Institute of Physics

Institute for Theoretical Physics (ITFA)
Van der Waals-Zeeman Institute (WZI)
Institute for High Energy Physics (IHEF)

- Quantum gases & quantum information
- Hard Condensed matter
- Soft matter

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How does the WZI score?

Van der Waals-Zeeman Institute WZI

- Quantum gases & quantum information
- Soft matter
- Hard Condensed matter

more than 40 publications every year

Nature Journals : 4
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Quantum gases & quantum information

Hard Condensed matter

Soft matter
Quantum gases & quantum information
Quantum physics with ultracold strontium

Fluorescing strontium atoms

Alex Bayerle (PhD)
Florian Schreck (PI)
Benjamin Pasquiou (Veni PI)
Alessio Ciamei (PhD)
Shayne Bennetts (PhD)
Georgios Siviloglou (postdoc)
Alex Onichstenko (PhD)
Wouter Meinster (master)

Oleksiy Meinster (PhD)
Shayne Bennetts (PhD)
Georgios Siviloglou (postdoc)
Benjamin Pasquiou (Veni PI)
Alex Bayerle (PhD)
Florian Schreck (PI)
Alessio Ciamei (PhD)
Chun-Chia Chen (PhD)
Projects

We are building a continuous atom laser and a Sr quantum gas microscope.

We have many interesting projects related to these new machines, for example:

2\textsuperscript{nd} and 3\textsuperscript{rd} year

- Build lasers.
- Build control system.
- Test magnetic traps.
- Build vacuum chamber.

3\textsuperscript{rd} year

- Develop new electronic devices.
- Create a quantum gas.
- Simulate the atom laser.
- Explore a new type of frequency comb.

More info: \url{www.StrontiumBEC.com} or simply visit us in lab D0.134!

Contact: Florian Schreck, F.Schreck@uva.nl
BSc-Projects on Rydberg interactions

We trap atoms in magnetic fields and make them interact with laserlight. *We can use your help to build these experiments or study them theoretically.*

**Goal:** Rydberg Quantum Simulation

Use red and blue lasers to create Rydberg interactions between clouds. Use interactions for quantum gates between qubits

Exp. 1: Magchips
Magnetically patterned film
traps 500 small clouds of atoms

Exp. 2: Celsius
Traps a 1D BEC Clouds.

87Rb atoms
300 nm FePt
Projects:

1. Characterisation of new magnetic chip experiment
   Contact: Arthur La Rooij & Robert Spreeuw

2. Simulating electric fields near atom chips
   Contact: Julius de Hond & Klaasjan v Druten

3. Calibrating magnetic trap array calculations
   Contact: Maarten Soudijn & Robert Spreeuw

More information and material on: http://iop.uva.nl/qgqi
Quantum gases & quantum information

Soft matter

Hard Condensed matter

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Soft matter group
Our key research themes:

Emergence of the macroscopic properties from the microscopic interactions

Tuning of the macroscopic properties using complex fluids: surfactants, polymers, ....
Why is clay slippery?

We understand friction on sand, but pyramid builders were likely also sliding on wet clay.

Experimental BSc project in which we combine mechanical tests with fluorescence microscopy learn more about the slippery nature of wet clay.

Contact: Daniel Bonn (dbonn@uva.nl)
Bart Weber (b.a.weber@uva.nl)
Surfactants – halide interactions

Surfactants are very important in many industrial applications.

World production: 15 Mton/year!

Dual nature: adsorption at the interfaces

can form monolayers at the interface (here air/water or oil/water) most importantly, self-assembly structures (micelles, vesicles) in bulk.

Alteration of the physical properties of those interfaces (i.e. interfacial tension).

Study of surfactant-salt interactions

- Impact of temperature on surface tension dynamics?
- Impact of halide salts on Kraftt temperature?

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Soft matter group (https://iop.fnwi.uva.nl/scm/)
Jamming in micro-emulsions
Studying the cross-over from thermal to athermal systems

Colloidal hard spheres
- Brownian motion
- Glass transition

Emulsion (oil in water)
- No thermal motion
- Jamming transition

Contact: Maureen Dinkgreve (m.dinkgreve@uva.nl), Daniel Bonn (d.bonn@uva.nl)
Ageing and decline of wood

Conservation and restoration of paintings on wood panels

Contactless non-invasive ultrasonic measuring & monitoring

Influence of moisture on
• Mechanical properties
• Strain & Stress

http://en.wikipedia.org/wiki/Panel_painting

Boy from Al-Fayum, 2nd century, Warsaw. Encaustic on wood

Dr. Rudolf Sprik  
R.Sprik@uva.nl

Example 19 mm oak  
Ultran Group 140kHz transducer

- Velocity of sound
- Sound absorption

Xenos beach wood board

1 night in water untreated
Enamel Coatings on Metals

The Rijksmuseum has a large collection of enamel on copper and silver artefacts.

For a better understanding, restoration and cleaning it is important to know:

- Thickness and condition of the enamel coating
- Metal substrate structure, composition, and condition (micro cracks)

Physics: Use eddy current imaging

Impedance measurements

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Quantum matter

Optoelectronics materials
Getting to grips with

Quantum Matter & Quantum Materials

- unconventional superconductors
- topological insulators
- oxide heterointerfaces
- 1D nanowires

Tomorrow's new materials

today

Golden Lab  van Heumen Lab  de Visser Lab
Unconventional superconductivity

• Research into novel materials that show “unconventional superconductivity”

• Interplay of magnetism and superconductivity

• Mixed even and odd parity Cooper pair states

• Project: to investigate novel unconventional superconductors
  — sample preparation and characterization
  — transport experiments
  — upper critical field measurements
  — dilatometry
  — high-pressure up to 25 kbar


Docent: Anne de Visser, a.devisser@uva.nl, WZI-IoP, rm. C4.235
Transport of surface states of topological insulators

- Research into a new class of materials “topological insulators” (TI’s)
- Insulating in the bulk but conducting on the surface
- Surface states are protected by topology

**Project:** to investigate surface states of TI’s by magnetotransport
  - resistance and Hall effect
  - weak antilocalization
  - universal conduction fluctuations
  - Shubnikov-de Haas effect
  - topological Berry phase

For a popular introduction on TI’s read: J.E. Moore, Nature 464 (2010) 8916

Docent: Anne de Visser, a.devisser@uva.nl, WZI-IoP, rm. C4.235

De Visser Lab @QMat: 1 x NatSter or βγ-Phys major
Topological insulators – offer topologically protected metallic surface states on insulating bulk crystals → candidate materials for spintronics and robust qubits

2016: Can you prove the existence of topological magneto-electricity?

Investigate their spectacular optical properties
By influencing the motion of electrons using laser light

• Improve the existing photocurrent microscope
• Combine it with A’dam samples
What kind of students do we need?

Motivated & clever –
the physics is the 'real stuff' we're getting paid millions to research, so you need to willing to bend your brains round the newest developments. This will be hard work: read, think, discuss.....

Resourceful and determined –
if we knew the answer already, we wouldn't waste our experimental resources on the question. You should be able to take the changes of plan, unexpected set-backs and challenges inherent to experimental work in your stride – and then find a solution.....

Pleasant to work with –
it's always teamwork, so a smile, a thought for how to help your colleagues and some cool tracks on your iTunes are always welcome...