NATHAN MANCHEUN LUI

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EDUCATION

Cornell University **Ithaca, NY, USA**
Doctor of Philosophy in Chemistry Candidate
Master of Science in Chemistry Dec 2020
Field: Physical organic chemistry
Advisor: Prof. David Collum
Thesis: **Structure and mechanism of the *N*-acyl Oppolzer sultam enolates**

New York University Abu Dhabi **Abu Dhabi, AD, UAE**
Bachelor of Science in Chemistry with specialization in Biochemistry May 2018
Honors thesis in physical biochemistry under supervision of Prof. Wael Rabeh and Prof. Panče Naumov
Thesis: **Conserved loops mediate the active site microenvironment and determine the color of bioluminescence in beetle luciferases**
Minor: Urban Studies

RESEARCH

The Collum Group **Cornell University, New York, USA**
Graduate Research Assistant Aug 2018 – Present
Advisor: Prof. David B. Collum, Ph.D.

Structural studies of enolates of the N-acyl Oppolzer sultams. A *general* method for the asymmetric alkylation of ketones remains, to this day, a mountain unconquered. While photo- and electro-catalytic methods may be the *flavor du jour*, the asymmetric alkylation of carbonyls was born from the chemistry of enolates and azaenolates through the use of chiral auxiliaries, a method that remains, to this day, the most effective route to optically pure α-substituted ketones. We are currently studying the structural and mechanistic underpinnings of the alkylations of *N*-acyl Oppolzer sultam enolates.

A new series of hydrocarbon-soluble organosodium bases with wide-ranging synthetic applications. Sodium hexamethyldisilazide is the synthetic world's preeminent organosodium reagent owing to its solubility, stability, and wide commercial availability; all reasons for which it has surpassed the performance of other foundational sodium reagents (namely, *n*-butylsodium and sodium diisopropylamide). However, NaHMDS suffers from its markedly low pK_a. We have recently developed a series of previously unexplored monosilyl sodium amides which possess good hydrocarbon solubility, remarkable stability, and *reactivity akin to that of lithium diisopropylamide (LDA)*.

The Rabeh Lab **New York University Abu Dhabi, Abu Dhabi, UAE**
Undergraduate Researcher Oct 2016 – Jul 2018
Advisor: Prof. Wael Rabeh, Ph.D.

Beetle luciferases with naturally red- and blue-shifted emission. The mechanism of color tuning in bioluminescence remains one of the longest standing questions in the field. In this mutagenesis study, we examined the luciferases of two far-emitting bioluminescent insects (*Phrixothrix hirtus* and *Amydetes vivianii*) characterizing their structures, kinetics, thermostability, and substrate affinities to reveal the effect of their subtle differences on the emission color.

Naumov Smart Materials Lab **New York University Abu Dhabi, Abu Dhabi, UAE**
Undergraduate Researcher May 2016 – Aug 2018
Advisor: Prof. Panče Naumov, Ph.D.

Thermochemiluminescent Peroxide Crystals. Chemiluminescence is a process of energy transduction which transforms chemical energy into light that is commonly reported in solution. We studied an occurrence of thermally induced chemiluminescence in a macroscopic crystal of lophine hydroperoxide, developing various low-light and variable-temperature analytical methods, elucidating the mechanism of hydroperoxide decomposition, and demonstrating the first instance of thermochemiluminescence in the solid state.

pH-Dependent fluorescence from firefly oxyluciferin in agarose thin films. Utilizing oxyluciferin, the product of firefly bioluminescence, we fabricated and spectroscopically characterized an agarose-based thin film for use as a humidity sensor. Absorbance and fluorescence studies found that the pH-responsive solution-state photochemistry of oxyluciferin is conserved in the solid-state demonstrating an alternative approach to the investigation of environmental effects on bioluminescent systems.

The Rivera Lab for Supramolecular Chemistry **University of Puerto Rico - Río Piedras, San Juan, PR, USA**
Visiting Scholar, NSF - REU program May 2017 – Jul 2017
Advisor: Prof. José Rivera, Ph.D.

Hierarchical assembly of supramolecular G-quadruplexes via enzyme instructed self-assembly. Building off the Rivera group's previous work with guanosine derived supramolecular complexes, we synthesized phosphorylated guanosine derivatives which form host-like microglobluar assemblies at high temperatures. We showed that dephosphorylation by a common alkaline phosphatase induces formation of the supramolecular assemblies. The project provided proof of concept for the enzyme-instructed formation of nonpolymeric supramolecular assemblies and laid the groundwork for creating artificial organelles *in vivo.*

TEACHING

CHEM 2510 Introduction to Experimental Organic Chemistry **Cornell University**
Teaching Assistant Spring 2019 – Spring 2020

CHEM 2070 General Chemistry I **Cornell University**
Teaching Assistant Fall 2018

PUBLICATIONS

Al-Handawi, M.B., Polavaram, S., Kurlevskaya, A., Commins, P., Schramm, S., Carrasco-López, C., **Lui, N.M.,** Solntsev, K. M., Laptenok, S.P., Navizet, I., Naumov, P. "Spectrochemistry of Firefly Bioluminescence." *Manuscript in review at Chemical Reviews*.

Carrasco-López, C., **Lui, N.M.,** Schramm, S., Naumov, P. "The elusive relationship between structure and colour emission in beetle luciferases." *Nature Reviews Chemistry* **2021**, *5* (1), 4.

Schramm, S., Karothu, D.P., **Lui, N.M.,** Commins, P., Ahmed, E., Catalano, L., Li, L., Weston, J., Moriwaki, T., Solntsev, K. M., Naumov, P. "Thermochemiluminescent Peroxide Crystals." *Nature Communications* **2019**, *10* (1), 997.

Lui, N.M., Schramm S., Naumov P. "pH-dependent fluorescence from firefly oxyluciferin in agarose thin films." *New Journal of Chemistry* **2019**, *43* (3), 1122.

- An abridged version of this paper was selected for an oral presentation at the 5th UAE Undergraduate Research Competition under the title "Humidity responsive luminescent switching in oxyluciferin-agarose thin films as a basis for optical humidity sensors."

Carrasco-López, C., Ferreira, J., **Lui, N.M.,** Schramm, S., Berraud-Pache, R., Navizet, I., Panjikar, S., Naumov, P., Rabeh, W. "Beetle luciferases with naturally red- and blue-shifted emission." *Life Science Alliance* **2018**, *1* (4), e201800072.

- Selected for spotlight talk at 2018 ISBC General Meeting (top abstract in section)
- Selected for Sci-Mix at the 255th ACS General Meeting (top 20 abstracts in biological chemistry division)

MANUSCRIPTS IN PREPARATION

Lui, N.M., MacMillan, S.N., Collum, D.B. "Oppolzer-Sultam-Derived Enolates: Structure and Mechanism of Alkylation." *Manuscript in preparation*.

Ma, Y., **Lui, N.M.,** Collum, D.B. "Reactivity of Sodium Monosilylamides" *Manuscript in preparation*.

SELECT PRESENTATIONS

Lui, N., Carrasco-López, C., Ferreira, J., Schramm, S., Berraud-Pache, R., Navizet, I., Panjikar, S., Naumov, P., Rabeh, W. "The active site microenvironment determines the color of emission in beetle luciferases." 20th International Symposium on Bioluminescence and Chemiluminescence. Selected for research spotlight talk (top abstract in section). 29 May 2018. Nantes, France.

Lui, N., Carrasco-López, C., Ferreira, J., Schramm, S., Naumov, P., Rabeh, W. "Approaching the color problem of bioluminescence: Contributions of the active site microenvironment to the emission of red and green luciferases." 255th National Meeting of the American Chemical Society. Selected for Sci-Mix (top 20 abstracts in biological chemistry division). 19 Mar 2018. New Orleans, LA, USA.

Lui, N., Prieto Costas, L., Rivera, J. "Cell^{Plus}: Paving the way for artificial organelles by the enzyme-instructed self-assembly of guanosine derivatives." 1st American Chemical Society Asia-Pacific International Chapters Conference (APICC). 6 Nov 2017. Jeju Island, South Korea.

Lui, N., Carrasco-López, C., Ferreira, J., Naumov, P., Rabeh, W. "Structural insight into the mechanism of a blue-shifted green-emitting luciferase." 2017 Middle East Molecular Biology Sources (MEMBS) Annual Congress. 3 Nov 2017. Abu Dhabi, UAE.

Lui, N., Prieto Costas, L., Rivera, J. "Cell^{Plus}: Paving the way for artificial organelles by the enzyme-instructed self-assembly of guanosine derivatives." Poster presentation for the NSF-REU: PR-CLIMB symposium at the University of Puerto Rico - Río Piedras. 27 July 2017. San Juan, Puerto Rico, USA.

Lui, N., Schramm S., Naumov P. "Humidity responsive luminescent switching in oxyluciferin-agarose thin films as a basis for optical humidity sensors." Annual UAE Undergraduate Research Competition at Abu Dhabi University. Selected for oral presentation. 8 May 2017. Abu Dhabi, UAE.

Lui, N., Schramm S., Naumov P. "Humidity responsive luminescent switching in oxyluciferin-agarose thin films as a basis for optical humidity sensors." 9th Annual International Workshop on Advanced Materials. 20 Feb 2017. Ras Al Khamiah, UAE.

Lam, A., **Lui, N.** "Crystallization of $NiSO_4$ polymorphs: The importance of temperature, saturation, and solvent polarity in crystallization" Presentation for the 2nd Annual Crystal Growth Symposium. 4 May 2016. Shanghai, China.

HONORS, GRANTS, AND AWARDS

ACS Graduate Teaching Award **2020**
Teaching award given by the Cornell Section of the American Chemical Society in recognition of performance as a teaching assistant. (Formerly known as the Bayer-Covestro Teaching Award)

NYUAD Conference Travel Grant **2018**
Travel grant awarded to give a spotlight talk at the 2018 Meeting of the International Society for Bioluminescence and Chemiluminescence in Nantes, France.

ACS International Undergraduate Student Chapter Travel Grant **2018**
Travel grant awarded to present honors thesis results at the 255th National Meeting of the American Chemical Society in New Orleans, LA, USA.

PR-CLIMB Travel Grant **2017**
Travel grant to present summer research results at the 1st ACS Asia Pacific International Chapters Conference in Jeju, South Korea; awarded for 2nd place presentation at the PR-CLIMB research symposium.

Capstone Research Grant **2017**
Research grant awarded by NYU Abu Dhabi to complete an honors thesis in biochemistry with Profs. Wael Rabeh and Panče Naumov including materials, equipment, and ancillary travel.

National Science Foundation – Research Experience for Undergraduates **2017**
Grant to complete research at the NSF-REU site at the University of Puerto Rico - Río Piedras in San Juan, including housing, board, ancillary travel, and personal expenses.

Summer Research Grants **2016/2017**
Fellowship from the NYU Abu Dhabi Division of Science and Mathematics to complete summer research with Profs. Panče Naumov (2016) and Wael Rabeh (2017) including housing, board, travel, and personal expenses.

RELEVANT COURSEWORK

Transcripts available upon request

CHEM-UH 2010/3010 Organic Chemistry I/II + Laboratory	**NYU Abu Dhabi**
CHEM-UH 3011/13/14 Physical Chemistry I/II + Laboratory	**NYU Abu Dhabi**
CHEM-UH 3015 Inorganic Chemistry	**NYU Abu Dhabi**
CHEM-UH 3016 Analytical Chemistry + Laboratory	**NYU Abu Dhabi**
CHEM-UH 3020/21/22 Biochemistry I/II + Laboratory	**NYU Abu Dhabi**
BIOMG 6310 Protein Structure & Function	**Cornell University**
CHEM 6250 Advanced Analytical Chemistry	**Cornell University**
CHEM 6650 Advanced Organic Chemistry	**Cornell University**
CHEM 6660 Synthetic Organic Chemistry	**Cornell University**
CHEME 6880 Industrial Big Data and Machine Learning	**Cornell University**
CS 2110 Object Oriented Programming and Data Structures	**Cornell University**
CS 2111 Programming Practicum	**Cornell University**
CS 5780 Introduction to Machine Learning	**Cornell University**
CS 5789 Foundations of Reinforcement Learning	**Cornell University**
ORIE 6125 Computational Methods in Operations Research	**Cornell University**

COMMUNITY AND OUTREACH

President **August 2017 – May 2018**
ACS International Student Chapter at NYU Abu Dhabi, Abu Dhabi, UAE

Responsibilities: Plan chapter activities and direction, organize student volunteers for local events, write and defend chapter activity grant applications

Director of Finance, Founding Board Member **July 2014 – May 2018**
Love Local Abu Dhabi, Abu Dhabi, UAE

Love Local Abu Dhabi is a community focused initiative which aims to foster relationships between NYUAD and the greater Abu Dhabi community by nurturing infant industries and independent businesses in the city. The initiative accomplishes this by providing workshops for local business owners and NYUAD community members on topics ranging from business plan writing to inventory management and organizing community events and exhibitions for our business partners through which we bridge NYUAD and small business.

Responsibilities: Serve on executive board as director of finance, administered budget, developed recruitment and expansion strategies, designed and coordinated Love Local events, served as interim chairperson

Class of 2018 Representative **Sep 2014 – June 2016**
The 2010 Fund Committee, NYU Abu Dhabi, Abu Dhabi, UAE

New York University Abu Dhabi's 2010 Fund seeks to enable young alumni to give back to the UAE and forge greater connections between NYU and the emirate of Abu Dhabi through the continual support of student lead community initiatives and short-term scholarships. In previous years the fund has supported projects focusing on issues ranging from teaching English to promoting awareness of autism. Each year the 2010 Fund Committee is responsible for coordinating a fundraising drive and administering the gifts of the previous class.

Responsibilities: Representative of the Class of 2018, designed and managed fundraising events for graduating seniors, managed the social media presence of the 2010 Fund, evaluated project proposals for potential impact and feasibility.

PROFESSIONAL MEMBERSHIP

American Chemical Society
International Society for Bioluminescence and Chemiluminescence

LANGUAGES

English (native), Cantonese Chinese (near-native), French (intermediate), Mandarin Chinese (elementary)

PROGRAMMING LANGUAGES

Python, Java, C++, Bash, git, LaTeX, Mathematica