

Academic research in surface science

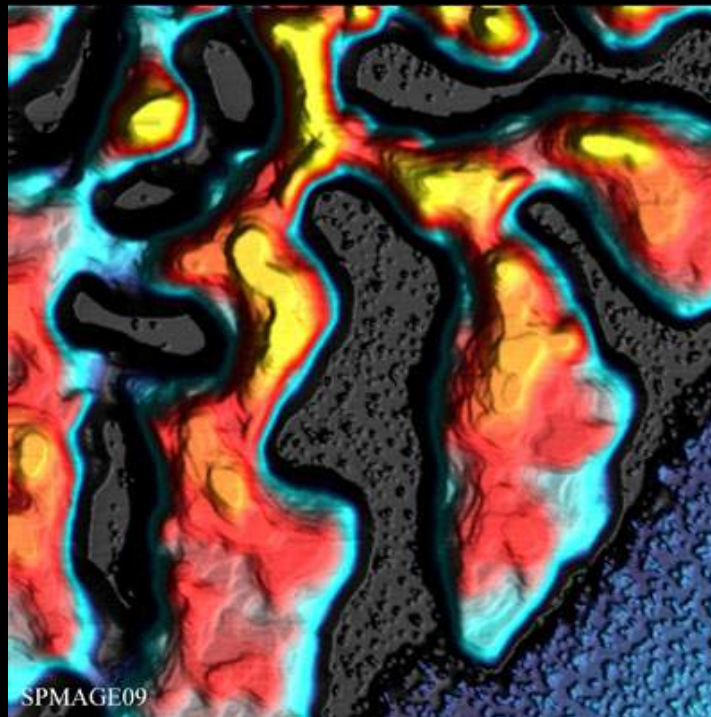
<http://www.physics.queensu.ca/~mclean/>

Jennifer MacLeod • Research Associate

Canadian Conference for Undergraduate Women in Physics

What is surface science?

The study of solid surfaces: structure, chemistry, reactivity, electronic properties, etc.



Ge on Si(111) – INRS EMT

J. M. MacLeod, J. A. Lipton-Duffin, U. Lanke, S. G. Urquhart, and F. Rosei. Shape transition in very large germanium islands on Si(111). *Applied Physics Letters*, 94, 103109 (2009)

materials science

nanoscience

condensed matter

surface science

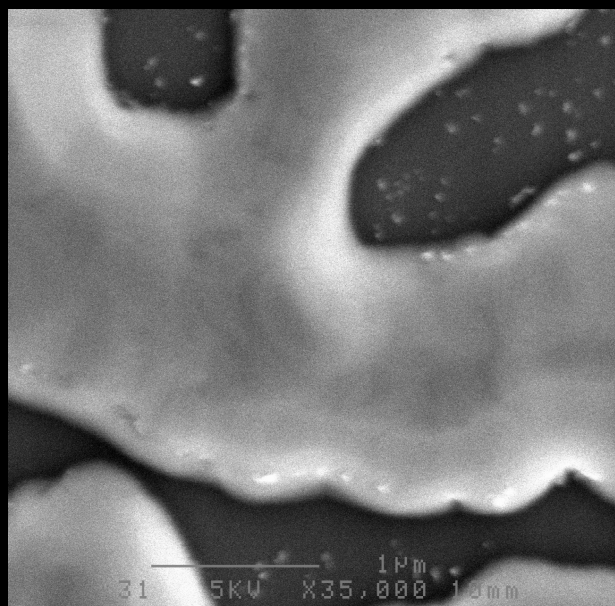
physical chemistry

supramolecular chemistry

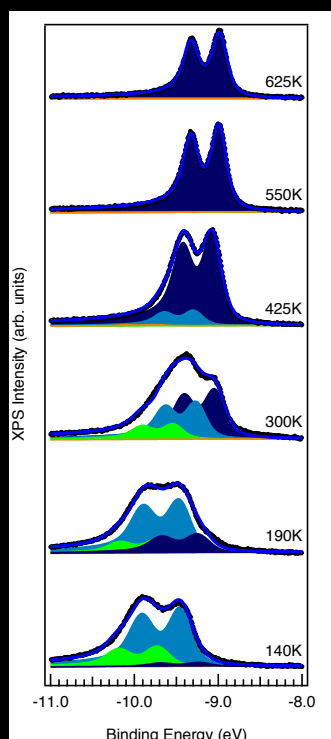
catalysis

How can we investigate surfaces?

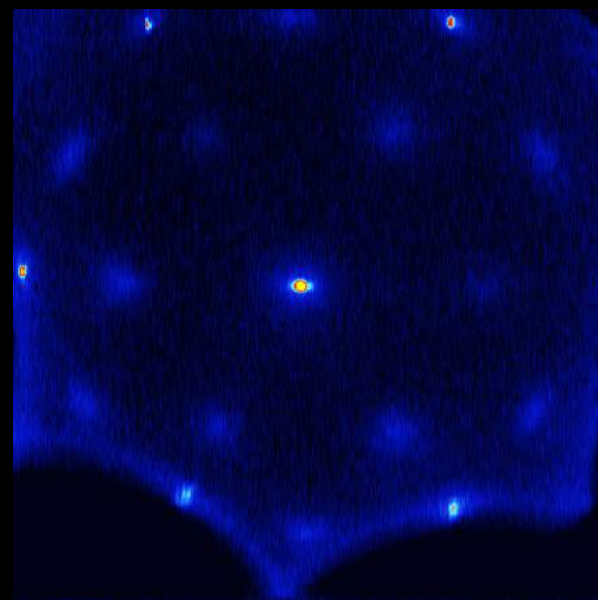
Microscopy



Spectroscopy



Diffraction

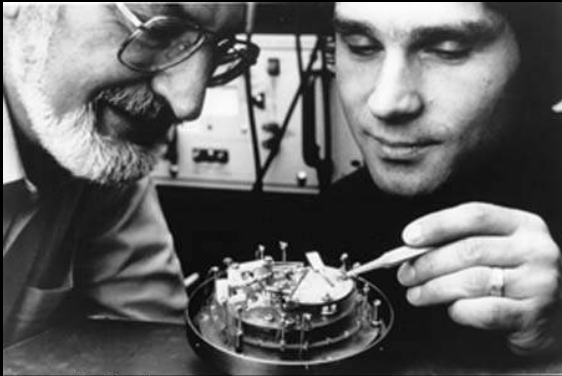


J. M. MacLeod, J. A. Lipton-Duffin, A. Baraldi, R. Rosei, and F. Rosei. Surface structure of Pd(111) with less than half a monolayer of Zn. *Physical Chemistry Chemical Physics*, (2013)

How can we investigate surfaces?

- Microscopy
 - Optical and electron (SEM)
 - Resolution limited by the Rayleigh Criterion
 - Scanning probe
- Spectroscopy
 - Particle in/particle out measurements of energy values that tell us about chemistry, electronics
- Diffraction/scattering
 - Structural information
 - Must be low energy/off angle to only get information about the surface

Scanning tunneling microscopy (STM)



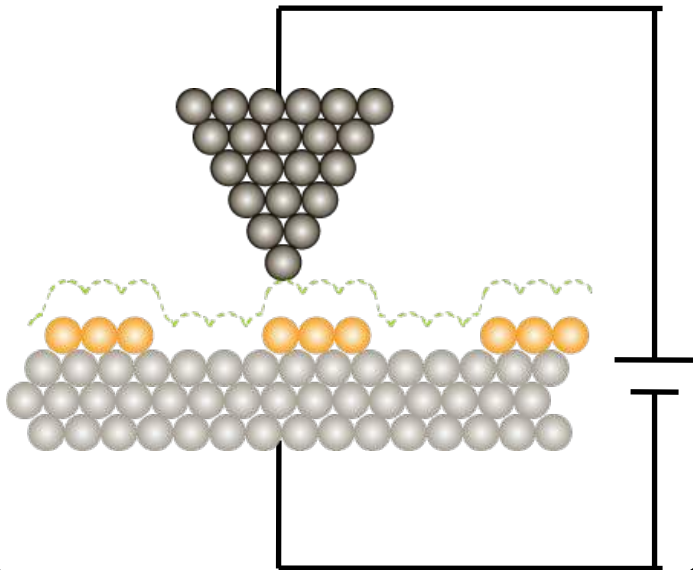
Scanned at the American Institute of Physics



Flickr user TheSeafarer

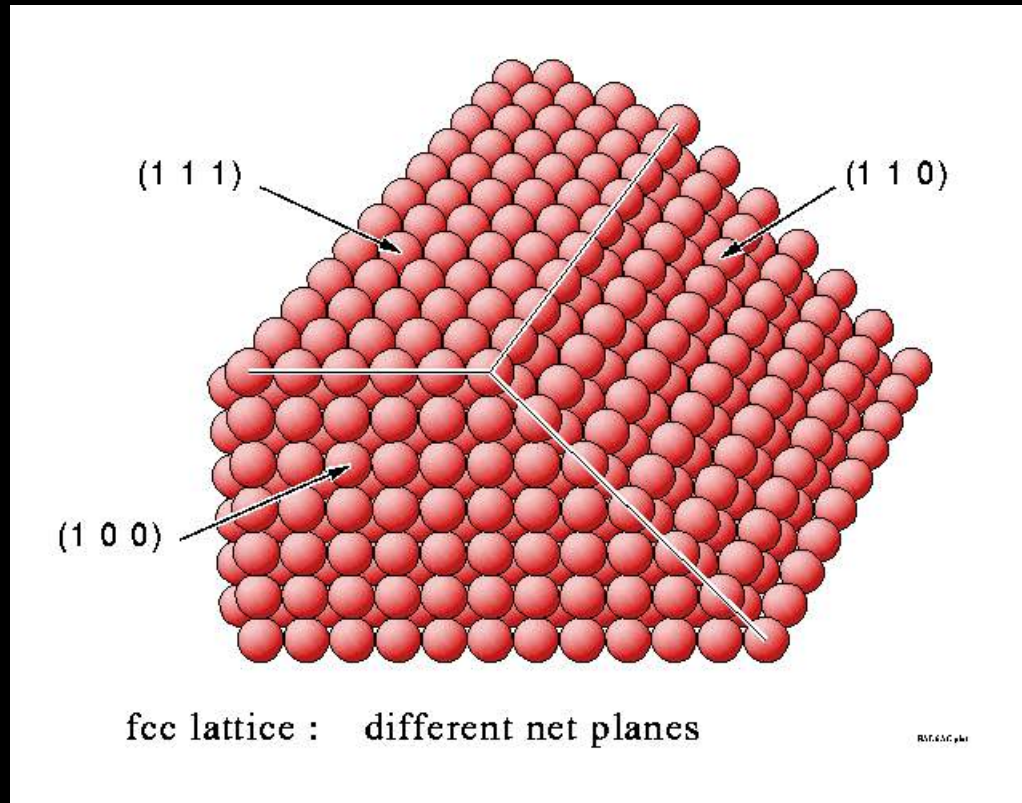


Flickr user thebadastromer



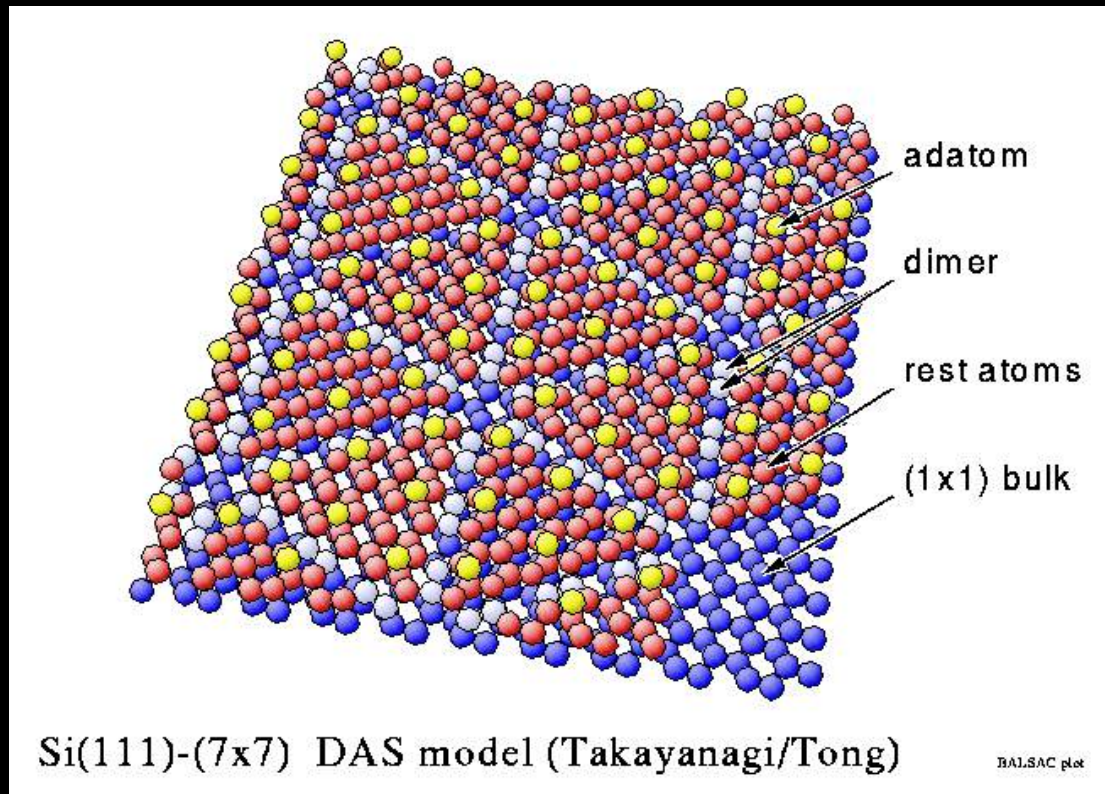
- capable of imaging individual atoms
- provides information about *local density of states*
- can be done in ambient, liquid or vacuum

One crystal, different surfaces



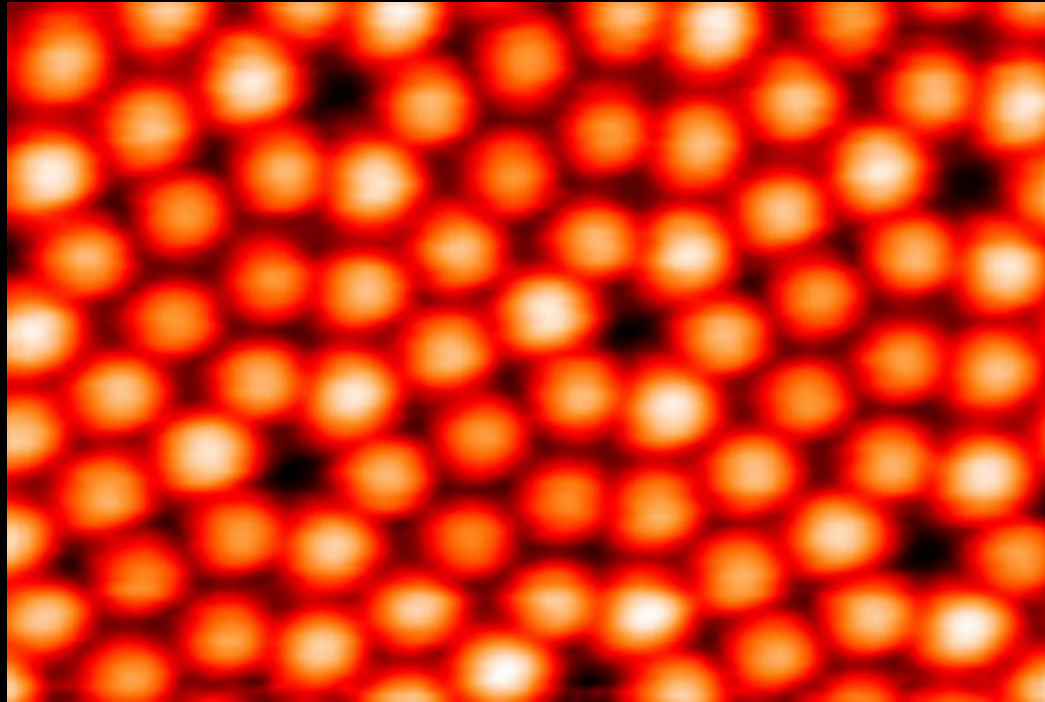
<http://www.fhi-berlin.mpg.de/KHsoftware/Balsac/BalsacPictures/fccnet.gif>

Semiconductors “reconstruct”



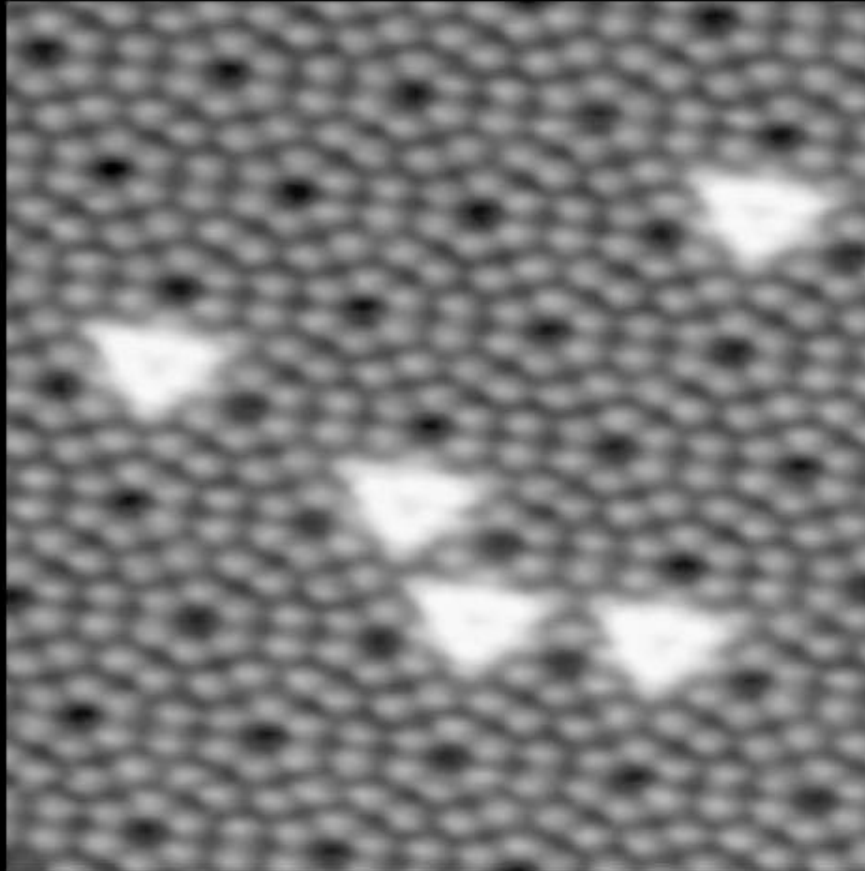
<http://www.fhi-berlin.mpg.de/KHsoftware/Balsac/BalsacPictures/Si7x7surface.gif>

Clean surfaces



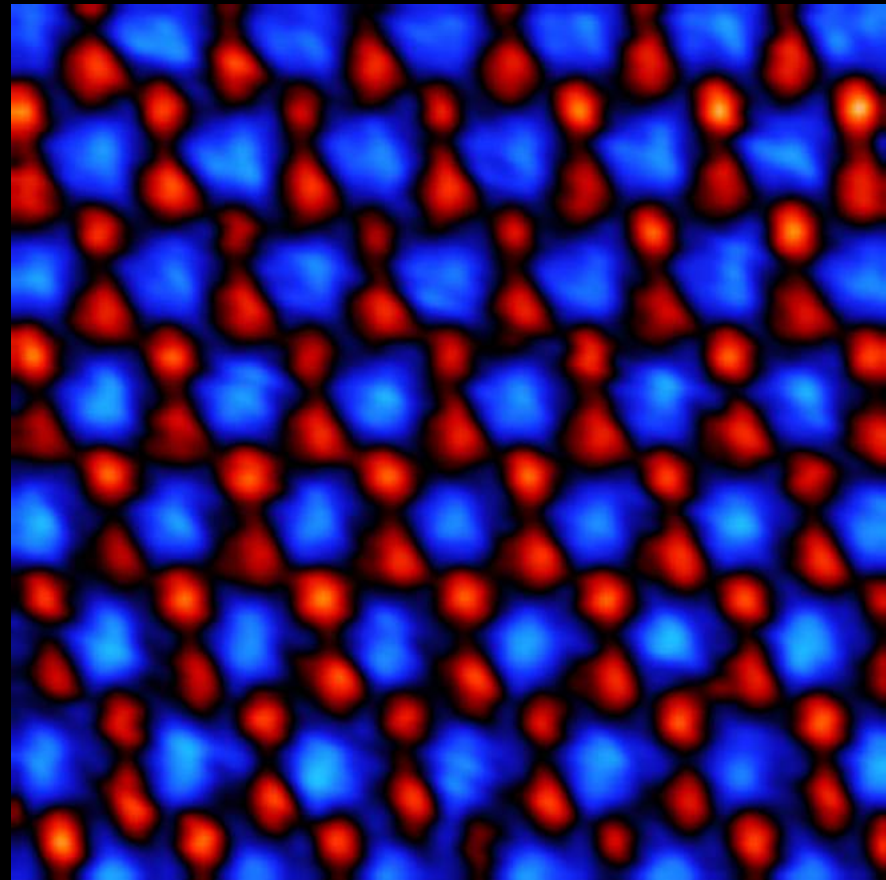
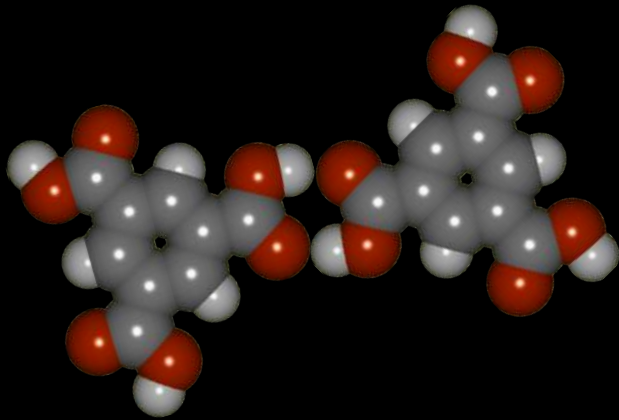
Si(111)-7×7 – Queen's University

Metal atoms on surfaces



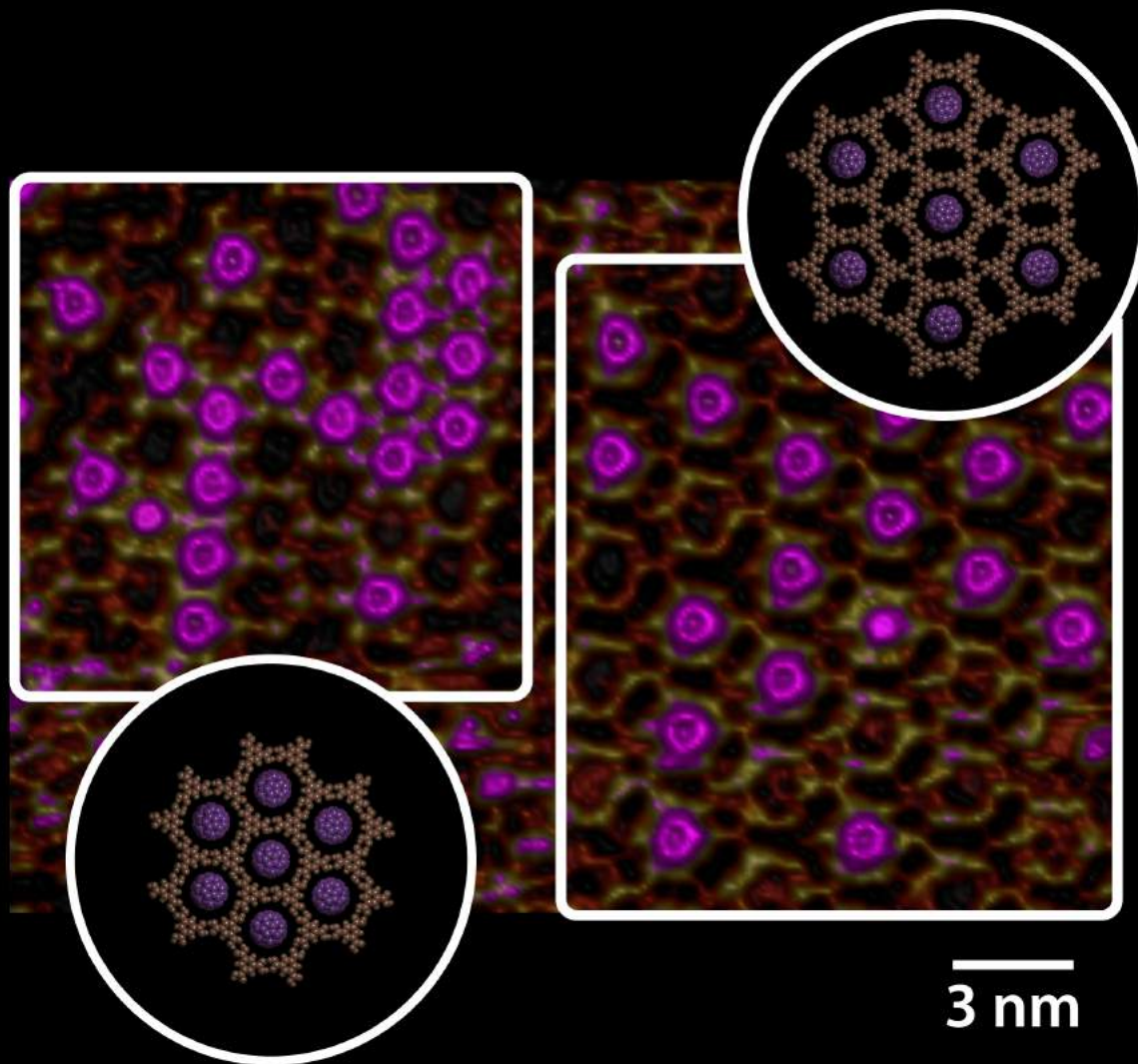
Si(111)-7×7 with In – Queen's University

Molecules on surfaces – self assembly



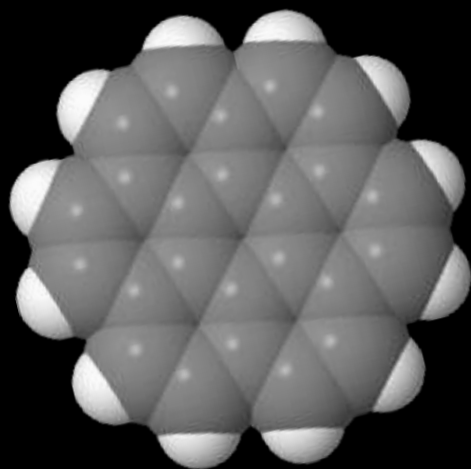
10 nm

Molecules on surfaces - guests



Jennifer MacLeod, Josh Lipton-Duffin, and Federico Rosei, *Towards designing the form and function of 2D molecular systems*, SPIE Newsroom, DOI: 10.1117/2.1200904.1614 (2009)

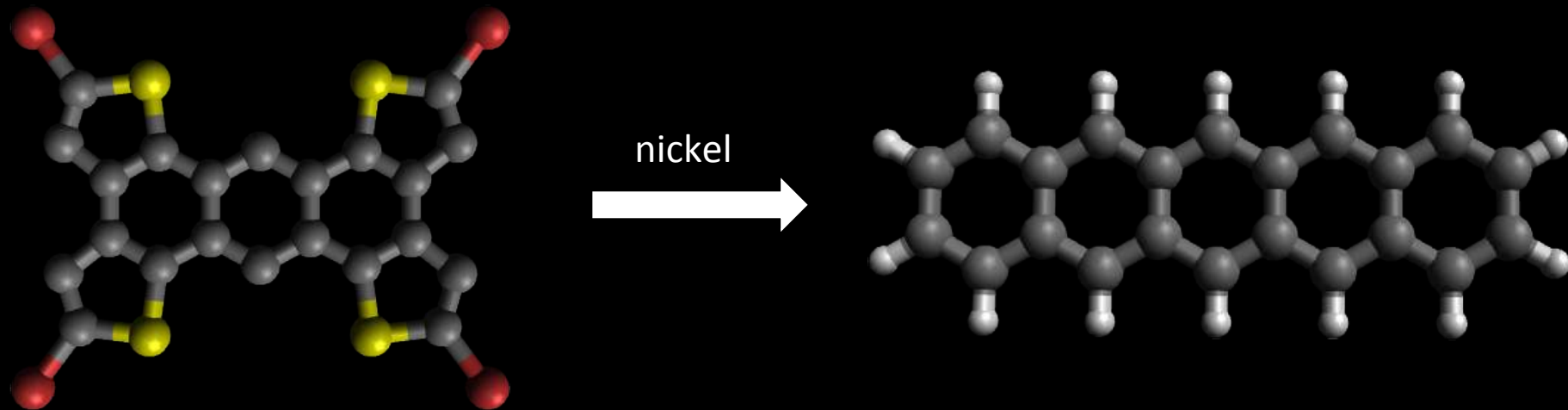
Sometimes molecules even look like themselves



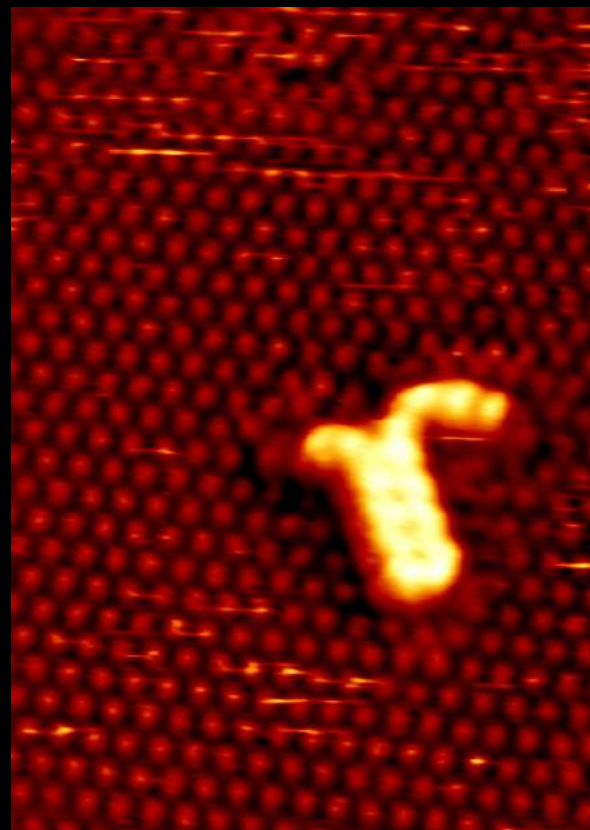
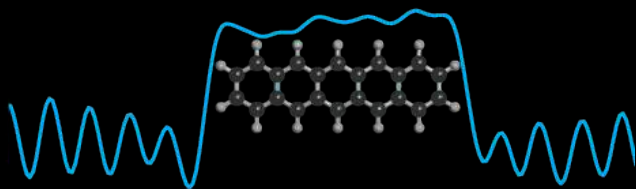
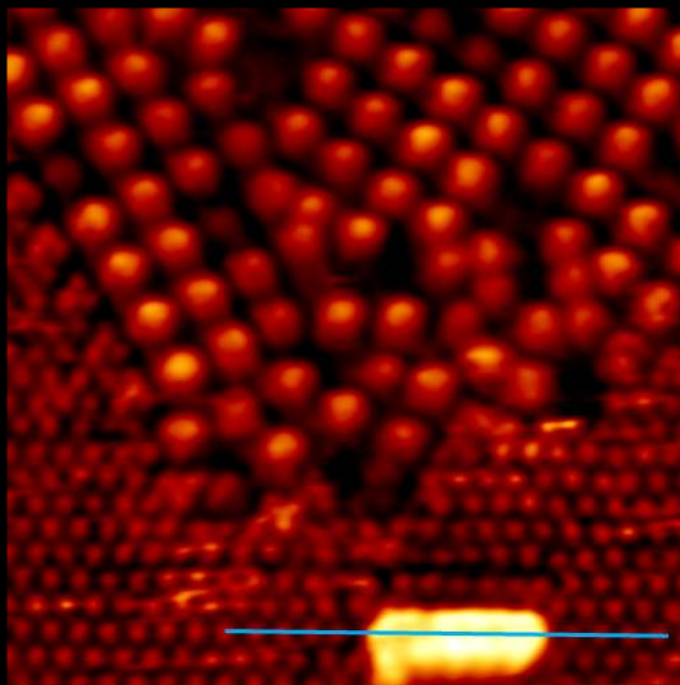
Zied Ben Chaouch, undergraduate summer student 2012

J. M. MacLeod, Z. Ben Chaouch, D. F. Perepichka, and F. Rosei. Two-Dimensional Self-Assembly of a Symmetry-Reduced Tricarboxylic Acid. *Langmuir*, 29, 7318–7324 (2013)

Molecules on surfaces - reactions



Molecules on surfaces - reactions



INRS-EMT, L. Dinca, PhD student

L. E. Dinca, C. Fu, J. M. MacLeod, J. Lipton-Duffin, J. L. Brusso, C. E. Szakacs, D. Ma, D. F. Perepichka, and F. Rosei.
Unprecedented Transformation of Tetrathienoanthracene into Pentacene on Ni(111). *ACS Nano*, 7, 1652–1657 (2013)

What is a Research Associate?

Primary Investigator
(Professor)

Research Associate

Postdoctoral Fellow

Postdoctoral Fellow

PhD Student

PhD Student

PhD Student

MSc Student

Undergraduate

What does a Research Associate do?

data analysis

experiments

planning experiments

writing papers

reviewing papers

supervising students

equipment maintenance

writing grant proposals

administrative work

organizational work

Is there a downside?

Not especially! But it's not a career.



graduate student

education

postdoctoral fellow

time-limited

research associate

“soft” money

professor

Real Job

How did I get here?



Undergraduate studies

University of Calgary BSc in Applied Physics (Co-operative education)

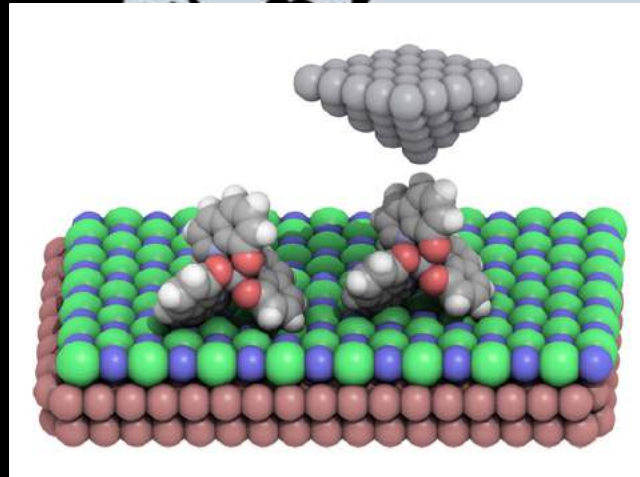


Undergraduate research



Isotope Science Laboratory

Graduate studies



NanoPhysics Group (Prof. A.B. McLean)

MSc Physics

PhD Physics

Postdoctoral work



INRS

Université d'avant-garde

elettra



NSERC
CRSNG

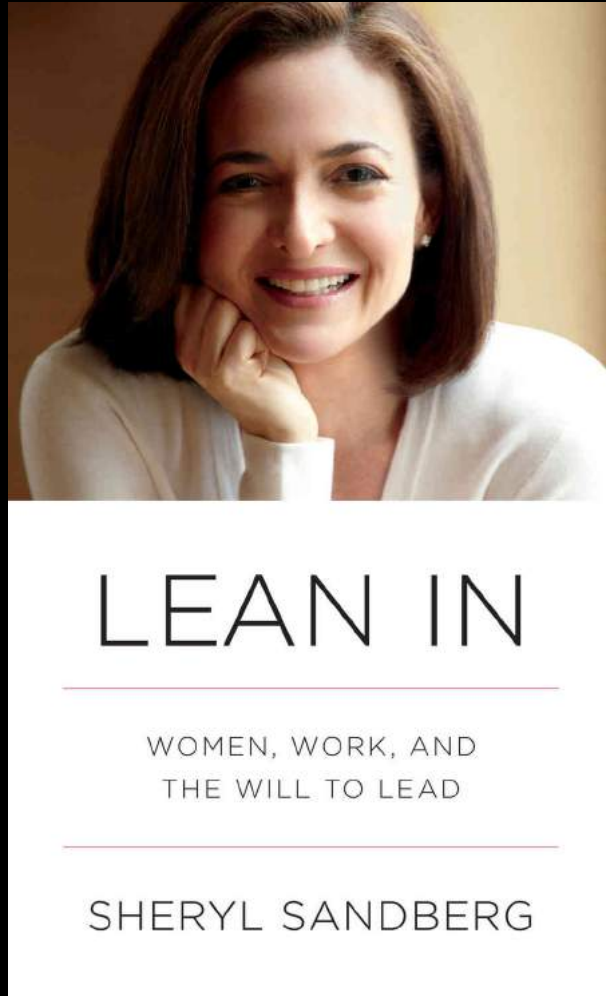
What undergraduate skills are useful?

- Physics and math
 - Electromagnetism, quantum mechanics, statistics, thermodynamics
- Writing
- Critical and logical thinking
- Breadth courses
 - Women's studies!

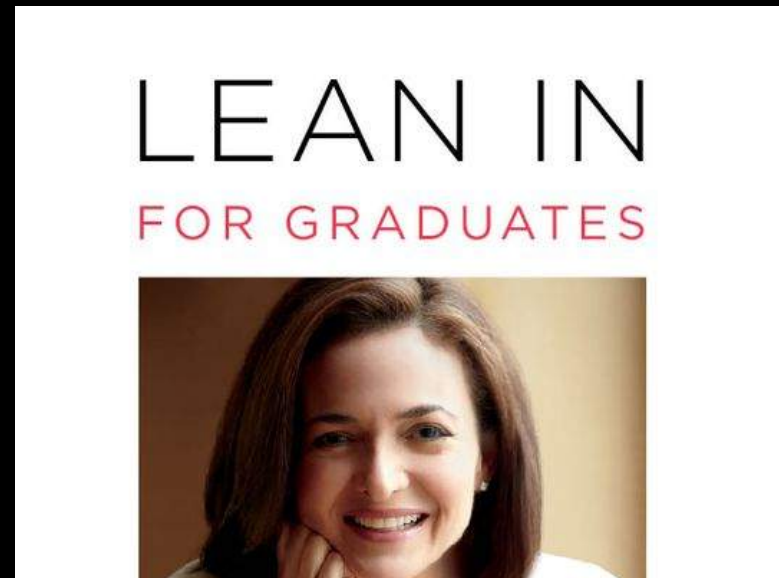
Things to keep in mind
as a woman
in physics

There is lots of advice out there

Original

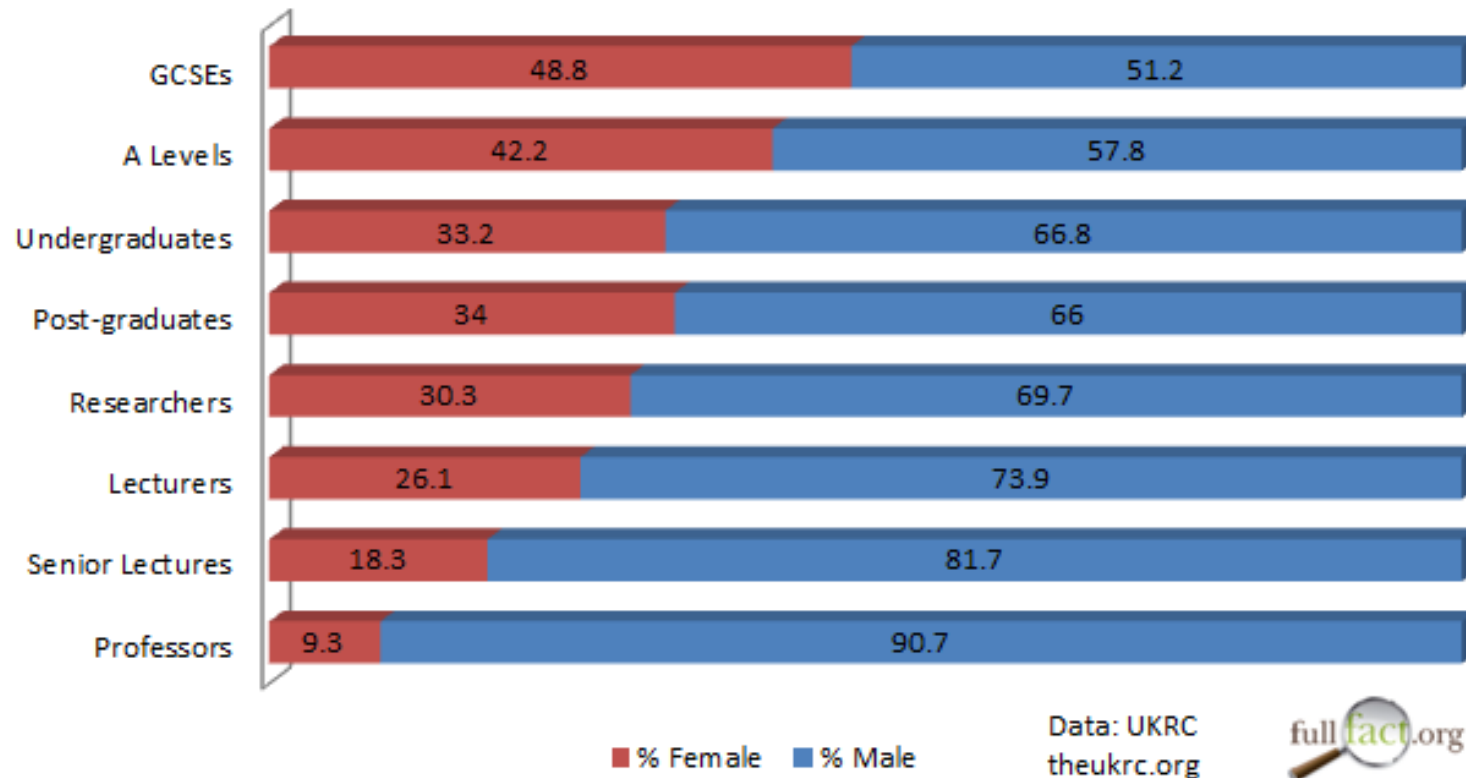


New version aimed at new grads.
Could not find image of whole cover!



But as physicists we face particular challenges

Science: a girl thing, not a women thing (yet)



Jobs are scarce in academia right now



So where's the advice?

- Balance long(er) term goals with your current happiness
- **Get teaching experience!**
- Meet and network with allies in academia
- Read blogs written by women science professors

FemaleScienceProfessor

Musings of a science professor at a large research university.

#HOPEJAHRENSURECANWRITE

Opportunities for undergraduates

INRS Summer Studentships

<http://www.inrs.ca/etudier/stages-ete-2014>

Deadline: February 7th



How to apply...

Requirements:

- Current enrollment in an undergraduate major in Chemistry, Physics, or Chemical Engineering
- Good academic record (3.0/4.0 minimum GPA)
- Must select two CSACS members

Documents required:

- CSACS Summer Student application (available from: www.csacs.mcgill.ca)
- Transcript of your grades

Submit the following documents **no later than February 16, 2014** to Professor Yves Duroy (Sherbrooke U.) or csacs.chemistry@mcgill.ca. The successful applicants will be contacted in the beginning of March, 2014.

CSACS/CRMAA Research:
www.csacs.mcgill.ca

See our website for information about the Professors and their research.

CSACS/CRMAA
Center for Self-Assembled Chemical Structures
Centre de recherche sur les matériaux auto-assemblés

2014 Undergraduate Summer Research Program

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H3A 2K6

Phone: 514-393-6288
Fax: 514-398-2797
E-mail: csacs.chemistry@mcgill.ca

<http://www.csacs.mcgill.ca>

CSACS Undergraduate Research Awards

<http://csacs.mcgill.ca/>

Deadline: February 16th

Thanks for your attention!

Prof. F. Rosei NanoFemto Lab (INRS-EMT)

<http://nanofemtolab.qc.ca/>

Prof. Alastair McLean (Queen's)

<http://www.physics.queensu.ca/~nanophys/index.html>


Ministère
du Développement
économique,
de l'innovation
et de l'Exportation

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et les technologies

Québec 

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