl and pyridinyl groups as well other bi-compartmental phenolate tetrapyrazolate are synthesized and their anticancer activities are currently tested.



Tripodal heterocyclic amine ligands

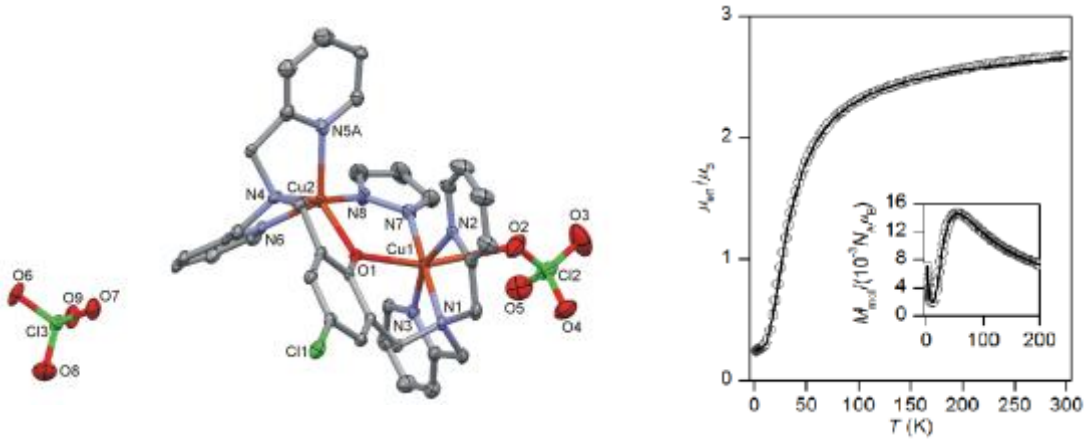
3. **Single Molecule Magnets (SMM).** Single Molecule Magnetic materials (**SMMs**) have attracted great attentions because of their potential applications in the construction of quantum computers. Information storage is certainly one of the most important uses of these materials as they increase the size of the memory elements in which information can be permanently stored. SMMs are polynuclear coordination compounds that exhibit magnetization hysteresis below certain temperatures and slow magnetic relaxation. Novel multi-dentate O- and N-donor atoms provided through a phenolate bearing alkxoy or carboxylate groups and pyrazolyl/flexible polyamines ligand are synthesized as well their corresponding hetero-polynuclear *3d-4f* or M(II)-Ln(III) (*3d-M* = Co, Ni, Cu and Zn; 4f-Ln = Pr, Nd, Gd, Tb, Dy). An example of the compounds which showed slow magnetic relaxation is the dinuclear complex $[Co_2(Bedmpzp)_2(\mu\text{-}Cl)_2]^{2+}$ (**I**)



The magnetic properties of **I**: in-phase χ_{real} and *Bottom*: out-of-phase χ_{imag} molar susceptibilities for **I** measured at the applied external field B_{dc} = 0.5 T and various frequencies showed in legend.

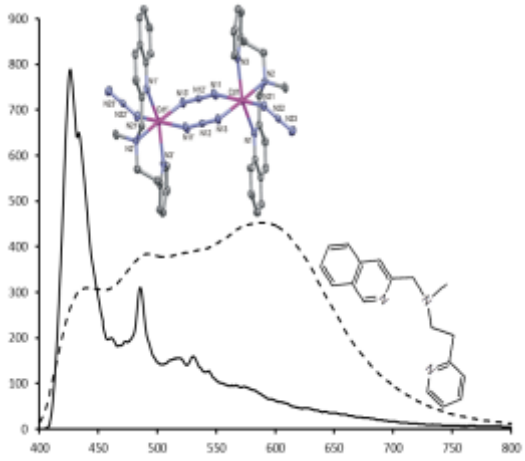
4. **Molecular Magnetism**. Magnetic coupling between 3d paramagnetic metal(II) ions in polynuclear and coordination polymers is another topic of interest in our research group. These molecules may utilize useful applications in material sciences and in the field of condensed matter physics. The strategy for synthesizing these compounds depends on assembling the paramagnetic centers (Cu^{2+}, Ni^{2+}, Co^{2+}) *via bridging ligands* such as pseudohalides (N_3^-, SCN^- and $NCNCN^-$), squarate dianion ($C_4O_4^{2-}$), croconate dianion ($C_5O_5^{2-}$) or polycarboxylic acids. The bridging ligands selected for this study allow a wide

separation range between metal ions (3-11Å) and hence the resulting complexes mediate different magnetic interactions. We are hopping to correlate the structural parameters in the bridging compounds (geometrical factor, the M^{2+}-X-M^{2+} torsion angle, the axial M-ligand bond lengths, the intradimer M···M distances) to their magnetic properties.



The temperature dependence of the effective magnetic moment of $[Cu_2(L^{Cl}O)(\mu\text{-pz})(ClO_4)]ClO_4$

5. Fluorescence Properties. Coordination polymers of Zn(II) and Cd(II) complexes are of special interest, especially those derived from heterocyclic coligands as they can enhance or quench the fluorescence emission of their parent organic ligands. The enhancement of fluorescence phenomenon through complexation is more interesting and attracts more attention as these compounds can be used as photochemical devices. Therefore, Zn(II) and Cd(II) coordination ploymers are synthesized using the coligands mentioned above and the metal ions are bridged via pseudo-halised, polycarboxylate compounds, squrate or croconates, and their fluorescence properties are investigated.



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