EDSC
École Doctorale des Sciences Chimiques

Université de Strasbourg

JOURNEE DES DOCTORANTS EN CHIMIE 2025

Mardi, 24 mars 2026

Programme et Résumés

Collège Doctoral Européen
Campus de l'Esplanade

http://ed.chimie.unistra.fr/

AVANT-PROPOS

La Journée des doctorants en chimie en est à sa **19ème édition**.

Pour les doctorants déjà engagés dans le cursus doctoral, cette journée leur permet d'exposer leurs travaux de recherche.

Pour les doctorants de 1ère année, elle fait office de journée de rentrée et leur donne l'occasion :

- D'avoir un aperçu des recherches menées dans les laboratoires de chimie de l'Université de Strasbourg et du CNRS,
- De nouer des contacts avec les doctorants plus anciens, notamment ceux d'autres équipes et d'autres campus,
- De poser toutes les questions concernant le déroulement de la formation doctorale en chimie ainsi que l'après-thèse.

Je tiens à remercier toutes les personnes qui ont accepté de présenter leurs travaux de recherche lors de cette journée ainsi que celles qui ont fait des Journées précédentes un succès.

Mes remerciements vont tout particulièrement à Nafissa Haddab pour sa contribution centrale dans l'organisation de la JDC 2025.

Gilles ULRICH

Directeur de l'EDSC

Journée des Doctorants en Chimie 2025

24 mars 2026 - Amphithéâtre du CDE

PROGRAMME

	Programme de la matinée
8h - 8h30	Emargement
8h30 - 8h45	**Présentation du Collège doctoral et formations** Exposé de Joëlle Hubé, responsable du collège doctoral
8h45 - 8h55	**Présentation du cursus/ école doctorale** Exposé de rentrée de Gilles ULRICH, directeur de l'EDSC / Discussion avec les doctorants
8h55 - 9h05	**Présentation "programme de mentorat aux doctorant.es"** Exposé de Cécilia MENARD-MOYON ou Valérie CAPS
9h05 - 9h20	**Présentation "SCF-ALSACE"** Exposé de Stefan CHASSAING
9h20 - 10h10	**Conférence** *"Advances in the chemo- and regio-selective conjugation of proteins"* **Pr. Guilhem CHAUBET** **Chémo-biologie synthétique et thérapeutique (UMR 7199)**
10h10 - 10h25	**Pause Café**
	Communications orales
10h25 - 10h40	**MIESCH Claire**
10h40- 10h55	**ANDRIS Theo**
10h55- 11h10	**FROSTEGARD Erica**
11h10- 11h25	**KHANTHONG Adisorn**
11h25- 11h40	**MADOULET Romane**
11h40 - 11h55	**MEHY-DINE Khaled**
11h55 - 13h05	**Pause Repas**
13h05 - 13h20	**Présentation PUI-A** Exposé de Felipe WASEM KLEIN et Christophe KAHLFUSS
13h20 - 13h35	**MITROVIC Stefan**
13 h 35 - 13 h 50	**NIKILOPOULOS Eleanna**
13 h 50 - 14 h 05	**OFFOR Onyeka**
14 h 05 - 14 h 20	**Pause Café**
14 h 20 - 14 h 35	**OTT Valentin**
14 h 35 - 14 h 50	**SANCHEZ Samuel**
14 h 50 - 15 h 05	**SEIVERT Océane**
15 h 05 - 15 h 20	**SIEGEL Guillaume**
15 h 20 - 15 h 35	**SIMON Titien**
15 h 35 - 15 h 50	**Pause Café**
15 h 50 - 16 h 05	**VILLOTET Augustin**
16 h 05 - 16 h 20	**ZARATE Yohan**
16h20 - 16h35	**GERVAIS Mathieu**

TITRES DES

COMMUNICATIONS ORALES

LISTE DES COMMUNICATIONS ORALES

(1) Switchable Reactivity of Homopropargylic Alcohols Towards γ-Arylated Ketones and α-Arylated Tetrahydrofurans in HFIP

Claire Miesch[1], Ewelina Krolicka[1], Robert J. Mayer[2], David Leboeuf[1]

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[2] Université de Haute-Alsace, 25 rue Becquerel, 67000 Strasbourg, France

(2) Resonance-Enhanced Excited-State Intramolecular Proton Transfer Emission by Base-Mediated Formation of α-Cyano-γ-lactone

Théo Andris[1]

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(3) Multifunctionalization of Iron Oxide Nanocubes for the Treatment of Metastatic Melanoma

Erica Frostegard[1]

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(4) Atropisomeric Viologen: A Study on the Photophysical and Redox Behavior of Biquinolinium Compounds

Adisorn Khantong[a], Anton Barbuta[a], Christophe Gourlaouen[b], Ryan Michael Young[c], Alberto Privitera[c], Giulio Ragazzon[*a]

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[c] Center for Molecular Quantum Transduction (CMQT), Northwestern University, Illinois, United States

(5) Assessment of environmental PFAS contamination using birds as biomonitors: An analytical approach based on LC- and GC-MS/MS

Romane Madoulet

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(6) Predicting affinities with coarse-grained simulations

K. MehyDine[*a], P. Souza[b], M. Cecchini[a]
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(7) Expanding the Cyclotribenzylene Toolkit: From Synthetic Advances to an Air-stable Copper(I) Metallocryptophane

S. Mitrovic[*], J. Weiss[a], J. A. Wytko[a]

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(8) Engineering Assemblies of Viologens

Eléanna Nikolopoulos[1], Elise Kolb[1], Cléa Pierron[1], Bruno Duez[1], Frédéric Cherioux[2], Frank Palmino[2], Corrine Boudon[1], Laurent Ruhlmann[1], Jean Weiss[1], Jennifer A. Wytko[1]

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(9) Thermophilic prokaryotic single cell separation and mass spectrometry integration

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(10) Ultrafused Dipyrromethene Borate complexes for deep NIR applications

Valentin Ott[1], Gilles Ulrich[1], Antoinette De Nicola[1], Lucie Sancey[2], Yann Bretonnière[3], Olivier Maury[3]

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(11) Driving molecular Upconversion with molecular wheels

Samuel Sanchez[1], Loïc Charbonnière[*1]

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(12) Exploring the Mechanism of Antibacterial Action of Minocycline-Loaded Carbon Nanodots

Océane Seivert[1], Yuta Takano[2,3], Junyue Qu[4], Kiwamu Sakaguchi[4], Atsuro Yokoyama[4], Eri Hirata[4], Alberto Bianco[1]

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(13) Towards a new direct method for the synthesis of aryl difluoroalkyl ethers from the difluoromethoxy (-OCHF2) moiety

Guillaume Siegel[1], A. Loison[1], G. Hanquet[1], F. R. Leroux[*1], and A. Panossian[*1]

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(14) Gold (I)-Catalyzed Synthesis of Infolizidiniums

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(15) Phosphonium ylides as strong Brønsted base catalysts

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(16) Integration of Light-Driven Molecular Motors in Soft Self-assemblies

Yohan Zarate, Dania Daou, Wenzhi Wang, Emilie Moulin, and Nicolas Giuseppone

SAMS Research Group, CNRS, Université de Strasbourg, Institut Charles Sadron UPR 22, Strasbourg 67000, France

(17) Development of organic ratiometric probe for operando confocal fluorescence microscopy

Mathieu Gervais[1], Paul Chassagne[1], Amandine Brige[1], Pascal Didier[2], Tristan Asset[1], Julien Massue[1]

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CONFERENCE

"Advances in the chemo- and regio-selective conjugation of proteins"

Pr. Guilhem CHAUBET,
Chémo-biologie synthétique et thérapeutique (UMR 7199)

"Advances in the chemo- and regio-selective conjugation of proteins".

Pr. Guilhem CHAUBET

Chémo-biologie synthétique et thérapeutique (UMR 7199)

"The chemical conjugation of proteins has seen considerable applications in recent decades, with the rise of antibody-drug conjugates and their use in oncology. This has required considerable effort, given that the conjugation of native proteins necessarily involves selectivity issues. Chemoselective conjugation strategies were therefore developed first, allowing the modification of virtually any amino acid residue carrying a reactive side chain. However, site-selective (or regioselective) methods are less common and more difficult to develop. In this context, we studied the application of the multicomponent Ugi reaction for the selective conjugation of neighbouring amine and carboxylate groups on the surface of proteins. Through in-depth methodological work, we succeeded in developing a set of conditions enabling the highly selective modification of antibodies carrying N-terminal glutamate and aspartate residues. We also showed that the selectivity of our strategy could be applied to other protein formats, in particular anticalins, for which site-directed mutagenesis revealed the key importance of a single lysine residue.

RESUMES DES

COMMUNICATIONS ORALES

Switchable Reactivity of Homopropargylic Alcohols Towards γ-Arylated Ketones and α-Arylated Tetrahydrofurans in HFIP

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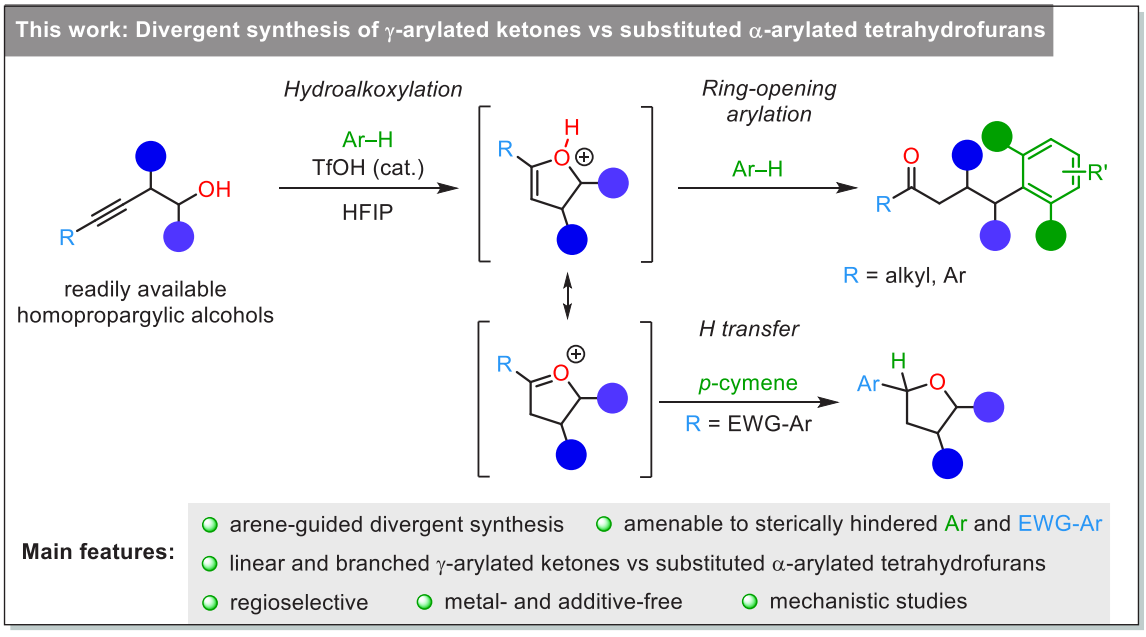
Despite their utility for constructing functional molecules such as pharmaceuticals and agrochemicals, assembling γ-arylated ketones in a straightforward fashion remains a major synthetic challenge. While several transition metal-based approaches have been developed over the past years,[1] ketone and arene substitution patterns remain underrepresented. We, herein, report a radically different strategy to expand the range of synthetically attainable γ-arylated ketones through the intermediacy of a 2,3-dihydrofuran. This method relies on a unique Brønsted acid-catalyzed formal 1,4-oxyarylation of widespread homopropargylic alcohols, whose key to its efficacy is the use of 1,1,1,3,3,3-hexafluoroisopropan-2-ol (HFIP) as a solvent.[2] This protocol offers a solution for preparing γ-arylated ketones incorporating sterically hindered arenes, while displaying a broad compatibility with synthetically relevant functionalities to deliver linear and branched γ-arylated ketones, including both aliphatic and aromatic ones. Importantly, using *p*-cymene as a hydride donor results in the formation of α-arylated tetrahydrofurans through reductive hydroalkoxylation, thereby providing a switchable reactivity starting from homopropargylic alcohols. Mechanistic studies supported by DFT computations suggest that a complex catalytic reaction network is at work to converge towards the target products.



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Resonance-Enhanced Excited-State Intramolecular Proton Transfer Emission by Base-Mediated Formation of *α*-Cyano-*γ*-lactone

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Abstract

Excited State Intramolecular Proton Transfer (ESIPT) corresponds to a photoinduced tautomerization between an excited normal (N*) and tautomeric (T*) species, within aromatic core presenting a 5- or 6-membered H-bonded ring in the ground state. Among reported ESIPT cores, 2-(2'-hydroxyphenyl)benzoxazoles (HBO) stand out for several beneficial characteristics: (1) synthetically accessible and stable, (2) large Stokes Shift, (3) environment-sensitive optical properties and (4) strong solid-state emission.[1] In addition, rational molecular design can lead to a partial modulation or total frustration of this specific excited-state dynamic.[2]

Dual-State Emitters (DSE) are dyes displaying fluorescence emission in the solution state as well as in the solid state. The tunable optical properties of ESIPT fluorophores make them promising candidates for developing Dual Solution-/Solid-state Emission (DSSE) emitters. However, strategies must be employed to increase the solution-state photoluminescent quantum yield while keeping strong emission in the solid state. On our part, we recently reported several strategies either based on the rigidification induced by ethynyl-extended functionalization of the HBX core[3] or on the protonation-mediated formation of a highly emissive merocyanine species induced by introducing proton-sensitive groups such as aza-heterocycles.[4]

To further explore the stabilization of the excited-state through resonance in the absence of external stimuli, we recently reported the introduction of an aryl-TCF (tricyanofuran) substituent on a HBO scaffold. During the course of our studies, we unexpectedly found the TCF group to be unstable under basic conditions and yield the corresponding *α*-cyano-*γ*-lactone through a nucleophilic attack of hydroxide ions, leading to a highly fluorescent derivative.[5]

Potential applications of the resulting *α*-cyano-*γ*-lactone are currently under investigation and will be discussed during this oral presentation.

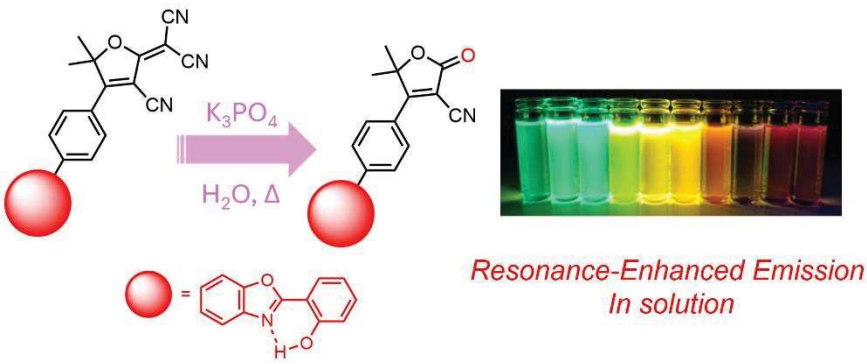

Figure 1. *Hydrolysis of HBO-TCF to highly fluorescent HBO-lactone*

Keywords : ESIPT, Dual-State Emitters, Tricyanofuran, Lactone

References

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Multifunctionalization of Iron Oxide Nanocubes for the Treatment of Metastatic Melanoma

Chimeric antigen receptor (CAR)-T cell therapy has revolutionized the treatment of several hematological malignancies. However, their application in solid tumors is limited by 1) poor infiltration due to the physical structure of solid tumors, and 2) low activity and proliferation caused by the immunosuppressive tumor microenvironment.[1] We aim to overcome these barriers by developing nanoparticles that can generate heat under both alternating magnetic field and laser irradiation, generate reactive oxygen species (ROS), and deliver therapeutic molecules to remodel the tumor microenvironment and favor the infiltration and proliferation of CAR-T cells. In this regard, we synthesized iron oxide nanocubes with an average size of 23 nm using a solvothermal method previously reported (Figure 1a).[2] They were first transferred to water via a ligand exchange with citric acid (CA). To enhance their photothermal properties and facilitate the conjugation of therapeutic molecules, they were coated with a polydopamine (PDA) layer (Figure 1b). The NPs exhibited heating both under laser irradiation and alternating magnetic field (Figure 1c, d). The PDA was doped with copper ions for the generation of ROS and potentially inducing cuproptosis.[3] To track the NPs in vivo, a NIR-emitting fluorophore was conjugated to the PDA by amidation. A peptide that binds to the vascular endothelial growth factor (VEGF) receptor was conjugated by Michael addition with the aim to target the tumor and hinder metastasis due to the antiangiogenic effect of the VEGF receptor blocking.[4] Doping the PDA with copper ions allowed for temperature-dependent ROS generation in the presence of H_2O_2. The copper ions could also oxidize glutathione, which further enhances the ROS generation in cells. Biological experiments will be performed soon to assess the NP targeting capability and their therapeutic efficiency.

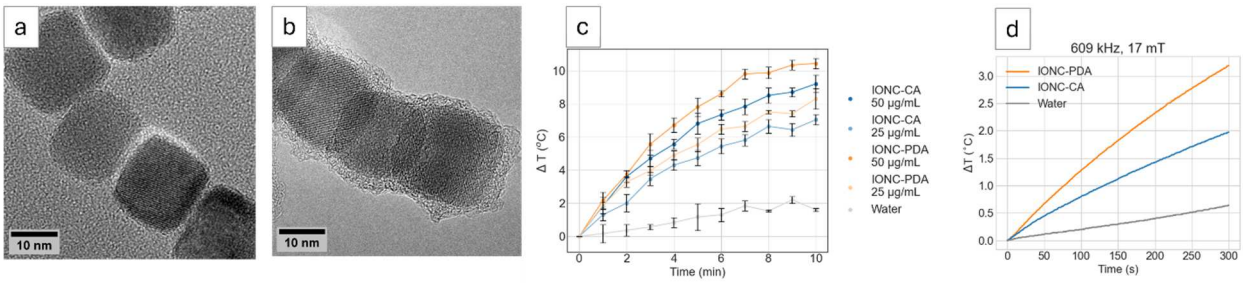

Figure 1 a) High-resolution transmission electron microscopy (HRTEM) image of IONCs. b) HRTEM image of IONC-PDA. c) Temperature increase of IONC-CA and IONC-PDA under laser irradiation (808 nm, 0.5 W/cm2). c) Temperature increase under an alternating magnetic field (609 kHz, 17 mT, 0.4 mg Fe/mL).

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Atropisomeric Viologen: A Study on the Photophysical and Redox Behavior of Biquinolinium Compounds

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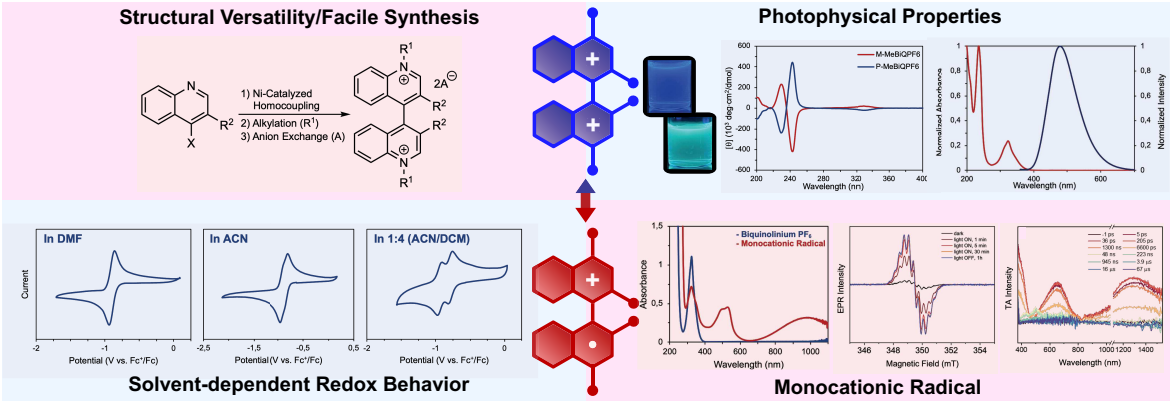
N,*N*′-Disubstituted 4,4′-bipyridinium derivatives, commonly known as viologens, represent a well-established family of reversible redox systems with broad applications in electrochromic displays, energy storage, and supramolecular chemistry.[1,2] In contrast, their structural analogues, *N*,*N*′-disubstituted biquinolinium derivatives remain largely unexplored, despite their potential to yield atropisomeric system with tunable photophysical and redox properties.[3] In particular, *N*,*N*′,3,3′-tetrasubstituted 4,4′-biquinoliniums offer axially chiral scaffolds of interest for chiral optoelectronic, spintronic applications, and supramolecular chemistry.[4] Herein, we report the synthesis of *N*,*N*′-disubstituted biquinolinium derivatives via a Ni-catalyzed homocoupling, followed by alkylation and anion exchange. The resulting optically stable enantiomers were separated by chiral chromatography. Their photophysical and electrochemical properties were investigated across various solvents, revealing solvent-dependent redox behavior which was interpreted using Catalán's solvatochromic parameters. This investigation identified conditions to observe the so-far elusive monocationic radical. Complementary spectroelectrochemistry, electron paramagnetic resonance, and transient absorption spectroscopy confirmed the formation of monocationic radicals. These findings highlight the versatility of *N*,*N*'-disubstituted 4,4′-biquinolinium derivatives, providing a new platform for the exploration of redox-active atropoisomeric systems.



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PREDICTING AFFINITIES WITH COARSE-GRAINED SIMULATIONS

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The Martini force field, originally conceived for simulating lipid membranes at a coarse-grained resolution, is being increasingly adapted towards molecular design and biotechnological applications [1-3]. Recently, Martini has proven its capacity to predict protein-ligand binding through unbiased molecular dynamics simulations with no a priori knowledge of the binding site [4-5]. The latter opens the perspective of developing highly efficient pipelines for drug discovery relying on coarse-grained simulations [6]. Traditional hit-to-lead campaigns often employ relative binding free-energy (RBFE) calculations grounded in free-energy perturbation theory [7]. This area remains unexplored in Martini, as there are no benchmarks, guidelines, or dedicated codes to facilitate such calculations. In this work, we take a step towards overcoming these limitations by developing a tool named “GIN” that allows for the easy setup of dual-topology structures within Martini. We use this tool to explore partitioning equilibria via out-of-equilibrium transformations [8]. The results show that mixing topologies in Martini offers a great promise for the efficient quantification of relative free-energy changes that govern protein-ligand and protein-protein binding.

References:

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Expanding the Cyclotribenzylene Toolkit: From Synthetic Advances to an Air-stable Copper(I) Metallocryptophane

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Metallocryptophanes[1] (MC) are a class of molecular cages analogous to cryptophanes[2] possessing a metal centre on the linkers connecting the two cyclotribenzylene (CTB) units. The incorporation of positive charges into the classical cryptophane structure allows for encapsulation of not only neutral, but also anionic guests. The aim of this project is the synthesis of MCs possessing redox-active metal centres occupying different geometries in their two respective oxidation states. To that end, copper has been chosen as copper(I) adopts a distorted tetrahedral geometry, whereas copper(II) is square planar in a four-coordination mode or square pyramidal in the five-coordinate mode. Electrochemical oxidation of the copper(I) cage would ideally lead either to the expansion of the cavity (thereby influencing the host-guest stoichiometry or guest selectivity) or to the complete disassembly of the cage.

The focus of this talk will be a novel CTB molecule incorporating 2,2'-bipyridine ligands directly appended to the CTB scaffold. Through this work, the scope of reactions applicable to the synthesis and functionalization of CTBs has been expanded and a copper(I) MC showing remarkable stability to air in acetonitrile was synthesised. Self-sorting during self-assembly was also observed, affording only the homochiral form of the MC from a racemic mixture of the ligand.

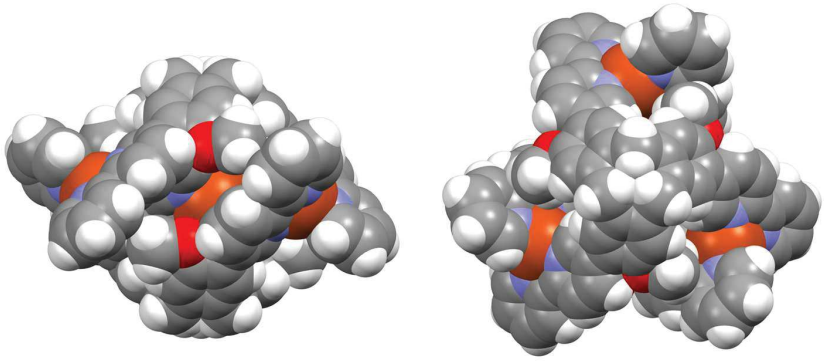

Figure 1. Single-crystal X-ray structure of the copper(I) tris-bipyridyl metallocryptophane; side view (left), top view (right). The anions were omitted for clarity

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Engineering Assemblies of Viologens

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Keywords: viologen, noncovalent interactions, spectro-electrochemistry

Summary: Structurally controlled self-assembly of redox active building blocks comprising aromatic cores remains a challenge.[1,2] Among redox active π-conjugated aromatic cores, viologens, with their low-energy LUMO and unique redox activity, are an interesting class of compounds and may provide the opportunity of studying electronic conduction in fibrils if adequately functionalized.[3] Previous work in our group showed that aryl viologens bearing four alkyl chains form organized structures in both the solid state and on an HOPG surface via van der Waals interactions.[4] However, in solution this molecule formed aggregates that precluded in-depth studies in the liquid state. To overcome this limitation, a new target molecule was designed to incorporate hydrogen-bonding sites in a functionalized viologen scaffold. The building blocks designed in this work are represented in Figure 1 and incorporate three different noncovalent interactions: electrostatic interactions (from the viologen core), hydrogen bonding (via four amide groups), and van der Waals interactions (using long alkyl chains). To establish the self-assembly behaviour of these viologen architectures, complementary analytical techniques were employed. Atomic force microscopy (AFM) reveals that the dicationic state forms extended organized networks on HOPG, whereas spectro-electrochemical characterisation demonstrates an attractive interaction between radical cation species and the formation of π-dimers. These structurally defined assemblies highlight the potential of such systems for constructing complex three-dimensional electronic nanomaterials and nanodevices.[2]

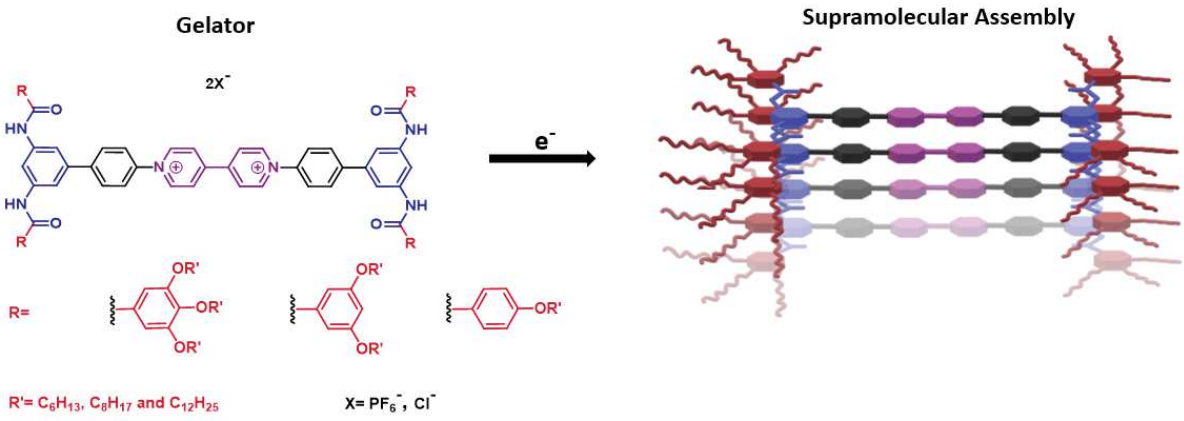

Fig. 1: Target molecule and envisioned supramolecular assembly upon reduction.

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THERMOPHILIC PROKARYOTIC SINGLE CELL SEPARATION AND MASS SPECTROMETRY INTEGRATION

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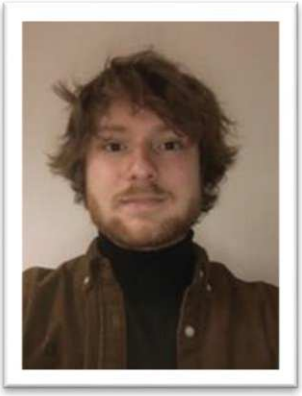
This research is conducted under the European Doctoral Network **'Prokaryote proteomics at high temperature for single cells**' whose primary goal is to combine experimental and computational methods to analyze the proteome of thermophilic prokaryotes. Achieving a sustainable, eco-friendly economy requires innovative cell factories where engineered organisms convert renewable biomass into valuable materials. Thermophilic prokaryotes, which thrive in extreme environments, hold great promises for improving such bio-productions. Studying these microorganisms at single-cell resolution will reveal key mechanisms of protein expression, providing insights that will help optimize cell factories production and thus support an eco-friendly economy. To achieve this goal, cellenONE robot was used for sample preparation coupled with cutting-edge nano LC-MS/MS mass spectrometers for proteomics analysis. By optimizing different parameters of the cellenONE system, a model mesophilic prokaryotic cell *Escherichia coli (*E. coli) and 3 thermophilic prokaryotes namely: *Sulfolobus acidocaldarius (saci)*, *Parageobacillus thermoglucosidasius (Pt) and Caldimonas thermodepolymerans (Ct)* have been isolated. Different mass spectrometry methods and LC-MS/MS parameters tuning were also tested to push the limits of detection and achieve maximal proteome coverage at the single thermophile cell level.

For preliminary experiments towards single prokaryotic cells, 20 and 100 *E. coli* cells were isolated to evaluate the sample preparation efficiency of a standard (master mix combining lysis buffer and protease for digestion) versus a two-steps sample preparation protocol (separated lysis and digestion steps). *Saci, Ct and Pt* mini bulk samples (100-1000 cells suspension) were lysed by three freeze-thaw cycles and digested using the cellenONE, while standard single-step protocol was optimized down to single cells (1 to 100 cells) for the 3 thermophilic prokaryotes. Samples were analyzed on a timsTOF Ultra 2 MS coupled to a nanoElute 2 LC, using Aurora C18-RP columns (5 cm X 75 µm, 1.7 µm) with 16-minute gradient and diaPASEF method (8 PASEF X 3 *m/z* regions, 400–1000 25 Da fix, 100ms Accumulation time and 0.96s cycle-time).

When the MS data of the 100 and 20 E. coli cells were processed with and without Match Between Run (MBR), about 90 and 55 proteins were identified respectively with MBR. However, when the same data was processed individually, there were no observed proteins for the 20 cells injection, but 76 proteins were observed for 100 cells. Preliminary single cell analysis of saci allowed identifying ~16 unique protein groups on average. This low number still suffers from significant contaminants, in particular trypsin autolysis peaks accounting for about 90% of the total ion intensity. However, for Pt, 66 proteins were identified from 100 cells without MBR, while no protein was identified from the search of 20 to single cells. For Ct, 565 proteins were identified in 100 cells while 20 and 5 isolated cells yielded 130 and 31 protein groups with no protein identification at single Ct cell. Nevertheless, when all data generated from the Pt run (100 cells to single cells) were processed together with MBR, 28 and 11 unique proteins were identified for 20 cells and single cells respectively using trypsin gold as the digestion enzyme. On the other hand, 242 and 18 proteins were identified for the 20 and single Ct cells, respectively. In conclusion, we have already managed to leverage a major analytical challenge by succeeding in detecting proteins at single cell level of thermophilic prokaryotes. Further investigations are now ongoing to reduce the contamination levels and optimize the analysis workflow in order improve the proteome coverage of single prokaryotic cell proteomics.



Ultrafused Dipyrromethene Borate complexes for deep NIR applications

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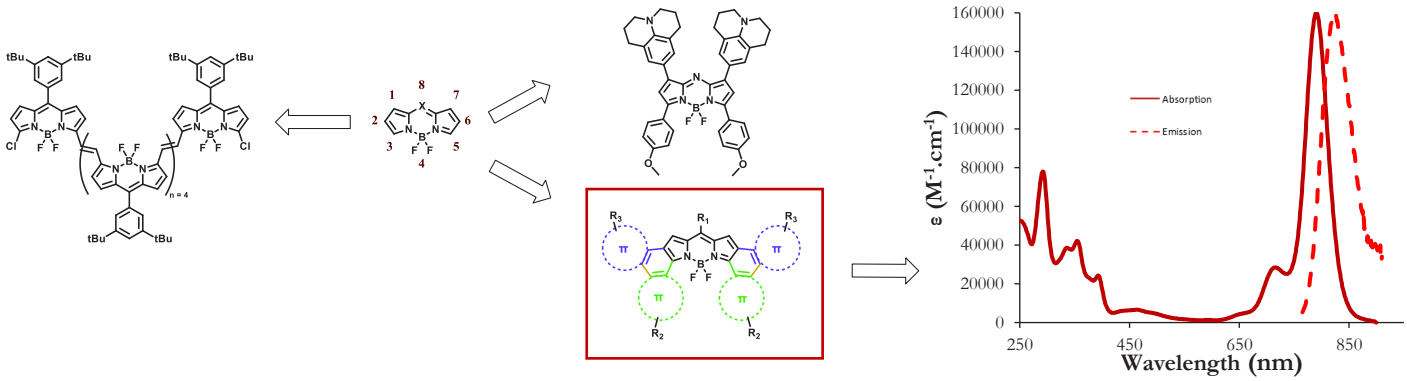
Abstract :

Biological imaging based on fluorescence has emerged as a powerful approach to non-invasively visualize dynamic, functional and molecular events in living organisms, without ionization and at low contrast agent concentration contrary to nuclear imaging and MRI[1]. Fluorescence imaging agents emitting in the visible and the close near-infrared I (650-1000 nm) have been well developed for imaging in living cells or tissues. However, a high resolution *in vivo* with these imaging agents is difficult to achieve due to scattering and interference in the tissue. The development of fluorescent imaging agents operating deeper in the NIR-I and -II (800-1000, 1000-1700 nm) is one strategy to overcome these obstacles[2]. Boron-dipyrromethene (BODIPY) dyes are widely used as small organic fluorescent probes in biological imaging thanks to their biocompatibility and tunable photophysical properties[3]. Recent studies shows that the emission wavelength of BODIPY dyes can be bathochromically shifted to the NIR-II region by a rational molecular design. Vinyl-bridged BODIPY oligomers[4], aza-BODIPY with strong electron-donating groups at the 1,3,5,7 positions of the core were developed with emission maximum (λ_{em}) in the NIR-II region but with moderate brightness[5,6]. While these examples have provided some clues for the construction and application of BODIPY dyes in the NIR, improvements still need to be sought, to go further into the deep NIR and improve the brightness.
With the aim to modulate photophysical properties of BODIPY to the NIR region, we synthesized ultrafused BODIPY by introduction of known strong electron-donating groups and extended of their π-system by cyclization of these groups. After pyrrole condensation to afford unsubstituted BODIPY which was then tetra-halogenated to gives the key intermediate involved in two subsequent Stille cross-coupling, various electron-donating groups were introduced on positions 2,3,5,6 and their impact on the photophysical properties of the BODIPY were studied. Oxidative cyclization of the tetra-substituted platforms allowed us to afford diverse ultrafused structures presenting strong bathochromic shift of their emission wavelengths into the NIR region.



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Driving molecular Upconversion with molecular wheels

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Upconversion (UC) is a photophysical phenomenon wherein multiple low-energy photons are absorbed and subsequently re-emitted as a single higher-energy photon.[1] This process typically manifests as an anti-Stokes emission, offering significant advantages due to its minimal background interference from auto-fluorescence and light scattering, thus enhancing sensitivity. UC materials generally present ladder-like energy levels that facilitate a stepwise energy ascent towards the emitting state and possess long-lived intermediate excited states, which help prevent premature decay to the ground state. Lanthanide ions, with their favorable energy level structures and long excited state lifetimes,[2] are particularly well-suited for the design of UC materials.

Although the phenomenon of UC has being known since the 1960s,[3] its observation has been predominantly confined to solid-state materials and, more recently, nanoparticles. Molecular scale UC was first reported in 2011 by Piguet's group, who demonstrated trinuclear [Er_2Cr] triple helicates exhibiting UC in organic solvents at low temperatures (30 K).[4] Despite this initial breakthrough, ensuing developments in new molecular UC devices have been sparse. With a notable advancement including our group's achievement of UC at the molecular scale in water at room temperature.[5]

This project aims to develop new supramolecular heteropolynuclear lanthanide-based clusters through a supramolecular approach, while thoroughly characterizing the cluster assembly processes, and optimizing the UC properties by strategic selection of lanthanide elements and optimization of ligands.

Using this conceptual supramolecular approach to cluster synthesis, we report a highly customizable, ''wheel-shaped'', hexanuclear cluster system with improved efficiency and control of UC at the molecular scale. To our knowledge, this is the first example of molecular UC in water for a cluster. Additionally, the high tunability of this cluster system, allowed for further functionalization of the system to obtain "liquid crystal" clusters capable of performing UC becoming a first example of such material.

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Exploring the Mechanism of Antibacterial Action of Minocycline-Loaded Carbon Nanodots

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Since their discovery in 2004, carbon dots (CNDs) have attracted significant interest due to their tunable fluorescence, good biocompatibility, and ease of preparation.[1] These properties make them promising materials for applications in sensing, catalysis, energy storage, and biomedicine.[2] Peri-implantitis is an infectious disease caused by gram-negative anaerobic bacteria that can develop after dental implant surgery. Current treatments rely on antibiotics such as minocycline (MC); however, systemic administration results in limited drug delivery to the infection site, highlighting the need for local delivery approaches.

In this context, red-emissive CNDs were synthesized from polythiophene phenylpropionic acid via hydrothermal carbonization.[3] Two strategies were investigated to complex MC with CNDs for local delivery: pristine CNDs and thymine-functionalized CNDs (CND-L1), designed to enhance MC loading through hydrogen bonding. Antibacterial assays against Aggregatibacter actinomycetemcomitans showed that MC alone and CNDs/MC were ineffective at subtherapeutic concentrations, whereas the CND-L1/MC complex reduced bacterial survival to 75%. Confocal microscopy revealed similar bacterial association for all CND formulations, indicating that enhanced efficacy was not due to increased uptake. Conversely, CND-L1 formed high–molecular weight complexes with DNA, suggesting intracellular DNA interactions that may contribute to bactericidal activity. All formulations maintained osteoblast (MC3T3-E1) viability above 80%. Overall, these results highlight CND-L1/MC as a promising local antimicrobial system that enhances MC efficacy while preserving biocompatibility.

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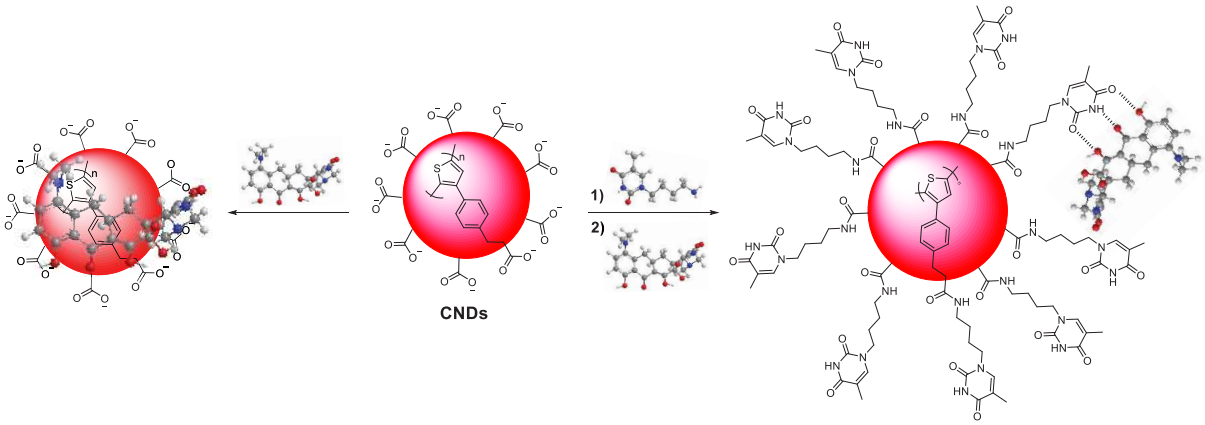

Towards a new direct method for the synthesis of aryl difluoroalkyl ethers from the difluoromethoxy (-$OCHF_2$) moiety

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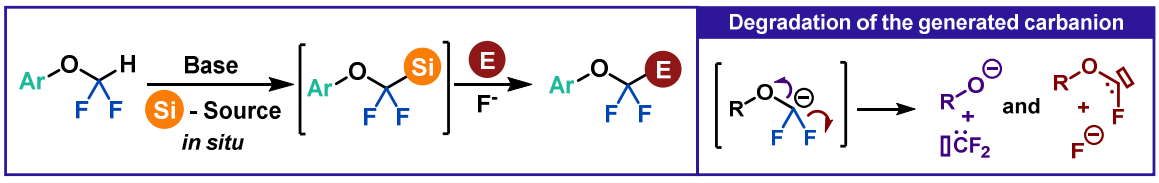
Over the past few years, fluorine chemistry has become an essential component in the synthesis of active medicinal ingredients due to the ability of fluorinated groups to change the **physicochemical properties** and **improve biological activity** of molecules compared to their hydrogen-bearing analogues.[1] Among emerging fluorinated motifs, **alkyl** or **aryl difluoroalkyl ethers** (**Alk/Ar-OCF_2-R**) could be of particular interest since the difluoroalkoxy motif greatly enhances the metabolic stability of neighbouring benzylic positions with regard to oxidation by CYP450 enzyme in liver, and because they are anticipated to behave as bioisosteres of esters or amides.[2,3] Nevertheless, access to these compounds is still limited to **harsh reaction conditions** using complex or unstable fluorination agents such as XeF_2, the desulfurization-fluorination process or strongly acidic conditions and applicable to a **limited scope of substrates**.[4,5] Moreover, many of the reagents relevant to the synthesis of these difluorinated compounds are toxic and dangerous to handle. It is therefore interesting to develop a complementary, **reliable** and **substrate-compatible** method to **facilitate access** to these interesting **aryl difluoroalkyl ethers**. The **optimization work** for introducing this group will be presented, as well as the **scope of application** on a new direct method of accessing this group from the difluoromethoxy moiety. The challenge here is to overcome the high instability of the generated carbanionic species and to bypass the formation of **fluorocarbenes**. For that, **difluorosilylated intermediates** were involved in this two-step reaction sequence to act as masked carbanions and enable their stabilization for further functionalization.[6]



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Gold (I)-Catalyzed Synthesis of Indolizidiniums

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Indolizidiniums are molecules widely found in Nature and exhibit various biological activities.[1] This structural scaffold also serves as an important building block for accessing other valuable heterocycles and relevant in the pharmaceutical field. Nowadays, gold(I) has emerged as a powerful tool for the synthesis of complex natural products.[2] Owing to its Lewis acidic and carbophilic properties, gold(I) is frequently used as an activator of unsaturated bonds.[3] However, alkene activation by gold(I) remains less explored in the literature.[4]

This work describes the development and optimization of a new synthetic methodology that provides access to various 2,3-dihydroindoliziniums **(2)** in a simple and efficient from 2-allyl-2-(pyrid-2-yl)-malonate derivatives **(1)** (***Scheme 1***). The strategy relies on the intramolecular cyclization of a pyridine onto an unactivated alkene catalyzed by gold(I). Once the optimal reaction conditions were established, the scope of the reaction was investigated and the possibility of accessing other heterocycles from indolizidiniums was explored.

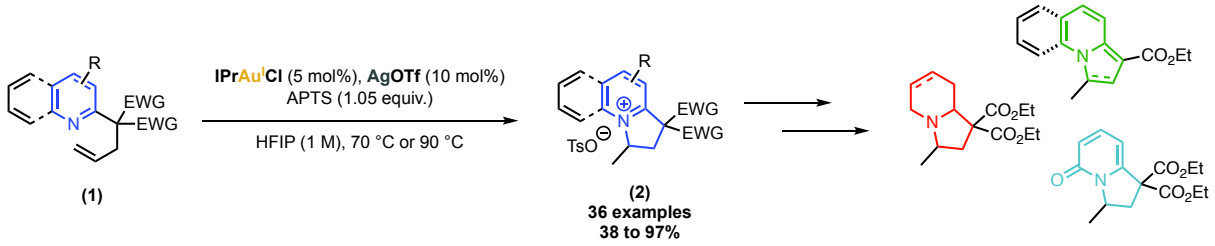

*Figure 1 : General conditions for the synthesis of indolizidiniums **(2)** and post-modifications.*

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Phosphonium ylides as strong Brønsted base catalysts

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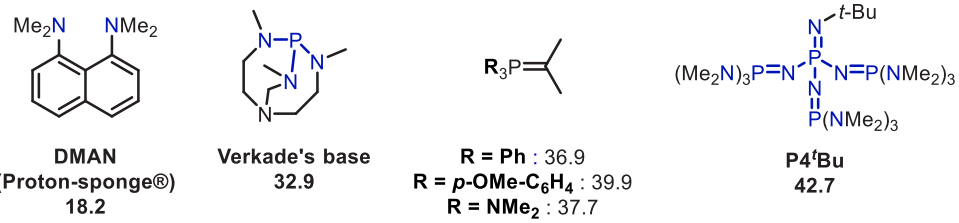
In recent years, the use of strong Brønsted bases as catalysts for the functionalization of weakly-acidic pronucleophiles has emerged as an attractive field of organocatalysis.[1] More particularly, organic superbases, defined as neutral organic species displaying Brønsted basicity higher than that of 1,8-bis(dimethylamino)naphthalene (Proton-sponge®),[2] show interesting properties such as high solubility in organic media and low nucleophilicity.[3] Among commonly used organosuperbases, proazaphosphatrane and phosphazenes show highest Brønsted basicity (pK_{BH^+} > 27-47 in MeCN) and have found numerous applications, but their synthesis often requires multiple steps. Interestingly, non-stabilized phosphorus ylides can exhibit very high Brønsted basicity, approaching the basicity range of phosphazenes.[4] However, to the best of our knowledge, and despite their easy synthesis, the use of phosphonium ylides as Brønsted bases and more especially as superbasic catalysts, remains very limited.[5]

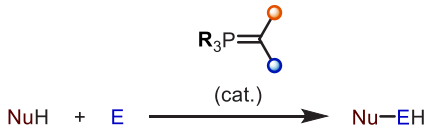
Therefore, we are currently interested in employing phosphonium ylides as organosuperbase catalysts in several organic transformations.

Basicity of common organic superbases (pK_{BH^+} values in MeCN)



DMAN (Proton-sponge®) 18.2 | **Verkade's base 32.9** | **R = Ph** : 36.9; **R = *p*-OMe-C_6H_4** : 39.9; **R = NMe_2** : 37.7 | **$P4^tBu$ 42.7**

Our idea : P-ylides as Brønsted base catalysts



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Integration of Light-Driven Molecular Motors in Soft Self-assemblies

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Light-driven artificial molecular motors, capable of converting photons into unidirectional motion, have emerged as powerful tools to manipulate soft matter at the nanoscale. Our research group has pioneered the integration of these molecular machines into soft materials, leveraging their continuous unidirectional rotation to induce emerging functions from nano- to macroscopic scales.[1,2] In this presentation, I will discuss two research projects that I developed during my PhD.

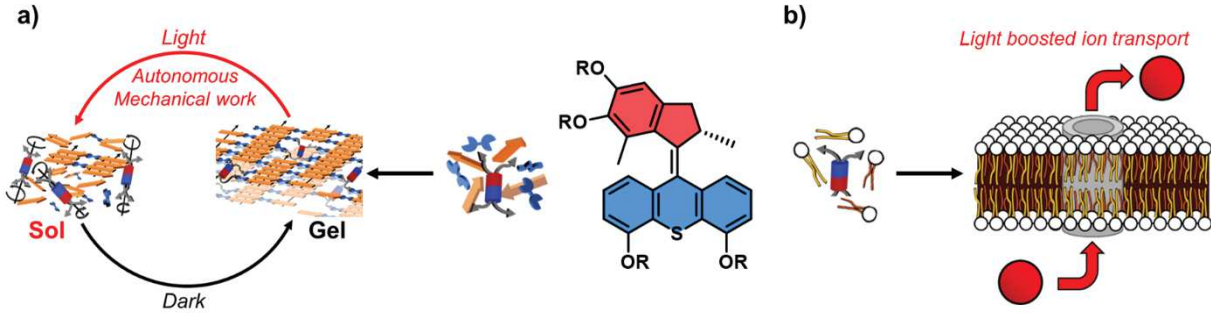

Figure 1. Schematic representation of a) gel-sol transition via ***β***-amyloid fiber disruption and b) molecularly motorized synthetic transmembrane channels

In the first project (Figure 1a), we incorporated light-driven artificial molecular motors in carboxybenzyl-protected-FF (Z-FF) supramolecular hydrogels that form ***β***-amyloid-like fibers involved in numerous pathologies such as Alzheimer's disease. Interestingly, the mechanical work generated during the constant rotation of the molecular motor under UV light is sufficient to disrupt the ***β***-amyloid fibers. This disruption was visible macroscopically as a gel-to-sol transition. In the absence of light, the system fully recovers its original microstructure. This unique reversible gel-sol transition phenomenon was studied by several techniques (rheology, TEM, AFM, CD, and SAXS) proving that the disruption of the ***β***-amyloid fibers originates solely from the work generated by the out-of-equilibrium rotation of the molecular motor.[3]

In the second project (Figure 1b), inspired by the selective transport capabilities of natural protein channels, we focused on the integration of light-driven molecular motors into synthetic phospholipid membranes.[4] By functionalizing these motors with various ligands, we developed artificial channels capable of selectively transporting cations, anions, and water. Under UV irradiation, HPTS fluorescence assays and patch-clamp experiments demonstrated that the unidirectional rotation of the motors can enhance transmembrane transport.

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Development of organic ratiometric probe for *operando* confocal fluorescence microscopy

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Electrochemists have been looking for a method to experimentally monitor the pH at the electrode/electrolyte interface for decades, rather than relying on simulated conditions. Among the different techniques[1], the use of fluorescence microscopy has many advantages: strong sensitivity, tuneable optical properties, pH range modulation upon structural modifications. Combining a fluorescent probe with confocal scanning laser microscopy and the adapted spectroelectrochemical cell allows for observation of the pH in the immediate vicinity of the electrode with high spatial and temporal resolutions. In this context, we are developing a family of new fluorescent probes, based on 2-(2'-hydroxyphenyl)benzazole HBX scaffold, sensitive to pH change, that benefit from Excited-State Intramolecular Proton Transfer (ESIPT) and its strong sensitivity to environment properties. This system has been used to study local pH on a nickel electrode using probe **1** (see **Figure 1.a**). In order to increase the quantum yield (QY), *i.e.* the effectiveness of the fluorophore based on the ratio of emitted and absorbed photons, and thus decrease the concentration of the probe in solution and its possible influence on the electrode kinetics, the reduction of the non-radiative pathways was investigated by introducing molecular rigidity and withdrawing electronic effects both known to boost QY[2] (see **Figure 1.b**).

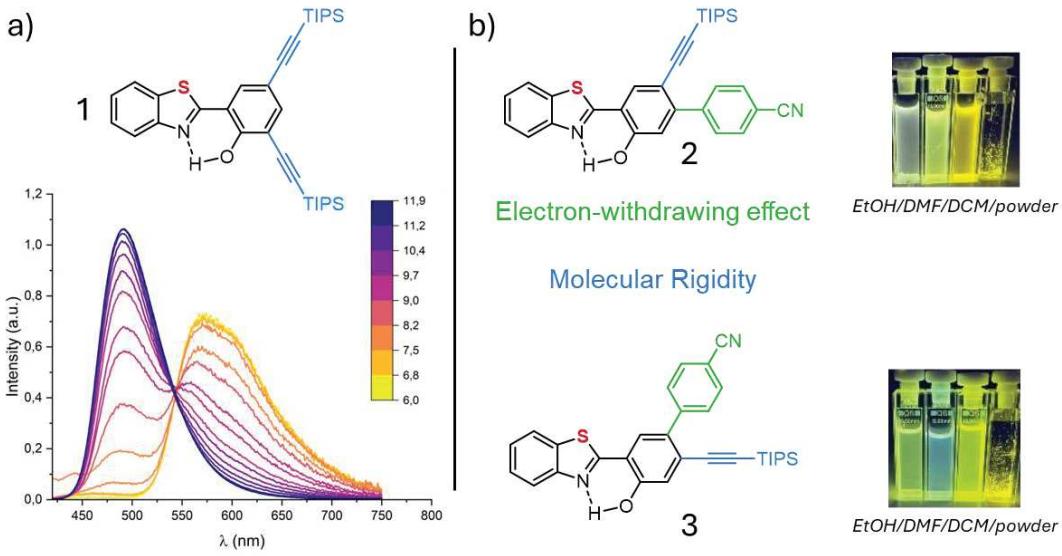

Figure 1. *a) pH-dependant emission spectrums of* ***1,*** *b) Structures of benzonitrile-functionalized HBX*

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