Toulouse/Mainz-Rice APP Student Scholar Exchange Program

Information Session

301A Space Science and Technology, Rice University, Houston, Texas
Wednesday, February 1, 2017

Organized by
Applied Physics Student Scholar Exchange Program

Overview

- Open to APP students at Rice
- Competitive selection process
- 6-month program (Sept. 1 – Feb. 15)
- Research in a lab in Toulouse or Mainz → count as an elective course (APPL 750)
- Optionally, one class in Toulouse or Mainz → count as an elective course (APPL 751)
Applied Physics Student Scholar Exchange Program

Mainz Exchange Courses

http://sci.rice.edu/appexchange/

Full Courses (55+):

- Advanced simulation techniques (4 h/week)
- Materials science: advanced materials and ultrafast spectroscopy (4 h/week)
- Experimental physics: nuclear and quantum physics (3 h/week)
- Theory of soft matter I (3 h/w)
- Theory of soft matter II (3 h/w)
- Photonics 1 and physics of the laser (3 h/w)
- Quantum optics 1 (3 h/w)
- Ion traps and mass spectrometry (3 h/w)
- Photonics 2 and nonlinear optics (3 h/w)
- Laser spectroscopy (3 h/w)
- Quantum optics 2 and quantum information (3 h/w)
Applied Physics Student Scholar Exchange Program

Toulouse Exchange Courses

Full Courses:
- Energy storage and conversion (55 h ≈ 5 h/w x 12 w)
- General electrochemistry (basics in electrochemistry, corrosion, analytical methods, 60 h ≈ 5 h/w x 12 w)
- Solid-state chemistry (inorganic solid-state chemistry, basics in chemistry of polymers, 70 h ≈ 6 h/w x 12 w)

Dual Combination of Courses (each counts as one half course):
- Physical chemistry of materials: bonds, defects, reactivity (30 h ≈ 3 h/w x 12 w)
- Application of surface treatments to energy storage (35 h ≈ 3 h/w x 12 w)
- Catalysis (30 h ≈ 3 h/w x 12 w)
- Chemical alternatives for energy (30 h ≈ 3 h/w x 12 w)
- Laser technics, quantum optoelectronics (30 h)
- Nanobiotechnology (lectures + cleanroom: 40 h)
- Microsystem (workshop) (lectures + cleanroom: 40 h)

http://sci.rice.edu/appexchange/
Applied Physics Student Scholar Exchange Program

Goals

• Strengthen our relationships with Toulouse and Mainz in research and education
• Enable students to acquire unique technical skills and expertise, *not available at Rice*
• Provide students with opportunities to *culturally engage and collaborate with students and researchers at their host universities*
APP Contacts:
Kevin Kelly & Carol Lively

APP Contact:
Jun Kono (ECE)

APP Contact:
Stephan Link (Chem)
MAINZ Exchange Program

Contact: Stephan Link, slink@rice.edu

http://www.mainz.uni-mainz.de/

http://www.mainz.uni-mainz.de/Principal_Investigators.php
Home of Johannes Gutenberg
A broad range of modern material science!
Research Area
Functional polymers
**Polyolefins**

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[CH2CH2]n
```

,,Plastic```

**Block Copolymers**

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**Energy**

**Conjugated Polymers**

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C6H5-S-S-C6H5
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**Organic Electronics**

**Drug delivery**

**Dendrimers**
Organic electronic devices: light, flexible, cheap
Ion conducting polymers

Reduced temperature dependence of the ion conductivity

Li-ion battery

Cathode

Elektrolyte

IRTG 1404
Self-organized Materials for Optoelectronics

Johannes Gutenberg Universität Mainz
Adhesion in biosystems

3D molding with micro and nanotemplates

Hierarchical structures with 3D contact geometry
Cellular uptake of colloids and block-copolymer aggregates

Cellular uptake, escape from endosome and delivery of load to cytoplasm.
Recombinant natural light-harvesting complex LH IIb
Research Area
Hybrid structures

FUNCTIONAL POLYMERS

HYBRID STRUCTURES

MODEL SYSTEMS AND CORRELATED MATTER

BIO-RELATED MATERIALS
Nano solar cells
towards displays and energy generation

Blockcopolymers
poly(TPA)-b-cysteaminacrylate

Functionalized CdSe Nanoparticles

Dispersion in polymer matrix possible

Pristine QDs

QD/BCP Hybrid
Au@MnO Nanoflowers

- Combination of:
  - Gold: optically active (SPR)
  - MnO: magnetically active (MRI)
- Two individually addressable surfaces:
  - Gold: Thiol
  - MnO: Catechol
- Proof of principle: attach different dyes to each component
  - Gold: red
  - MnO: green
Prof. Dr. Carsten Sönnichsen
Institute of Physical Chemistry, Johannes Gutenberg
University Mainz

Area of research

The Nanobiotechnology Group (AG Sönnichsen) at the Institute of Physical Chemistry at the University of Mainz studies the physical chemistry of nanoparticles, and their application in nanosciences, biochemistry, and medicine. Our focus is on the utilization of metal nanoparticles for the sensing of single biomolecules, the measurement of dynamic processes of medically relevant molecular targets in tissues and cells, and the development of nanoparticles for photocatalytic applications. While an important part of our work focusses on the application of nanoparticles, e.g. their appropriate functionalization for biosensing purposes, we are also very interested in the physical and chemical mechanisms of wet-chemical nanoparticle formation itself and the basic physical and chemical properties of the resulting particles. Besides optical microscopy, our workhorse characterization techniques are electron and dark-field microscopy. Beyond the synthetic level, our group has a complete array of methods and expertise at their hand to develop nanoparticles for biomedical applications, spanning from tissue culture experimentation to pre-clinical in-vivo testing.

Selected publications


Prof. Dr. Thomas Basché  
Institute of Physical Chemistry, Johannes Gutenberg University Mainz  

Area of research  

Fluorescence microscopy and scanning force microscopy are employed to study single molecules and nanoparticles. We are interested in the photophysics and photochemistry of the individual particles as well as energy and charge transport in their assemblies. The simultaneous use of both microscopies allows for correlating structure and photophysics of individual molecules or to study the impact of localized stress on their optical properties. In another line of research, semiconductor and gold nanocrystals are assembled into supramolecular aggregates to achieve novel optical properties.

Selected publications  


Prof. Dr. Mathias Kläui
Institute of Physics, Johannes Gutenberg University Mainz

Area of research

Our research focuses on the static and dynamic magnetic and electronic properties of nanostructures made from advanced materials and possible applications in devices ("Spintronics"). We design materials to exhibit particular electronic and magnetic properties and additionally the electronic and magnetic properties change radically when going from bulk materials to nanostructures with reduced dimensions (2D thin films, 1D wires and 0D dots). Rather than being dominated only by materials features, the shape starts to play a key role and allows one to geometrically engineer the properties. We focus on the dynamic non-equilibrium properties by investigating spin dynamics excited by magnetic fields, spin-polarized currents and photons. Our investigations range from fundamental research of novel effects to more applied developments of sensing, storage or logic devices.

Selected publications

Synchronous precessional motion of multiple domain walls in a ferromagnetic nanowire by perpendicular field pulses
NATURE COMMUNICATIONS 5, 3429

Correlation between spin structure oscillations and domain wall velocities
NATURE COMMUNICATIONS 4, 2328
Prof. Dr. Friederike Schmid
Institute of Physics, Johannes Gutenberg University Mainz

Area of research

The research of the Condensed Matter Theory group is devoted to the statistical thermodynamics of solids and liquids, with special focus on soft condensed matter and complex fluids (membranes, polymers, colloids), and on biologically motivated problems. Since our research heavily relies on computer simulations, much effort is also spent on the development of new efficient simulation techniques. Among other, we are currently interested in transport and electrohydrodynamic phenomena in electrolyte solutions (electrophoresis and dielectrophoresis), in self-organizing macromolecular systems, and in membrane phase transitions. We perform our simulations on local clusters (including GPUs) and on parallel supercomputers.

Selected publications

Meinhardt, S, Vink, RLC, Schmid, F, (2013). Monolayer curvature stabilizes nanoscale raft domains in mixed lipid bilayers. PNAS 110, 4476


Prof. Dr. Angelika Kühnle
Institute of Physical Chemistry, Johannes Gutenberg University Mainz

Area of research

Molecular self-assembly represents a very promising strategy for fabrication of tailor-made functional structures, e.g., for future molecular electronic devices. Consequently, molecular self-assembly has been studied extensively on metallic surfaces, gaining deep insight into the mechanisms governing molecular self-assembly. For many applications, however, these studies need to be extended to insulating substrates, e.g., in order to reduce electronic coupling to the substrate surface. Other areas of interest include biomineralization, incrustation inhibition and on-surface synthesis.

Our research is dedicated to understanding molecular binding and structure formation on dielectric surfaces both under the precise control of ultra-high vacuum as well as in biological relevant environments such as aqueous solutions. Our main experimental technique is atomic force microscopy operated in the non-contact mode, allowing for true atomic resolution imaging.

We enjoy close cooperation with organic chemists to explore the structural variety of tailor-made organic molecules providing dedicated functionalities. For detailed data interpretation, we work in close cooperation with theoreticians, revealing insights into molecule-surface interactions and contrast formation in atomic force microscopy. Besides project dedicated to a fundamental understanding of molecular structure formation, we also perform application-oriented projects in cooperation with industrial partners.

Selected publications


Toulouse, France

- 4th largest city in France (~1.3 million people)
- Center of the European aerospace industry, with the headquarters and assembly-lines of Airbus
Toulouse – the best place to be a student in France

1. Toulouse
2. Grenoble
3. Montpellier
4. Bordeaux
5. Rennes

“It's easy, it's fun, and it's safe.”

“Students can move from academic life to social life by simply stepping out into the streets in the old town.”

“... can get to beaches on the Mediterranean in just an hour using the very efficient public transport.”

“... can reach 10 ski resorts within an hour and a half.”
WHY THE FIRST-STUDENT CITY IN FRANCE?

The University of Toulouse (Université de Toulouse), established in **1229**

- University of Sciences
- University of Arts and Literature
- University of Law
- Engineering Schools

UNIVERSITIES ARE FREE

Paul Sabatier
Chemist 1912

Jean Tirole
Economist 2014
WHY THE FIRST-STUDENT CITY IN FRANCE?

4 BEAUTIFUL SEASONS

✓ Good weather
✓ Plant Garden
✓ Japanese Garden
✓ Canal du Midi

Toulouse is SAFE
WHY THE FIRST-STUDENT CITY IN FRANCE?

✔ Markets: Good quality and cheap food

« I love Victor Hugo (Market) for the smells » (Brazilian res.)
« The bread is extraordinary at Victor Hugo » (Londonian res.)

✔ 169 bars
  (open until 3:00 am)

✔ 20 night clubs
  (open until 6:00 am)

✔ Remarkable wines at less than 20 €

✔ Many restaurants
Excitons in Carbon Nanotubes with Broken Time-Reversal Symmetry

S. Zaric,1 G. N. Ostojic,† J. Shaver,1 J. Kono,1,…,2 O. Portugall,2 P. H. Frings,2 G. L. J. A. Tikken,2 M. Furis,2 S. A. Crooker,3 X. Wei,7 V. C. Moore,3 R. H. Haug,4 and R. E. Smalley3
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2Laboratoire National des Champs Magnétiques Pulsés, 31432 Toulouse Cedex 04, France
3National High Magnetic Field Laboratory, Los Alamos National Laboratory, Los Alamos, New Mexico 87545, USA
4National High Magnetic Field Laboratory, Florida State University, Tallahassee, Florida 32310, USA
5Department of Chemistry, Rice University, Houston, Texas 77005, USA
(Received 15 September 2005; published 11 January 2006)

Magnetic Brightening of Carbon Nanotube Photoluminescence through Symmetry Breaking

Jonah Shaver,† Junichiro Kono,‡,1 Oliver Portugall,2 Vojislav Krsitić,‡,1 Geert L. J. A. Tikken,2 Yuhel Miyachi,3 Shigeo Maruyama,3 and Vassil Perebeinos1

Department of Electrical & Computer Engineering and Carbon Nanotechnology Laboratory, Rice University, Houston, Texas 77005, Laboratory National des Champs Magnétiques Pulsés, CNRS-INSU-UPS, 31400 Toulouse, France, Department of Mechanical Engineering, The University of Tokyo, 7-3-1 Hongo, Bunkyo-ku, Tokyo 113-8656, Japan, and IBM Research Division, T. J. Watson Research Center, Yorktown Heights, New York 10598

Plasmonic Pumping of Excitonic Photoluminescence in Hybrid MoS2–Au Nanostructures

Sina Najmaei,1 Adnen Mlayah,1 Arnaud Arbiouet,† Christian Girard,1 Jean Leotin,1 and Jun Lou1,‡
1Department of Materials Science and NanoEngineering, Rice University, Houston, Texas 77005, United States, 2Centre d’Élaboration de Matériaux et d’Études Structurales, UPR 8011, CNRS-Université de Toulouse, 29 Rue Jeanne Marvig, BP 94347, F-31055 Toulouse, France, and 3Laboratoire National des Champs Magnétiques Intenses, UPR 7228, CNRS-UM IUPS-INS, Grenoble and Toulouse, France

Enlightening the ultrahigh electrical conductivities of doped double-wall carbon nanotube fibers by Raman spectroscopy and first-principles calculations†

Nanoscale, 2016, 8, 19668–19676

Jean Léotin, Oliver Portugall, Walter Escoffier, Pascal Puech, Iann Gerber, Xavier Marie, … — Junichiro Kono

Adnen Mlayah & Jeremie Grisolia — Jun Lou

David Guéry-Odelin — Randy Hulet

Christian Joachim — James Tour

Pascal Puech, Iann Gerber, Jean Leotin — Matteo Pasquali
Rice to Toulouse

Sina Najmaiei (Rice, MSNE): visit to CEMES (07/2014)

Ahmed Zubair (Rice, ECE): visit to LNCMI & CEMES (03/2015 & 09/2016-12/2016)

Toulouse to Rice

Florian Vigneau (LNCMI): visit to Rice (09/2015-10/2015)

Damien Tristant (LPCNO): visit to Rice (12/2015-02/2016)
From Atoms, Molecules, Experiments/Theory …to Nanomaterials and Nanodevices

Keywords: Atom technology, Quantum information, Coherent Control, DFT, FFC, Materials Science, Nanomagnetism, Nano-transport, Spintronics, Nanoelectronics, Molecular electronics, Nanoscale characterization...

Xavier Marie
Director
~450 people
~200 PIs
~200 PhD students & postdocs

Université de Toulouse
Université Paul Sabatier
INSA Toulouse
LNCMI
LCPQ
CEMES
INSA Toulouse
Laboratoire de Chimie et Physique Quantiques
IRSAMC
Laboratoire National des Champs Magnétiques Intenses (LNCMI)
Laboratoire National des Champs Magnétiques Intenses (LNCMI)
RAMBO: Rice Advanced Magnet with Broadband Optics

30 Tesla every 5 minutes!

Magnet Cryostat
Helium Cryostat

5.6 mF Capacitor Bank

Table-top magnet with direct high-NA optical access

Mini-coil
Lower Field Instrument/Educational Demonstration Model

5 Tesla every 5 seconds!

5 Tesla every 5 seconds!

Laboratoire de Chimie et Physique Quantiques

The laboratory is organised in four teams:
Methods and Tools of Quantum Chemistry (GMO)
Theoretical and Computational Photochemistry (PTC)
Extended Systems and Magnetism (SEM)
Modelisation, Clusters, Dynamics (MAD)
<table>
<thead>
<tr>
<th>Team Name</th>
<th>University/Country</th>
</tr>
</thead>
<tbody>
<tr>
<td>NanoMobile club</td>
<td>CEMES-CNRS (France)</td>
</tr>
<tr>
<td>Nanocar Team</td>
<td>Rice (USA) &amp; Graz (Austria) Universities</td>
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<tr>
<td>Nano-windmill Company</td>
<td>Dresden Technical University (Germany)</td>
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<tr>
<td>MANA-NIMS</td>
<td>Nano-Vehicle (Japan)</td>
</tr>
<tr>
<td>Ohio Bobcat nanowagon team</td>
<td>Ohio University (USA)</td>
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Rice to enter first international nanocar race

MIKE WILLIAMS – DECEMBER 14, 2015

POSTED IN: NEWS RELEASES

Nanocar Team
Rice (USA) & Graz (Austria) Universities

http://nanocar-race.cnrs.fr/indexEnglish.php
International cooperation in science is not a luxury; it is a necessity – and the foundation for the future.

Arden L. Bement, Jr.
NSF Director
May 2006
Applied Physics Student Scholar Exchange Program

Timeline

**Year 1**

- **August**: arrive, info session
- **Fall semester**: take 3 or 4 classes
- **January**: another info session
- **Spring semester**: take 3 or 4 classes (a total of 7 classes including all required courses should be completed by the end of spring semester)
- **January 30**: deadline for Letter of Interest submission
- **February & March**: interview of candidates and evaluation of fall class performance
- **March**: establish connection with potential host labs; proposal submission to APCAC; and final selection
- **May 15**: officially join a group at Rice
- **Summer**: research at Rice in the lab of the student’s PI

**Year 2**

- **September 1**: arrive in Toulouse or Mainz
- **Fall semester**: research and one class in Toulouse or Mainz
- **February 15**: return from Toulouse or Mainz
Appendix
WHY THE FIRST-STUDENT CITY IN FRANCE?

27th for Accommodation:

- Private room: 500 €/month
- Flatsharing: 400 €/month
- University room: 300 €/month

1€ ≈ 1$

Culturally interesting
WHY THE FIRST-STUDENT CITY IN FRANCE?

- 24th for Sports:
  - Olympic Pool
  - Soccer, Rugby
  - Martial Arts

MANY OTHER SPORTS

In Toulouse (June to July)
WHY THE FIRST-STUDENT CITY IN FRANCE?

➢ 5th for Culture:

✓ 20 Museums: Arts, Aerospace, Sciences… 3 to 10 €

✓ 20 Theaters, 1 Opera, 6 Cinemas 6 to 20 €

MANY FREE EXPOSITIONS
WHY THE FIRST-STUDENT CITY IN FRANCE?

- 4th for International influence:
  - 13% of foreign students

AN IMPORTANT CULTURAL EXCHANGE
WHY THE FIRST-STUDENT CITY IN FRANCE?

- **1st for Job:**
  - 1st Airbus
  - 2nd Pharmaceutical laboratory Pierre Fabre
  - 3rd Alcatel Alenia Space

RESEARCH DOMINATES in Toulouse
WHY THE FIRST-STUDENT CITY IN FRANCE?

1st for Transport:

- Subway
- Tramway
- Bus
- Bicycle

EASY TO GO ANYWHERE in Toulouse

- 100 €/year ➔ UNLIMITED

- W: 5:15 am to midnight
- WE: 24h/24 Noctambus (subway until 3:00 am)
WHAT TO DO AROUND TOULOUSE?

- Bordeaux
- Carcassonne
- Agen
- SPAIN
- Mountain
- Yellow train
- Atlantic Ocean
- Tautavel
- Biarritz
- SPAIN
- Mountain
- Yellow train
- Mediterranean Sea
- Barcelona
- Zaragoza