

# **5<sup>TH</sup> ANNUAL RISE CONFERENCE**

*Reactive Intermediates Student Exchange Program*

# **PROGRAM AND ABSTRACTS**

**CONCORDIA UNIVERSITY**  
**AUGUST 25-27, 2000**

Ann M. English  
Conference organizer and chair

<http://www.chemistry.mcmaster.ca/rise.html>

## Welcome to Concordia and Montreal

### *The RISE Faculty .....*

Monica Barra (University of Waterloo, Waterloo)  
Cornelia Bohne (University of Victoria, Victoria)  
Fran Cozens (Dalhousie University, Halifax)  
Ann English (Concordia University, Montreal)  
Linda Johnston (National Research Council, Ottawa)  
William Leigh (McMaster University, Hamilton)  
Glen Loppnow (University of Alberta, Edmonton)  
Robert McClelland (University of Toronto, Toronto)  
Tito Scaiano (University of Ottawa, Ottawa)  
John Scheffer (University of British Columbia, Vancouver)  
Ronald Steer (University of Saskatchewan, Saskatoon)  
Arthur Szabo (Wilfrid Laurier University, Waterloo)

### *wish to thank all our sponsors.....*

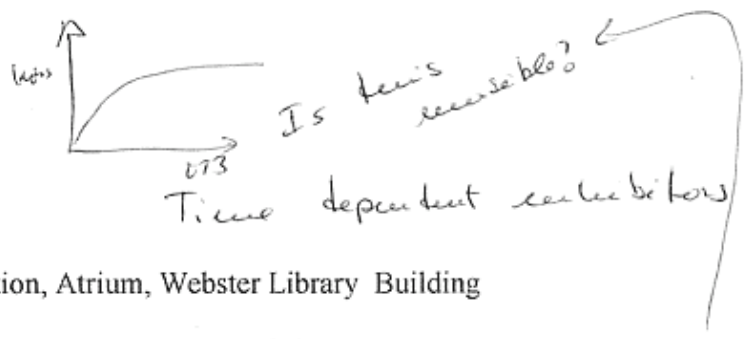
Dean of Arts and Science, Concordia University  
Department of Chemistry and Biochemistry, Concordia University  
Dean of Graduate Studies, Concordia University

Merck Frosst Centre for Therapeutic Research, Montreal  
The Xerox Research Centre of Canada, Mississauga — *Rena Carline*  
Boehringer Ingelheim (Canada) Ltd., Montreal — *Mike Little*  
AstraZeneca R&D Montreal  
Fisher Scientific, Montreal  
*St. Jean Photochem. Corp.*

# PROGRAM

## Friday August 25

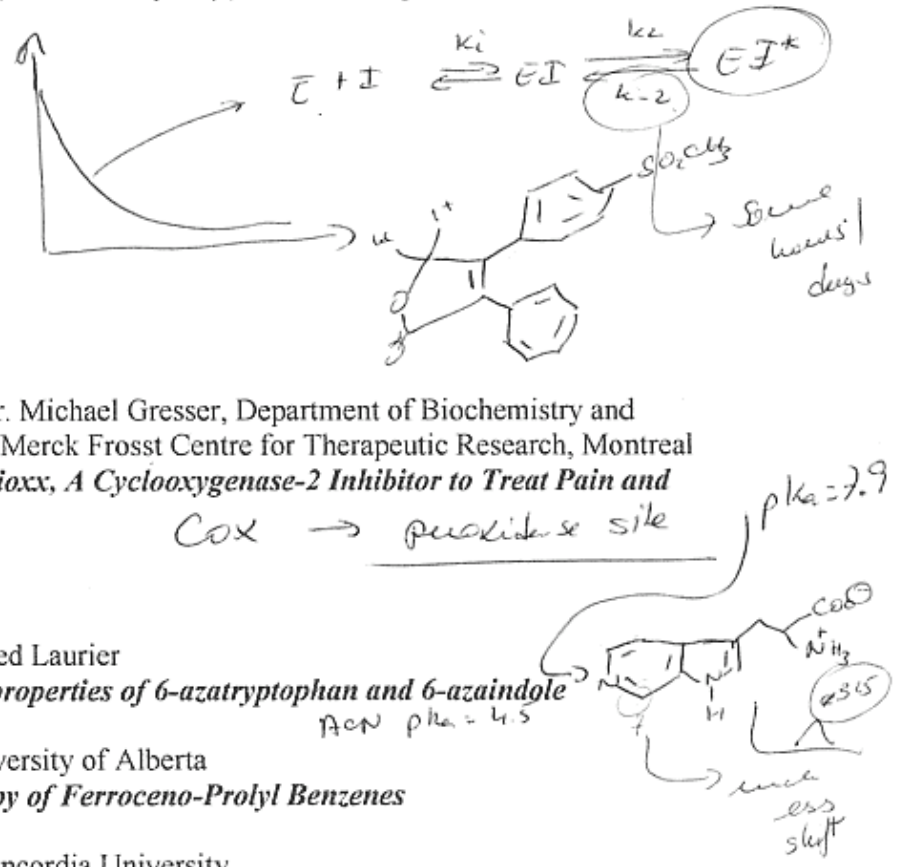
- 5:00 pm Cheese and Wine Reception, Atrium, Webster Library Building
- 7:30 pm Business Meeting (RISE Faculty *only*) Hall Building - 1053

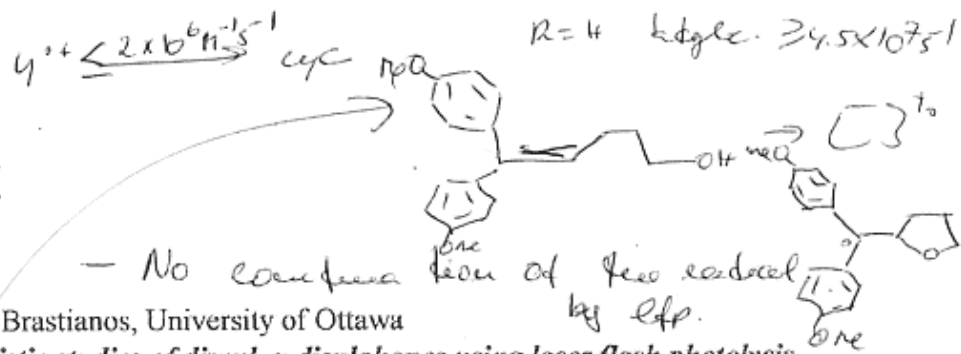


## Saturday August 26

Hall Building - 760

- 8:15 am **Breakfast**
- 9:00 am Welcome
- 9:05 am **Invited speaker:** Dr. Michael Gresser, Department of Biochemistry and Molecular Biology, Merck Frosst Centre for Therapeutic Research, Montreal  
**The Discovery of Vioxx, A Cyclooxygenase-2 Inhibitor to Treat Pain and Inflammation**
- 10:00 am **Coffee**
- 10:20 am Lise Murphy, Wilfred Laurier  
**The spectroscopic properties of 6-azatryptophan and 6-azaindole**
- 10:40 am Anna Zavodni, University of Alberta  
**Raman Spectroscopy of Ferrocene-Prolyl Benzenes**
- 11:00 am Jeremy Flowers, Concordia University  
**The Nature of the Interaction Between Denaturants and Polypeptides**
- 11:20 am Ursula Kisiel, University of Victoria  
**Complexation Dynamics of Pyrene with Cyclodextrins**
- 11:40 am Hughie Fraser, University of Saskatchewan  
**Photophysics of Some Azulene Derivatives**
- 12:00 noon Elizabeth Mader, Dalhousie University  
**Time-Resolved Diffuse Reflectance Investigations of Electron and Hole Transport in NaY Zeolites**





Saturday August 26

- 12:30 pm **Lunch**
- 2:00 pm Priscilla Brastianos, University of Ottawa  
*Mechanistic studies of diaryl- $\alpha$ -disulphones using laser flash photolysis*
- 2:20 pm Adam Elwi, University of Toronto  
*Quinone Methides as Biologically Relevant Electrophiles: Kinetic and Mechanistic Studies*
- 2:40 pm Jazmin Marlinga, National Research Council, Ottawa  
*Generation and Characterization of Diarylpentenol radical cations and their photocyclized products via Laser Flash Photolysis*
- 3:00 pm **Coffee**
- 3:20 pm Matthew Moran, Chemistry, University of British Columbia  
*Synthesis and photolysis of 2-benzoyl-2-phenylbicyclo[3.1.0]hexane*
- 3:40 pm Navjot Chahal, University of Waterloo  
*Substituent effects on the mechanism of cis to trans isomerization of triazenes*
- 4:00 pm Sherman Hon, MacMaster University  
*Kinetics of the dimerization of methylphenylsilene*
- 4:30 pm **Invited speaker:** Professor John Scheffer, University of British Columbia  
*In the Footsteps of Pasteur: Asymmetric Induction in the Photochemistry of Crystalline Ammonium Carboxylate Salts*
- 6:30 pm **RISE Banquet**  
at **ALDO RESTAURANT, 1231 Mountain Street**  
(2 blocks west of Hall Building, below Ste-Catherine Street, about 10 min walk)

Sunday August, 27

Free for sightseeing....

Friguerid  
 + Acetyl Chloride  
 - ~~Wanted~~ Acetyl Chloride  
 Steam Winograd

## Abstracts

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### **THE SPECTROSCOPIC PROPERTIES OF 6-AZATRYPTOPHAN AND 6-AZAINDOLE**

Lise Murphy, Department of Chemistry, Wilfrid Laurier University  
(Home Institution: University of Ottawa)

Analogues of the aromatic amino acid Tryptophan when incorporated into proteins have been shown to be useful in the study of protein-protein interactions. The laboratory has recently shown that 6-azatryptophan (6AW) can also be biosynthetically incorporated into proteins. The spectroscopic and photophysical properties of 6AW have not been extensively investigated. In order to understand the properties of this analogue when incorporated into a protein this project has involved the study of 6AW and the parent indole, 6-azaindoles, in a variety of solution conditions. The experiments include characterization of their absorption and fluorescence properties at different pH values, determining the different pKa's as well as the study of their behaviour in solvents of different polarity such as acetonitrile and methanol. Steady state measurement will be performed.

### **RAMAN SPECTROSCOPY OF FERROCENO-PROLYL BENZENES**

Anna Zavodni, Department of Chemistry, University of Alberta  
(Home Institution: MacMaster University)

Ferroceno-prolyl benzene molecules, which act as model peptides, may be used to gain a better understanding of electron transfer in protein. Using Resonance Raman techniques to selectively excite the iron atom of the ferrocene chromophore, the spectra of molecules which contain the ferrocene group and a benzene ring separated by a variable number of proline residues are obtained. When the vibrations of the ferrocene group are selectively enhanced, bands which correspond to proline and benzene vibrations are observed in the spectra.

Resonance Raman involves excitation at frequencies within the visible region of the electromagnetic spectrum which correspond to  $d \rightarrow d^*$  transitions for the iron atom. By taking spectra of these peptide models and comparing them to each other and to those spectra of the component parts of these compounds, information can be gathered about the way vibrations and electrons are transferred along the molecules.

Long-range vibronic coupling is observed with the model protein molecules. These spectra contain fewer modes than would be expected from the superposition of the individual spectra of acetyl ferrocene, L-proline, and benzyl acetate, when each are taken independently. The vibrations which do contribute to the peaks observed in the spectra of the ferroceno-prolyl benzene compounds are not the strongest modes of the contributing parts, another result which would be expected from a simple summation. Rather, these peaks correspond to some of the weaker vibrations and even vary in their relative intensities with each other. Such observations seem to indicate that certain movements are selectively enhanced when the components of the model peptide are joined.

Other differences are seen when comparing the spectra obtained in various phases. Previously, another student observed the model peptides in solution. Her results suggest the



possibility of orientational or distance-related effects impacting upon the transmission of vibrations from one end of the molecules to the other. Such speculation is not supported by the results obtained in solid phase. The earlier observations may be indicative of some type of solute - solvent interactions acting independently or in conjunction with dynamic effects which vary when the model peptides are examined as films.

### **THE NATURE OF THE INTERACTION BETWEEN DENATURANTS AND POLYPEPTIDES**

Jeremy Flowers, Department of Chemistry and Biochemistry, Concordia University  
(Home Institution: University of Waterloo)

The interactions between denaturants and proteins is under investigation using the FTIR spectrum in the amide I region. Arg, Asp, Asn and Lys homo-polypeptides are being used to establish how different amino acid side chains interact with denaturants. Guanidine-HCl (Gdn-HCl) has been used to show that association between the denaturant and various polypeptides does occur. Gdn-HCl has a positive charge, hence it was deduced that a possible Cl<sup>-</sup> bridge develops between the denaturant and Lys side chain. SCN<sup>-</sup> is expected form a stronger salt bridge, so use of Gdn-HSCN will allow the salt-bridging hypothesis to be tested. Urea has a similar structure to Gdn, but is uncharged; thus, urea is to be used to observe how charge affects the association. As well, deuterium labeled Gdn-DCl, Gdn-DSCN and urea were prepared to aid in the analysis of the data. The molecular vibrations of urea and guanidine under various conditions are to be modeled by computer to check the observed *vs* calculated vibrations.

### **COMPLEXATION DYNAMICS OF PYRENE WITH CYCLODEXTRINS**

Ursula Kisiel, Department of Chemistry, University of Victoria  
(Home Institution: University of Windsor)

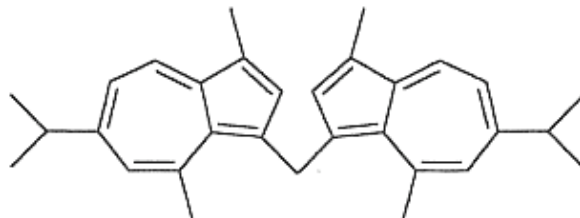
The focus of my project is to study the complexation dynamics of guest molecules within cyclodextrins (CD's). Utilization of pyrene as a guest/probe is frequent since the shape and intensity of its fluorescence spectra are extremely sensitive to the polarity of the microenvironment. Thus, most of my experiments center around pyrene and its interaction with cyclodextrins. The 1:1 pyrene:CD complex is formed readily, however, our main interest lies in the study of the effect of excimer formation (2:2 complex) on the overall kinetics of complex formation and dissociation.

The supramolecular chemistry between pyrene and  $\gamma$ -CD's is studied with the help of a fluorimeter and a stopped flow apparatus. The former allows us to see the slow kinetics (slower than 20 s), whereas the latter permits the study of complexation on a microsecond time scale. The data gathered from the instruments is fitted via Kaleidagraph (software v.3.0) to yield equilibrium constants and entry/exit rate constants. We have shown that the binding dynamics for the complex with 2:2 stoichiometry is not straight forward and occurs on time scales slower than milliseconds. This time scale is at least one hundred times slower than previously observed for the complexation dynamics of various compounds in guest:CD stoichiometries of 1:1.

## PHOTOPHYSICS OF SOME AZULENE DERIVATIVES

Hughie Fraser, Department of Chemistry, University of Saskatchewan  
(Home Institution: Dalhousie University)

Absorption and emission spectra of various azulene derivatives (1-carboxaldehydeazulene, 1,3-dicarboxaldehydeazulene and diethyl 1,3-dipropenoateazulene) and diazulenenes [3-(3-methylguaiazulene)guaiazulene (GMG), azulene-methyl-azulene (AMA), azulene-ethyl-azulene (AEA) and azulene-methyl-azulene-methyl-azulene (AMAMA)] have been measured in hydrocarbon and the analogous perfluorinated solvents. Fluorescence quantum yields were measured in the same solvents and as a function of temperature in low-temperature glasses. Perfluorinated solvents, which are very inert, increased the fluorescence quantum yield dramatically in the diazulenenes suggesting that an excited state relaxation process such as hydrogen abstraction is not a feasible pathway in these solvents. Excited state lifetimes were also determined for some of these compounds using a time-correlated single photon counting method.



Guaiiazulene-Methyl-Guaiiazulene or GMG

Of the diazulenenes studied, GMG proved to be the most interesting. It had the highest fluorescence quantum yield of all the diazulenenes studied ( $\phi_{\text{GMG}} = 7.99 \times 10^{-3}$  in perfluoro-1, 3-dimethylcyclohexane) and the fluorescence quantum yield increased by about a factor of five from 295 K to 77 K. The excited state decay exhibits two fluorescence lifetimes for GMG, which are solvent dependent. GMG was found to be photochemically active with a quantum yield of photodecomposition ( $\phi = 6.64 \times 10^{-3}$ ) nearly equal to that of the quantum yield of fluorescence. The interpretation of these data will be discussed.

## TIME-RESOLVED DIFFUSE REFLECTANCE INVESTIGATIONS OF ELECTRON AND HOLE TRANSPORT IN NaY ZEOLITES

Elizabeth Mader, Department of Chemistry, Dalhousie University  
(Home Institution: University of Ottawa)

Zeolites are crystalline aluminosilicates constructed of molecular sized pores and cavities. They make excellent host materials and catalysts that provide a unique and versatile media for conducting a variety of chemical reactions. For instance, studies of electron transfer reactions within zeolites demonstrate the impressive ability of these materials to influence the lifetime and behaviour of reactive intermediates, modifying the resultant chemistry from that observed in homogeneous solution. It is well known that these solids can act as electron acceptors and the role of zeolites as electron donors has recently begun to receive attention. In addition, electron transfer between zeolite encapsulated donors and acceptors is also of significant interest, particularly in terms of decreasing the rate constants for energy wasting back electron transfer. There has been little discussion, however, of the mechanisms of these reactions and the possibility for long distance charge migration mediated by the zeolite. The goal of this research project is to explore intrazeolite charge transport in order to address some of these issues.

Specifically, this study probes the mechanistic differences between electron transport and hole transport using a system based on a common donor and two chemically similar acceptors with modified chromophores. Nanosecond lasers are used to selectively excite either the donor or the acceptor that has been included in the zeolite along with a non-absorbing redox partner. The generation and decay behaviour of the resulting reactive intermediates are then monitored by time resolved diffuse reflectance. Electron transport is initiated by photoionization of the zeolite encapsulated donor, creating a radical cation, a spectroscopically visible reaction intermediate. The electron, liberated from the donor molecule, is associated with the zeolite framework and is often complexed with the charge balancing cations. Trapping of this electron by a co-incorporated ground state acceptor generates a radical anion as a second spectroscopically visible reaction intermediate. Conversely, hole transport can be initiated by a reaction in which the zeolite donates an electron to a photoexcited acceptor molecule, creating a "hole" in the zeolite framework as well as the corresponding radical anion. Transport of this hole through the zeolite and trapping by a co-incorporated donor yields the donor radical cation.

The system currently being explored employs *trans*-stilbene as the donor and cyano-substituted aromatics, dicyanobenzene and dicyanoanthracene as the acceptors. Electron transport involves selectively exciting stilbene with 308 nm laser light in NaY containing dicyanobenzene, while hole transport experiments utilize 355 nm laser light to selectively excite dicyanoanthracene in NaY containing stilbene. To date, both electron and hole transport have been observed with this system. The decay kinetics and the yields of radical ions are being studied in order to understand the reaction dynamics and effect of intermolecular distance on electron and hole transport.



intramolecular trapping, will be monitored with the use of NMQ-Toluene sensitizer system in attempts to monitor the short-lived radical cation indirectly. A 9,10-dicyanoanthracene (DCA) sensitizer system with biphenyl cosensitizer will be used to conduct all experiments.

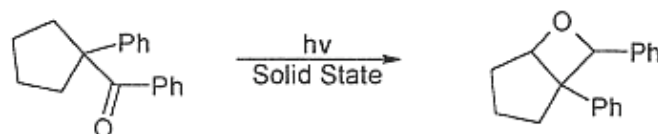
<sup>1</sup> Shukla, D., Chong, L., Schepp, N., Bentrude, W., Johnston, J. *Manuscript*. 2000

### SYNTHESIS AND PHOTOLYSIS OF 2-BENZOYL-2-PHENYLBICYCLO[3.1.0]HEXANE

Matthew Moran, Department of Chemistry, University of British Columbia  
(Home Institution: University of Waterloo)

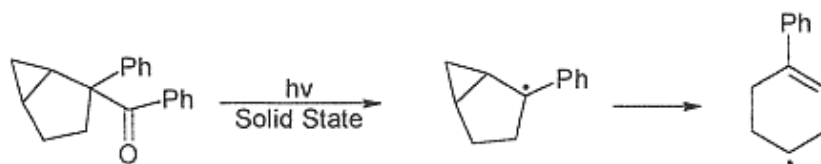
Photolysis of organic molecules, coupled with computational studies, has been integral in elucidating the reaction mechanisms that govern photochemical reactions. Of particular interest is solid state photolysis, as it negates any possible interference from solvents on the course of the reaction, especially when very reactive radical intermediates are formed. In keeping with such investigations, current efforts are being made to determine the mechanism by which oxetane formation occurs after photolysis of 1-benzenoyl-1-phenylcyclopentane.

Previous work by Dr. Scheffer's group (T. Kang et al., unpublished) shows that photolysis of 1-benzenoyl-1-phenylcyclopentane in the solid state (but not in solution) leads to the formation of 1,7 diphenyl-6-oxobicyclo[3.2.0]heptane.



Such a reaction is believed to happen through one of two mechanisms: (1) the Paterno-Büchi mechanism, which involves  $\alpha$ -cleavage followed by hydrogen abstraction and [2+2] cycloaddition of the resulting aldehyde to 2-phenylcyclopent-1-ene, or (2)  $\beta$ -hydrogen abstraction by the carbonyl carbon followed by a radical ring closure.

In order to elucidate the mechanism of this solid state reaction, efforts are being made to synthesize 2-benzenoyl-2-phenylbicyclo[3.1.0]hexane for similar solid state photolysis. It is thought that the addition of the cyclopropane ring will enable the system to undergo a classic radical rearrangement, forming a cyclohexenyl radical:



Such a rearrangement is made possible by the generation of a radical at the number two position of the bicyclic system after cleavage of the carbonyl group. As such, the formation of an oxetane to a six-membered ring would indicate that mechanism (1) was dominant. Otherwise, oxetane formation to the bicyclic system would suggest that mechanism (2) was preferred.

## MECHANISTIC STUDIES OF DIARYL- $\alpha$ -DISULPHONES USING LASER FLASH PHOTOLYSIS

Priscilla Brastianos, Department of Chemistry, University of Ottawa  
(Home Institution: University of British Columbia)

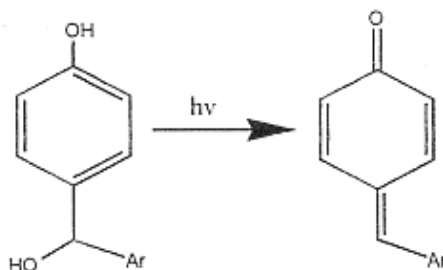
Photoacid generators (PAGs) are used by the microlithographic community in the preparation of photoresist materials. Photogenerated acid in chemically amplified photoresists serves to catalyze deblocking or crosslinking in the polymeric resist material thereby allowing for the development of a pattern in the resist. The study of possible reactions PAGs undergo upon photoexcitation is important for the purpose of gauging their potential for practical applications and determining their efficiency as acid generators. The goal of this project was to perform mechanistic studies using laser flash photolysis on a specific class of PAGs, diaryl- $\alpha$ -disulphones. These PAGs are particularly interesting because they can potentially decompose to yield acids as the only products. Additionally, the synthesis of a new class of PAGs, thiohydroxamic acid esters, was attempted.

## QUINONE METHIDES AS BIOLOGICALLY RELEVANT ELECTROPHILES: KINETIC AND MECHANISTIC STUDIES

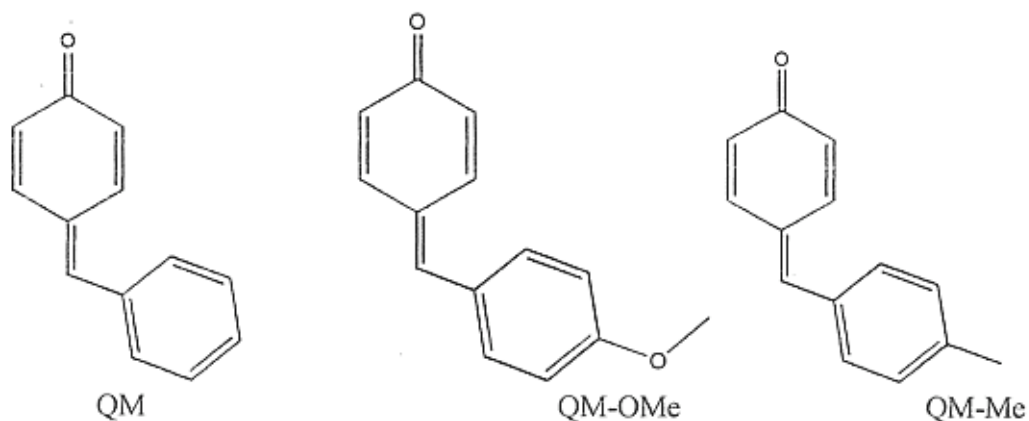
Adam Elwi, Department of Chemistry, University of Toronto  
(Home Institution: University of Alberta)

Quinone methides are unsaturated cyclic conjugated ketones involved in a variety of chemical and biochemical reactions. They have been identified as components of plant pigments, have found usage in medicine, and are also intermediates in the metabolism of natural products and drugs. As intermediates in metabolism, quinone methides have received significant attention as being possible carcinogens. In our research, we are investigating the reaction kinetics of several quinone methides with deoxyguanosine, a DNA monomer.

We generate the quinone methides photochemically from the corresponding hydroxybenzyl alcohol.



The structure of the quinone methide gives it a high reactivity with a nucleophilic center at the oxygen atom and an electrophilic center at the  $\alpha$  carbon atom of the methylene group. As such they are involved in electrophilic and nucleophilic 1,6-addition. By comparing substituent effects at the methylene group and studying the pH rate profiles we are able to construct rate equations governing the reactions of these compounds. The pH rate profiles of the following compounds are being studied.



Currently we are studying the pH rate profile of QM with deoxyguanosine and N - methyl guanosine. We also anticipate performing an isodesmic calculation on the protonation of QM, and synthesizing a quinone methide that is stable in solid form and soluble in water so the kinetics with DNA can be studied.

### **GENERATION AND CHARACTERIZATION OF DIARYLPENTENOL RADICAL CATIONS AND THEIR PHOTOCYCLIZED PRODUCTS VIA LASER FLASH PHOTOLYSIS**

Jazmin Marlinga, National Research Council, Ottawa  
(Home Institution: University of Victoria)

To date, relatively little is known about photoinduced cyclizations and the mechanisms of intramolecular trapping. However, these types of reactions are growing in importance due to their increased synthetic utility (i.e. commercial production of lactones, etc.). Herein lies the impetus in recording such key data as lifetimes and decay and quenching rates to develop a firm mechanistic basis for the use of radical ion cyclization chemistry in synthesis and other biologically important reactions.

In this study, the radical cation intermediate of 5,5-diphenylpent-4-en-1-ol will be generated and characterized by laser flash photolytic techniques. The induction of photocyclization and the mechanism for product formation has been well documented. The measured first order rate constant for the disappearance of the transient presumably corresponds to the cyclization step and provides one of the first calibrations of an intramolecular trapping rate for a functionalized olefin<sup>1</sup>. Competitive quenching studies will also be performed (namely with methanol and other anionic nucleophiles) to further discern the radical cation reactivity and its propensity for intramolecular nucleophile trapping.

Preliminary experiments have demonstrated a quick trapping rate, or short lifetime of this radical cation on the nanosecond timescale. To better resolve its kinetics, other methods will be employed, such as low temperature studies, and the use of an anisyl derivative whose methoxy substituents should provide additional stability thus allowing the transient to persist. Product studies with the anisyl analog will be carried out to parallel those previously performed with the phenyl compound.

Comparative experiments with simple 1,1-diarylethylenes may give some indication of the alkyl chain contribution towards transient reactivity. The cyclized radical, the product of the



Presently the synthesis of 2-benzenoyl-2-phenylbicyclo[3.1.0]hexane is being attempted as outlined on page 3. To date, 3-ethoxycarbonyl-3-phenylcyclopent-1-ene has been prepared in enough quantity to continue to the carbene cyclopropanation reaction.

### **SUBSTITUENT EFFECTS ON THE MECHANISM OF *CIS* TO *TRANS* ISOMERIZATION OF TRIAZENES**

Navjot Chahal, Department of Chemistry, University of Waterloo  
(Home Institution: University of Alberta)

Triazenes, compounds containing a diazoamino group have important industrial and medical applications. They are used as dyestuffs, clinical anticancer agents and in rubber technology. It is known that aromatic triazenes undergo *cis-trans* isomerization around the nitrogen-nitrogen double bond, therefore they are of potential use as molecular switches and information storing media. The thermal *cis to trans* isomerization of laser photolysis formed *cis*-1,3-diphenyltriazene taking place in aqueous solution is known to depend on pH, buffer concentration and buffer species. Our objective is to study the influence of substituents on the mechanism of thermal *cis to trans* isomerization. This project involves synthesis of the substrates, studying their stability (using UV-visible absorption spectroscopy) and isomerization mechanism (by means of laser-flash photolysis techniques).

### **KINETICS OF THE DIMERIZATION OF METHYLPHENYLSILENE**

Sherman Hon, Department of Chemistry, MacMasterUniversity  
(Home Institution: University of British Columbia)

My project studies the kinetics of the dimerization of methylphenylsilene. There are 2 proposed mechanism for the reaction: 1) a concerted reaction; 2) a stepwise one with a .Si-C-Si-C. biradical as the intermediate. The silene is generated photochemically from methylphenylsilacyclobutane, which is synthesized by a Grignard reaction. The Arrhenius parameters for the dimerization process will be determined by flash photolysis of the silacyclobutane. The *cis* and *trans* isomers of the dimer will then be photolysed separately to quantify the reactivity of the 1,4-biradical. This should give some insight towards the true mechanism of the reaction. Initial attempts to synthesize the dimer by photolysis of the silacyclobutane proved unsuccessful; we are trying to find an alternate source for the compound at this moment.