INTRODUCTION
Ligand bridged polynuclear complexes made up of metal containing subunits with long-lived excited states are suited for the study of intramolecular electronic energy transfer. The photochemistry and photophysics of simple coordination compounds has made substantial progress in the last two decades. By now, the fundamental factor governing the excited state behaviour of several classes of coordination compounds are relatively well understood. For many metal complexes synthetic control and tuning of important properties such as excited state redox energy and lifetime emission yields, photoactivity and excited potential is now feasible. Following this current supramolecular tendency of chemical research, inorganic photochemistry is evolving from the study of simple coordination compounds to that of more complex systems. Particularly interesting from this point of view are molecular systems that contain two or more metal centres connected by bridging ligands. These compounds are conveniently called polynuclear complexes.

The synthesis and reactivity of transition metal main group element multiple bonds have been subjects of numerous studies. Seriously underrepresented, however are studies of their photophysics and photochemistry. The importance of the photochemistry of metal-element multiple bonds can be found in their application to small molecule cleavage and reactivity as shown by Neyhart et. al.

Wen Mei Xue et. al. have studied photoluminescence, photoredox and crystal structure of rhenium (v) benzylidine complexes with phosphine ligands. The design of photoluminescent metal complexes with long-lived excited states for photoinduced electron-transfer reaction has been an area of considerable interest. Recent studies have revealed the intriguing photophysical and chemical properties of d metal complexes in which the metal atom is multiply bonded to a heteroatom, such as oxygen and nitrogen. In some of these complexes the $3[(\sigma^1)I(\pi^1)]$ excited states have been found to be long lived and emissive in solution at room temperature. It was anticipated that population of an electron in the $\pi$ orbital would weaken the metal-ligand multiple bond. Thus these complexes, if suitably designed, are potent reagent for the photoinduced atom transfers reaction.

Meyer et.al. reported earlier that d tungsten (IV) alkylidyne complexes are luminescent. However these tungsten complexes have emission lifetimes hardly greater than 1 μs in solution at room temperature, rendering difficult some of the Stern-Volmer kinetic
experiments. The rich photoluminescence and photochemical properties displayed by the trans-dioxo and nitrido-rhenium (V) complexes led Xue et al. to investigate the photophysical and chemical properties of the isoelectronic rhenium (V) benzylidene complexes with an objective to develop highly reactive metal-benzylidene complexes through light excitation. Simple strategies for the design of mononuclear sensitizer and of artificial supramolecular system, featuring function such as photoinduced charge separation and the antenna effect for their use in sensitization of semiconductors have also been discussed\textsuperscript{11}. These function depend on the chiche of the specific molecular components which may control the kinetics of the interfacial and intercomponent processes.

The study of photophysical and photochemical properties of coordinate compounds has received a great deal of attention since 1960\textsuperscript{12}. It can be truly asserted that over four decades, the most extensively investigated family of complexes is that of Ru(II)-polypyridine [Ru(PP)m]\textsuperscript{2+}, thanks to the work of numerous groups worldwide, such as those of T.J. Meyer and Balzani\textsuperscript{13}. The main reason for success is based on the fact that most of these complexes combine remarkable features like (I) ease of preparation (II) reversible electrochemical behaviour (III) light absorption in the visible region (IV) intense luminescence (V) long-lived electronically excited states. All these characteristics make them attractive for the study of the fundamental processes such as photoinduced energy and electron transfer under diffusional (bimolecular) conditions\textsuperscript{12,13} or with in multicomponent (supramolecular) arrays\textsuperscript{14}. Developments in these fields have been of great interest from the practical point of view since various applications can be envisaged, including solar energy conversion\textsuperscript{11}.

The use of metal atoms (or ions) as key elements in the assembly of supramolecular arrays has emerged as an area of great interest, and much effort has been devoted to the assemblage of molecules having a great variety of polygon and polyhedra\textsuperscript{15}. So for, practically all of the effort has been directed to the use of mononuclear coordination centres as the
geometry-setting elements in the arrays\textsuperscript{15,16} but a few isolated examples containing non and metal-metal bonded units exists\textsuperscript{16}. Recently Albert cotton et.al. have reported the singly bonded Rh\textsubscript{2}\textsuperscript{4+} compounds [\textbf{Rh}\textsubscript{2}(\textbf{cis-DAniF})\textsubscript{2}(\textbf{CH}\textsubscript{3}CN\textsubscript{eq})\textsubscript{4}((\textbf{CH}\textsubscript{3}CN\textsubscript{ax})\textsubscript{2})\textsubscript{2}][\textbf{BF}\textsubscript{4}]\textsubscript{2} because Rh\textsubscript{2}\textsuperscript{4+} units appropriately ligate to assure stability to form molecular squares.

Design of biological labels for various therapeutic, diagnostic and mechanistic applications is currently attracting much interest. Transition metal complexes, by virtue of their variable oxidation states, unique photophysical and photochemical properties and variable coordination geometries have been covalently linked to different biomolecules in electron transfer studies and other analytical application\textsuperscript{17}. In this context rhenium (I) polypyridine complexes show a great potential to be developed in bioanalytical application in view of their remarkable photophysical and photochemical properties\textsuperscript{18,19}. Recently studies on the utilization of luminescent rhenium(I) polypyridine complexes as a DNA probe using extensively planar diimine ligands\textsuperscript{20} as well as from a strategy based on intramolecular energy transfer quenching\textsuperscript{21} have been reported. These complexes have also been used as photooxidant in the studies of electron tunneling in proteins\textsuperscript{22} and as anisotropy probe for protein hydrodynamics\textsuperscript{23}. However, to date a systematic design of luminescent rhenium (I) polypyridine complex as a label for biological substrates, such as DNA and protein, has not been realized.

Kenneth Kam Wing Lo\textsuperscript{24} envisaged that the intense and long lived photoluminescence properties of rhenium (I) polypyridine complexes can be exploited in the development of luminescent labelling reagents for biomolecules because (I) the use of various diimine ligands for the rhenium (I) complex can alter the MLCT emission energy and give rise to the series of multicolor labelling reagents (II) the large Stoke's shifts could minimize selfquenching effects which are commonly observed in multiple labelling of biomolecules with fluorescent organic dyes such as fluorescein\textsuperscript{25} and the long emission life time of rhenium (I) polypyridine complexes could be applied in time resolved detection techniques that can offer higher sensitivity\textsuperscript{26}. 

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Recently Kenneth Kam Wing Lo et.al\textsuperscript{24} reported the synthesis, characterization and photophysical properties of a series of new rhenium(I) polypyridine complexes, [Re(N\textsubscript{3}N)(CO\textsubscript{3})(Py\textsubscript{3}NCS)]\textsuperscript{−}; The isothiocyanate moiety enables these complexes to react with primary amine groups of modified oligonucleotide and proteins.

Electron transfer is often the rate determining step in biological catalysis. The reaction of the cytochromes P450 are an excellent case in point\textsuperscript{27}. In the archetypal P450 from \textit{Psodomonas patida} the natural redox partner, putidaredoxin, reduces the enzyme far too slowly (K\textsubscript{red} = 50s\textsuperscript{−1}) to allow catalytic intermediates to accumulate under biological conditions\textsuperscript{28}.

Alexander R. Dunn et.al.\textsuperscript{29} have studied a variety of Ru diimine sensitizers designed to replace the slow biological reduction with a rapid optical redox trigger\textsuperscript{30,31}. Each of the most promising sensitizers employs a perfluorobiphenyl group that couples the Ru-diimine to a terminal functionality.

The recent developments in the design, synthesis and characterization of supramolecular architectures\textsuperscript{32-35} allowed the construction of fairly sophisticated systems capable of selectively reacting to a given external input and behaving as devices at the molecular level\textsuperscript{36}. In the case of photosensitized functional assemblies, so called photochemical molecular devices (PMDs)\textsuperscript{35}, the input is light and the response can be either a change in the structural features\textsuperscript{37} or a change in the photochemical properties\textsuperscript{38}.

Among the basic light triggerd processes, the most widely studied ones are, by far, photoinduced electron transfers due to the prominent part they take in biological systems\textsuperscript{39} as well as in the intermingled research fields of molecular electronics\textsuperscript{32-38,40,41}. And photochemical conversion (and storage) of solar energy\textsuperscript{32,34,35,41-43}, one of the major aims, when investigating functional model systems for artificial photosynthesis\textsuperscript{44} is to build molecular assemblies showing photoinduced long-lived charge separated states\textsuperscript{44}. Such excited states actually corresponds to the transient conversion of light into electrochemical potential, which can be used for energy storage\textsuperscript{41,42,44,45} or electricity production\textsuperscript{43,46}. Specific-
cally developed PMDs, generally referred to as polyad systems, are typically constituted by electron-donating (D) and/or accepting (A) components together with a photosensitizing unit (P). Such systems can be defined, with in the conceptual framework of supramolecular photochemistry as multicomponent systems, where the different units preserve their functional characteristics (namely their electronic properties) even when embedded in an assembly. The building blocks, preferably arranged in a linear fashion according to the D-P-A sequence, are usually held together by covalent (but saturated) links, hydrogen bonding, or even mechanical contacts. The overall working mechanism of a resulting prototypical triad, D-P-A, is also relatively well settled. After light excitation of the P unit (the primary donor), a cascade of intramolecular electron transfer takes place, leading to the lower-lying CS state \([D^+P-A^-]\). This state is then intended to be employed before charge recombination (CR) occurs. This state is then intended to be employed before charge recombination (C) occurs.

A great deal to synthetic works have been carried out by experimentalists in the past decades to identify and select the different P, A and D building blocks as well as to propose satisfactory intercomponent bridging units. Although the nature of the various functional components is not well established, still a vivid activity is going on to optimize them and to adjust their relative "electronic coupling".

Recently Ilaria.Ciofini et al. have proposed Ru(II) and Os(II) complexes of \([4^-,(p\text{-phenyl})][\text{terpyridyliigand}]\)(ptpy) derivatised within electron acceptor (A) of the triphenylpyridinium \((H_3TP^-)\) type as functional models for electron transfer (ET) processes in the context of artificial photosynthesis. These inorganic dyads, P-A-P are expected to undergo intramolecular photoinduced ET to form a charge separated (CS) state of pivotal interest. To draw a complete picture of possible ET processes, the ground and excited state properties of the complexes, both in their native and monoreduced forms have been studied by the means of density functional theory (D.F.T.).

Because of outstanding role in the fields connected too solar energy conversion and storage of light and/or electronic information at the molecular
level$^{56}$Ru(II) polypyridine complexes have become widely studied within the fields of inorganic chemistry$^1$. The prototype of this class of compounds, [Ru(bpy)$_3$]$^{2+}$ has been one of the most studied metal containing species$^{56a,57}$. However, compared with achiral Ru(tpy)$_3$$^{2+}$ complexes based on the tridentate polypyridyl ligand 2,2':6'2'-terpyridine (tpy) [Ru(bpy)$_3$]$^{2+}$ has two main structural disadvantages; the and enantiomers of [Ru(bpy)$_3$]$^{2+}$ give rise to many diastereomers in polynuclear complexes and Ru(II) complexes of mono-substituted bpy ligands are a mixture of fac and mer isomers. These problems, inherent to the [Ru(bpy)$_3$]$^{2+}$ structural motif, can be overcome by the use of tridentate tpy-type polypyridyl ligands. However [Ru(tpy)$_3$]$^{2+}$ and its derivatives have far less useful photophysical properties as compared to [Ru(bpy)$_3$]$^{2+}$. This is due to shorter excited-state lifetime (<250ps) at room temperature (rt) resulting from the population of a nonemissive metal-centred triplet[$^3$MC] state from the potentially emissive metal-to-ligand-charge transfer$^4$. Nevertheless, this shortcoming may be overcome if new ligands are designed which enhance the rt luminescence lifetimes of Ru(II) complexes of tridentate ligands$^{58}$.

Jianhua Wang et al.$^{59}$ have shown that the introduction of the strongly electron withdrawing cyano group into the Ru(tpy)$_3$$^{2+}$ moiety dramatically changes its photophysical and redox properties as well as prolongs its room temperature excited state lifetime.

During these last years, several mono-and polynuclear transition metal complexes (based on Ru(II), Os(II) or Ir(III) with different extended polyazaaromatic planar ligands have been prepared and studied$^{60-65}$. Upto now, only a few of the bridging ligands with an extended planar aromaticity are, to our knowledge, nonsymmetrical. This is actually the case of the 1,10-phenanthrolino [5,6-b]-1,4,5,8,9,12-hexaazatriphenylene ligand studied which consists of two units; a phenanthroline (phen) and a hexa aza triphenylene(HAT) motif. Such a nonsymmetrical ligand should allow the introduction of a new direction in the energy or electron transfer process inside the multinuclear complexes. Dinuclear and tetranuclear Ru(II) complexes based on the 1,10-phenanthrolino[5,6b]-1,4,5,8,9,12-hexa azatriphenylene are prepared and characterized on the basis of the data for other related mononuclear species by
Julian Leveque et al\textsuperscript{46}, from their electrochemical and spectroscopic behavior. They also concluded that the internal energy transfer takes place from the core to the peripheral metallic unit. Multinuclear metal complexes play a central role in the study of supramolecular structure as possible building blocks for photochemical and electrochemical molecular assemblies. Many multinuclear compounds containing two are more metallic sites have been synthesized and their optical electronic and photophysical properties have been studied. In particular ruthenium and rhenium polypyridine complexes are popular in both fundamental studies and applications. These complexes form appealing subunits for nanoscaled devices because of their strong visible absorption, their advanced photochemical and redox properties and their stability against photodecomposition. There exists a number of means to fine-tune these features via made to order modifications on peripheral ligands. Rhenium polypyridine complexes are known to act as photocatalyst and electrocatalyst for reducing CO\textsubscript{2} to CO\textsuperscript{3}. A major problem with these photocatalysts is the lack of an extended absorption into the visible region. The present approach is to fabricate supramolecules of the rhenium complex as a visible-light absorption. Boback et al.\textsuperscript{74} have described the electrochemical, spectroscopic and photocatalytic properties of a series of Ru(II)-Re(I) binuclear complexes linked by the bridging ligands bis(4'-methyl-[2,2' bipyridinyl-4-yl] propane-2-ol and 4-methyl-4'-[1,10] phenanthroline-[5,6-d]imidazol-2-yl] bipyridine and a tetranuclearcomplex on which three [Re(CO\textsubscript{3}Cl) moieties are coordinated to the central Ru using the bpyc bpy ligands.

Polynuclear metal complexes based on ruthenium (II) and /or Osmium (II) polypyridine building blocks constitute a class of compounds which has attracted the attention of many researchers in the last decade and continue to be subject to an ever increasing research effort. This is due to the fact that these species play a central role in many fields of both fundamental and applied research. Primarily this is because the building blocks exhibits an unusual combination of properties rarely found simultaneously in other compounds. The relevant properties of Ru(II) and Os(II) polypyridine complexes are (I) good stability of the ground as well as the excited and redox state; (II) absorption in the visible
region due to spin allowed (and in case of osmium compounds, also spin forbidden) metal to 
ligand charge transfer(MLCT) bands; (III) relatively long-lived (typically in the microsecond 
time range) and luminescent excited states; Emission is usually due to radiative deactivation of 
the lowest-lying 3MLCT level(s) (IV) reversible metal centred oxidation and ligand-centred 
reduction process at assessable potentials (V) tunability of all the properties by the judicious 
choice and combination of the ligands45. This unique combination of the properties has indeed 
allowed Ru(II) and Os(II) polypyridine complexes to be perfect candidates for many types of 
investigation, mostly based on their photophysical and redox properties75,45.

The contemporary presence of several Ru(II) and/or Os(II) polypyridine complexes 
with in the same polynuclear structure adds new properties to the multimetal arrays, due to 
the supramolecular nature of these systems1,3,5 besides the basic properties of the building 
blocks cited above. The new properties depend on the electronic interaction between the 
various subunits, which is in turn due to connection used and the topography of the systems. 
Among the various (Supramolecular) properties that Ru(II) and Os(II) based polynuclear 
complexes can exhibit, photoinduced energy transfer processes with in the arrays and simulta-
taneous multielectron redox processes are particularly intriguing since they can lead to useful 
functions such as light harvesting antenna affect for solar energy conversion purposes and 
multielectron/ hole storage75.

The most noticeable trend in current years is a progressive displacement of interest 
from intra- and intermolecular photochemical processes towards processes occurring in su-
pramolecular systems (i.e. assemblies of two or more molecular components)76,77. This has 
made possible by the extraordinary progress of chemical synthesis and the extensive knowl-
dge reached in the fields of molecular photochemistry. A prominent research line in the field of 
supramolecular photochemistry is that concerning luminescent and/or redox activ polymetallic 
complexes, where the various molecular components are assembled to obtain vectorial 
electron or energy migration. The most common building block to design such polynuclear 
systems are polypyridine complexes or Ru12, Os12 and Cr13 while the bridging ligands may range
from simple anion like CN- to multichelating aromatic type molecules\textsuperscript{77,78}.

The field of supramolecular photochemistry includes another important research line. In several problems of practical interest, there is a need to modify the excited state behaviour of a molecule. this can be done by perturbing the molecule via appropriate nuclear and / or electronic mechanism\textsuperscript{79}. In most of the cases, such a perturbation can be performed by assembling the molecule with a perturbation appropriate supramolecular structure via ion pairing\textsuperscript{79-81}, second sphere coordination\textsuperscript{79,82} and host guest interaction\textsuperscript{83,84}.

Polynuclear complexes featuring efficient antenna effects could serve as energy conversions like - NC-Ru(bpy)\textsubscript{2}-CN-Ru[bpy(COO)\textsubscript{2}]-NC-Ru(bpy)\textsubscript{2}-CN\textsuperscript{-2} are more extended versions of it could be used to overcome the problem of insufficient light absorption in the sensitization of semiconductor electrode for wet voltaic cell. In perspective view supramolecular complexes featuring chemiluminescent charge recombination also look as interesting building blocks for PMDs. PMDs are present of course in nature where they perform functions essential to life as photosynthesis and vision. Examination of natural PMDs shows that they are extensively complex systems where the various molecular components are suitably organise the dimension of space energy and time. Their molecular components however must be suitably chosen and connected so as to yield the space-energy time organisation which allows a correct elaborations of photon input\textsuperscript{86,87}.

Substantial efforts are directed towards mimicking the organisation of polysynthetic reaction centre\textsuperscript{88,89} and triads\textsuperscript{90} has been extensively studied and was acheived. The use of photosensitizers Ru(II) tris \{4,4'-bis[(methylenedioxy) tris(ethyleneoxy)(4-methoxybenzene)]-2,2'-bipyridine\}(1) exhibits the common photophysical properties Ru(II) tris pyridine compounds, but includes in addition covalently tethered p-dialkoxybenzene units. Recent studies\textsuperscript{91-93} reveal that dialkoxy benzene components form intermolecular complexes with bipyridinium salts such as N,N'-bi pyridinium, (2) and cyclo [bisN,N'-p-xylene-4,4'-bipyridinium)]. The formation of these supramolecular assemblies and characterization on the electron transfer properties of the photosensitizer with in the
complexes as well as by diffusional path way was also investigated.

In an attempt to explore some synthetic rooots along the new direction the bimetallic catenates RuCu, RuAg and RuZn which are examples of [2]-catenane structure were synthesized. One of the most important properties of these compounds is their ability to undergo mechanical motions under the action of chemical\textsuperscript{94}, electrochemical\textsuperscript{95} or photochemical\textsuperscript{96}, stimulation (molecular level mechanical machine\textsuperscript{97}). Incorporation in such supramolecular species of Ru(II)- polypyridine units, which exhibits outstanding electrochemical and excited states- properties \textsuperscript{98,99} open the way to new kind of electrochemically and light driven molecular machines as well as the supramolecular species capable of conducting electrons or electronic energy long distances\textsuperscript{100}. The work to take advantage of the tunability of the energy level of the cat-M moiety on changing the nature of the metal ion, to switch the direction of the energy transfer between the two components of the supramolecular structure is one of the prime aims.

In these supramolecular assemblies an alternative approach has been reported to tailor donor acceptor complexes based on guest host interaction. Magnetic field dependent investigation for complexe kinetics in supramolecular system with sequential cyclic electron transfer shows spin chemical studies on a series of donor-chromophore acceptor (D-C-A) triad\textsuperscript{102-110}. Investigation of (C\textsuperscript{2+}-D)\textsuperscript{26} and (C\textsuperscript{2+}-A\textsuperscript{2-})\textsuperscript{102-107,109,110} diads and triads with picosecondtime resolved optical spectroscopy shows that quenching of the metal to ligand charge transferer (MLCT) state of Ru(II) complex by electron transfer to DQ\textsuperscript{2} generates the charge transfer (CT) state Ru\textsuperscript{3+}-DQ\textsuperscript{1-} and the time constant of this process ranging between 250 to 3000 ps, decreases with increasing methylene units (p) which is constants with the process being in the normal Marcus region \textsuperscript{104,107} 1'. Reverse electron transfer regenerates the Ru(II) complex in its ground state which is always faster than process 1 so that only lower limit of ca(*0 ps) could be estimated for its rate constants. It is important to note that direct dection of the CT state was not possible for either C-A- diads of D--C\textsuperscript{2+}--A\textsuperscript{2-} triads. The reason being that process 2 and the
competing process I' are both much faster than process I consequently, the CS state (D'-C\textsuperscript{2}-A\textsuperscript{2}) of the triad appear at the same effect rate as the MLCT state emission disappears\textsuperscript{104,107}. Further more the rate of emission decays are the same between analogous C\textsuperscript{2}-A\textsuperscript{2} and D-C\textsuperscript{2}-A\textsuperscript{2} and D-C\textsuperscript{2}-A\textsuperscript{2} complexes indicating that the initial C- state is D-C\textsuperscript{3}-A- irrespective of the presence or absence of the donor in the complexes\textsuperscript{102,112,107}. The investigation of kinetic rule of electron spin processes and the possibility of their modulation by an external magnetic field\textsuperscript{111} requires explicit consideration of the spin multiplicity of the states involved and application of the spin conservation rules in all electron transfer process. The triplet nature of photoreactive MLCT states of Ru complexes is well established\textsuperscript{106} with such a precursor that CT state must be created with initial triplet spin, therefore, reverse electron transfer I' cannot follow immediately but only, after spin conversion to single indication process I' not as elementary process but showing its dependence on the spin equilibration time $\tau_{sd}$ and the rate constant of spin allowed backward transfer I'. The spin chemical situation corresponding to process I and I' is very similar to that encountered in the quenching of MLCT excited Ru(bpy) by methyl viologen., the spin chemistry of which is well characterized both experimentally and thoratically\textsuperscript{112,117}.

The two main features specific to this type of spin chemistry: a very fast magnetic field independent spin relaxation and characteristic time $\tau_{sd}$ of T-----S spin equilibration of 20-30 ps\textsuperscript{115} and a magnetic field driven T-----S process, caused by the large differences of g factors of the two radicals (Ru\textsuperscript{3},DQ\textsuperscript{+}) involved and the strong anisotropy of the g tensor of the Ru\textsuperscript{3} complex. The final recombination process regenerating the D-C\textsuperscript{2}-A\textsuperscript{2} ground state is spin forbidden from the 3CS state. Therefore, spin conversion to CS is necessary and the process 3, like process I' is a compound process, the overall rate of which is determined by the kinetics of spin equilibration mainly through the Zeeman effect. In general T-----S process are retarded with inceasing Zeeman level splitting with generally leads to slowing down of the rate T-----S equilibration with increasing magnetic field. With in the field of polypyridine transition metal complexes, investigation of photoinduced energy transfer
Scheme 1  \((D\rightarrow C^{12} \rightarrow A^{2})\) singlet ground state
Fig. Structural formulas of the investigated catenane-type moieties
in diad based on \([\text{Ru(bpy)}_3]^{1+2}\) and \([\text{Os(bpy)}_3]^{2+}\) units in which the energy transfer process is switchable. It is achieved either due to conformational changes in a flexible linker\(^{118,119}\) or due to two main components associated by a non-covalent hydrogen bonding interaction whose formation relies on the solvent properties\(^{120,121}\).

The photophysical properties diad containing \([\text{Ru(bpy)}_3]^{1+2}\) and \([\text{Re(bpy)}(\text{CO})_3\text{H}_2\text{O}]\) chromophore are affected by the binding of an additional metal ion \(\text{Ba}^{2+}\) to an aza crown macrocyclic unit which separates the metal fragment\(^{122}\). The molecule \({\{\text{Ru(bpy)}_3\} (\mu-L)\{\text{Re(CO)}_3\text{H}_2\text{O}}\}}\)[PF\(_6\)](Ru-crw-Re) allows control over intercomponent photoinduced electron and energy transfer processes on the binding with \(\text{Ba}^{2+}\).

**Scope Of Work**

1. Synthesis of supramolecular assemblies of mononuclear & heteronuclear complexes of Ru (II), Os(II), Re (I) & Cr (III) of polypyridine and cyanide complexes.
2. Study of photoelectron-transfer properties of the photosensitizer within complexes as well as diffusional path.
3. Spin chemical studies on series triad complexes to see their kinetic role on electron spin process and the possibility on their modulation by an external magnetic field.
4. Study of intercomponent photoinduced electron energy transfer processes by an additional metal \(\text{Ba}^{2+}\) macrocyclic site of M-Crw-M.

**Experimental Section :-**

(A) Synthesis:-

**Mononuclear complexes :-** Reaction\(^{123}\) of 1,10-diaza-18-crown-6 with only one equivalent of 5-bromomethyl-2,2'-bipyridine in basic solution will afford a good yield of the intermediate ligand \(L_2\) which will readily afford the desired mononuclear complex \([\text{M(bpy)}_2(L_2)][\text{PF}_6]_2\).

**Heterodinuclear Complex :-** Reaction of the mononuclear complex \([\text{M(bpy)}_2(L_1)][\text{PF}_6]_2\) with \([\text{Re(CO)}_3\text{Cl}]\) in toluene:MeCN under \(N_2\) followed by removal of solvents will afford a compound \({\{\text{M(bpy)}_2(L_1)\{\text{Re(CO)}_3\text{Cl}}\}}[\text{PF}_6]_2\) followed the well known preparation\(^{124}\).
(B) Instrumentation :-

(I) All Photochemical measurements will be performed in triply distilled water. Time-resolved fluorescence decays and steady-state emission of compound Z will be recorded in a 0.11 cm cuvette equipped with a stopper.

(II) The changes in emission spectra for M-crw-M will be observed after titration with Ba(ClO$_4$)$_2$ using an excitation wavelength of 323 nm.

(III) The preparation, purification and solution of all the complexes$^{125, 126}$ as well as the preparation of the individual ligands will be carried out by literature method$^{127, 128}$ for the study of kinetic & magnetic field effect.