



Universiteit Utrecht



# **Master's programme Experimental Physics**



## Some core facts about the programme:

- your hosts are:

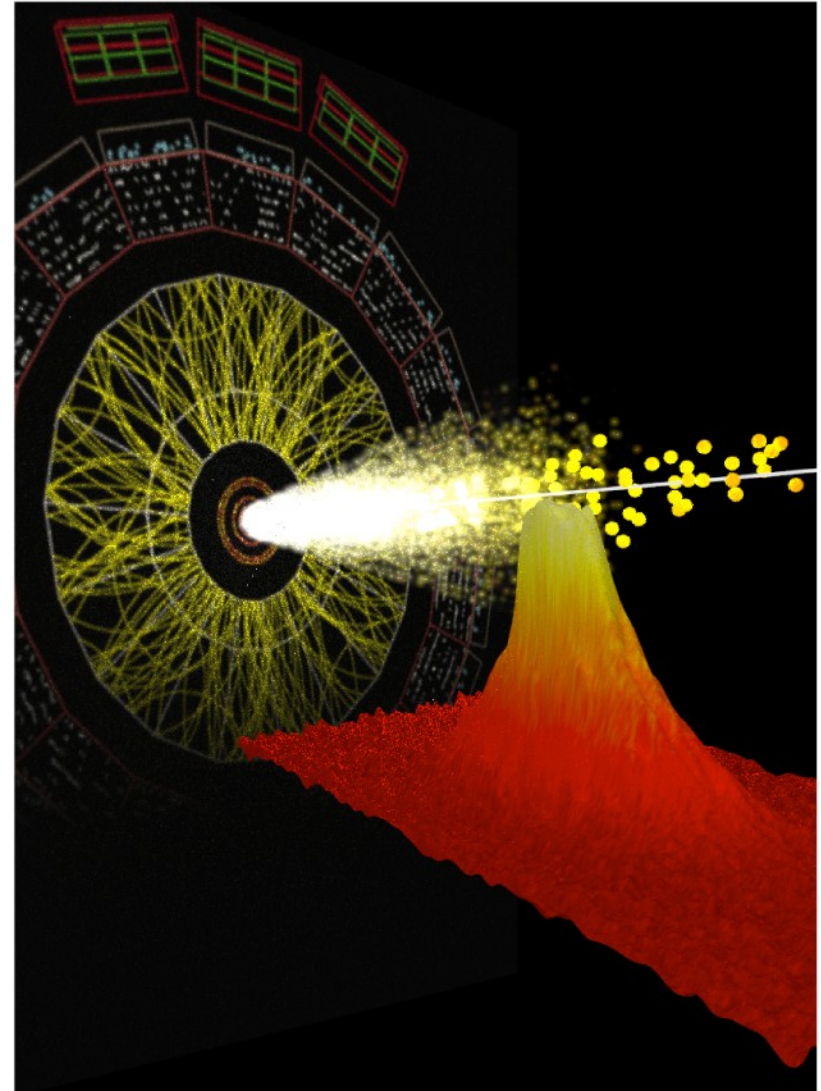
Raimond Snellings  
Professor, Subatomic Physics  
*Programme Leader*



Gerhard Blab  
UD, SCM & Biophysics  
*Programme Coordinator*



- the language is English.
- it is a full-time and takes 2 years (120 EC).
- the programme starts in September, starting in February is possible, but less than ideal.

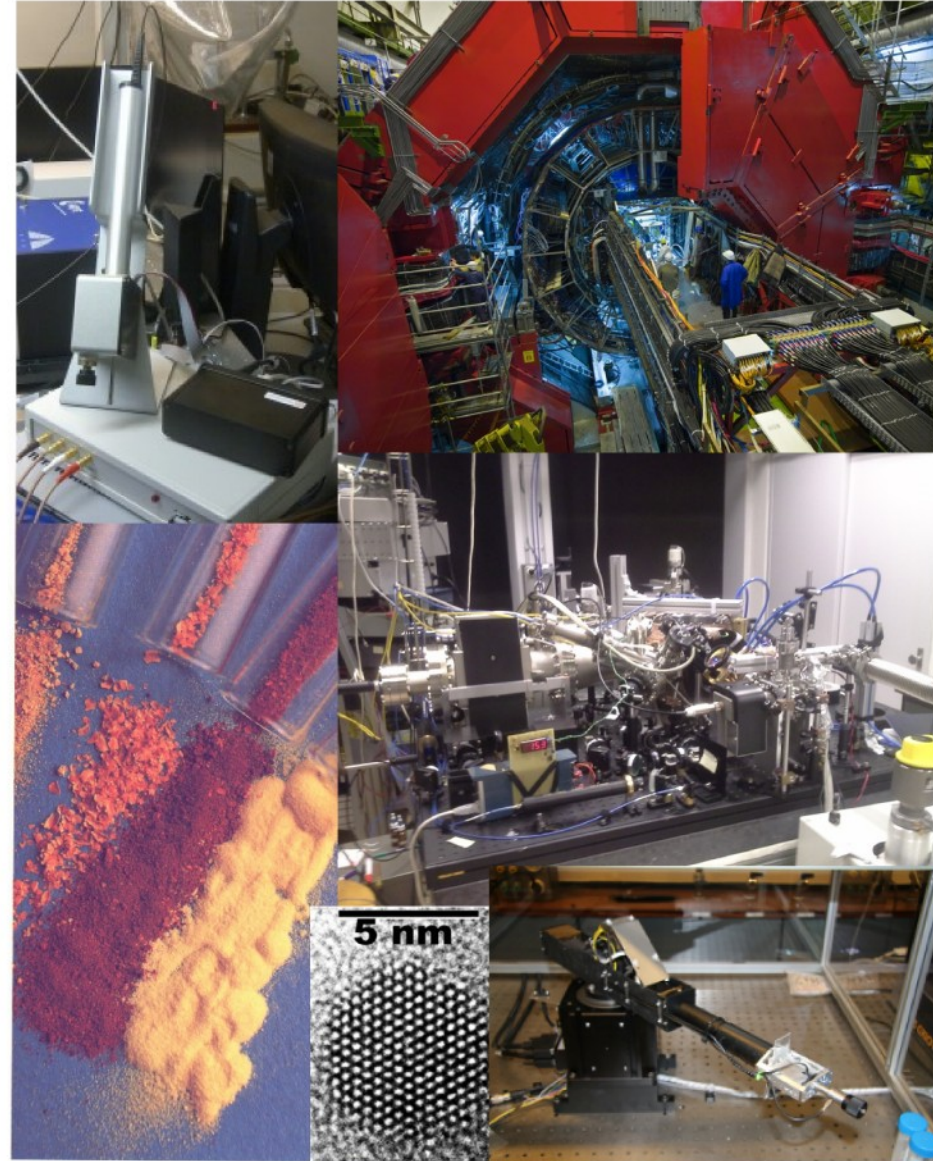






## Aim of the programme

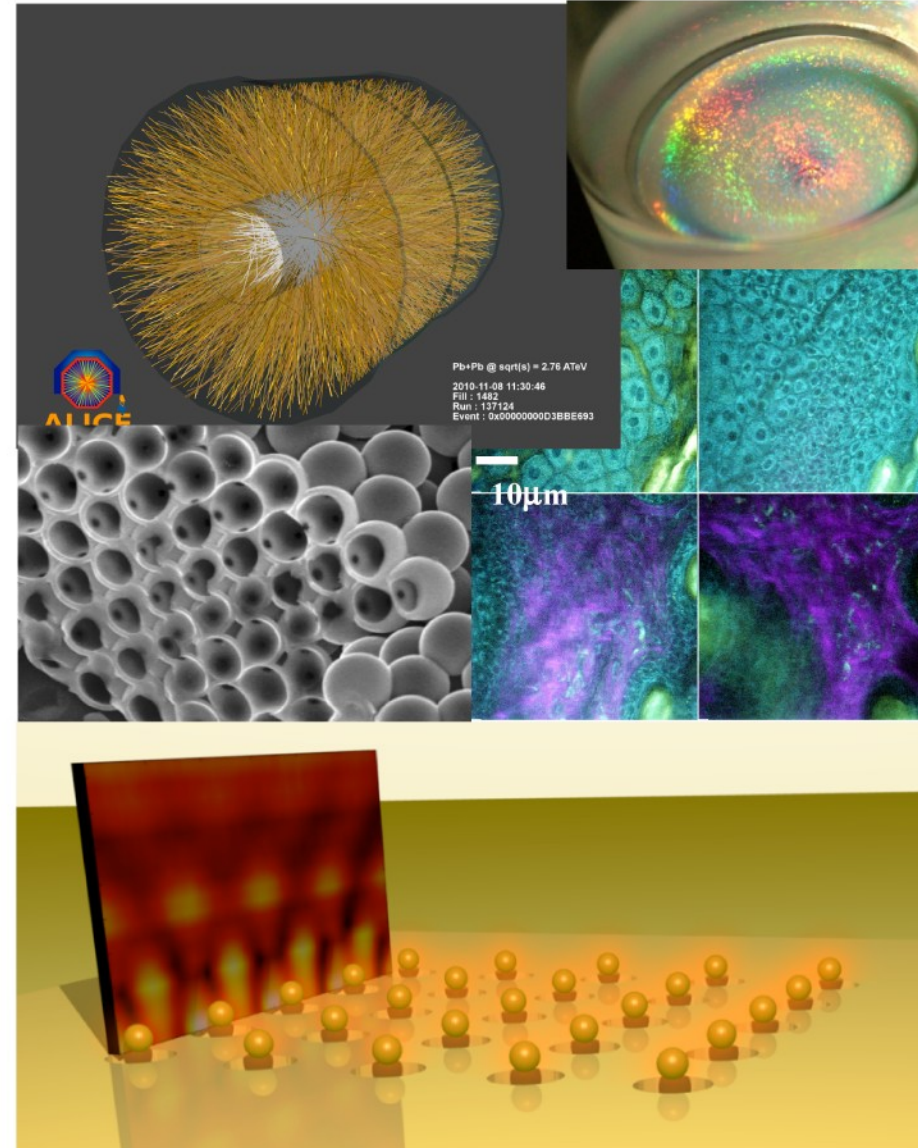
This master program offers courses with a **strong link to experimental research** carried out by research groups in the Department of Physics. The research undertaken at Utrecht is at the forefront of fundamental experimental physics. You will have the opportunity to work in close cooperation with research groups that specialize in colloidal physics, top-of-the-line integrated microscopy, the strong nuclear forces, Bose-Einstein or ultrafast light-matter interaction.





## Academic context

- Fundamental physics research:
  - What are the elementary building blocks of matter?
  - How do building blocks of matter interact, and how do those interaction scale?
  - How can you observe interactions at a (sub)molecular level?
  - How do light and matter interact?
  - What happens at the extremes of the temperature scale?
- You do not have to answer all those questions completely to get your degree!







## Organisation

- Experimental Physics is a Master in the Graduate School of Natural Sciences (GSNS) within the Faculty of Science (Bèta).
- The research is performed at Utrecht University in state of the art laboratories and in international collaborations at research centers in Europe (CERN), the EU (Nano-material safety) and the US. Nationally we cooperate in the Nikhef consortium:
  - **Nikhef:**
    - National institute for Particle and Astro-particle Physics,
    - Partners: FOM, RUN, UU, UvA, VU (contacts RUG, UL, UT)
    - Theory department
    - Detector development group, mechanical and electronics workshops
    - Staff: about 250, 125 scientific (80 PhD students)



# Programme structure

- **Core Mandatory Courses** (choose three out of 4, total 22.5 EC)
  - Particle Physics I
    - The standard model: fundamentals of modern particle physics  
In collaboration with UvA, VU  
Lectures: Monday and Wednesday, first block at Nikhef second at Utrecht
  - Photon Physics
    - Understand the interactions between light and matter
  - Experimental Quantum Physics
    - Understanding of the theory and experimental techniques in modern physics
  - Soft Condensed Matter Theory
    - Learn to interpret, describe, and predict the physical properties of soft matter, such as colloidal particles, polymers, or macromolecules.
- Electives (37.5 EC)
- Thesis Research Project (60 EC)



## Programme structure

- Core Mandatory Courses (choose three out of 4, total 22.5 EC)
- **Electives** (37.5 EC)
  - Primary Electives (22.5 EC)
    - The current list of primary electives can be found on the [UU master's page](#).
    - NIKHEF offers additional courses that count as primary electives.
  - Secondary Electives (15 EC)
    - You may chose from any master level course offered by GSNS.
    - *Please note: due to limited resources, some courses are offered every other year!*
  - There are currently two “**profiles**” (30 EC) available for students of Experimental Physics:
    - Profile Complex Systems
    - Educational Profile
- Thesis Research Project (60 EC)



## Programme structure

- Core Mandatory Courses (choose three out of 4, total 22.5 EC)
- Electives (37.5 EC)
- **Thesis Research Project** (60 EC)
  - Locally in groups or institutes at the UU:
    - Hard Condensed Matter or Nanophotonics
      - Particle Physics
      - Soft condensed Matter & Biophysics
      - or quasi-local: AMOLF, DIFFER, Nikhef,...
  - Externally at other universities or in a company, but also abroad (*e.g.* CERN) pending approval from the program coordinator.  
**NB:** you will always need two local staff members who are responsible for your thesis work)



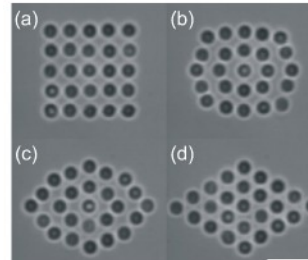
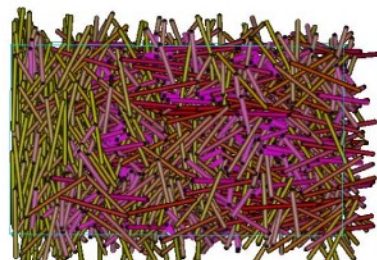
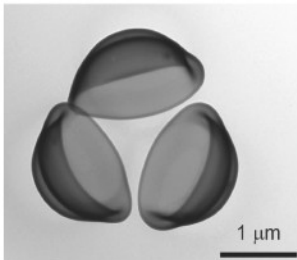
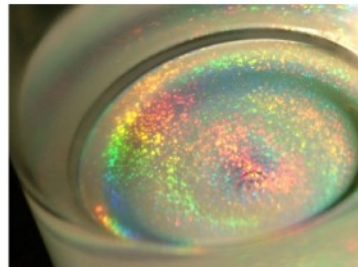
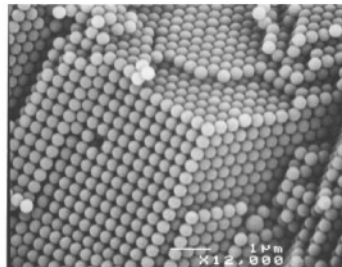
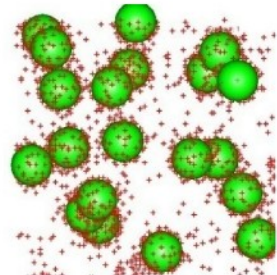
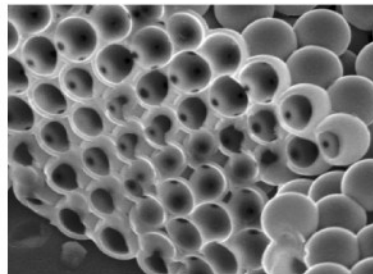
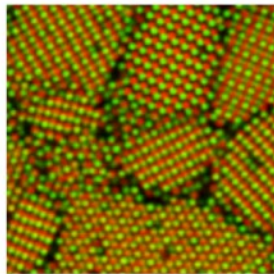
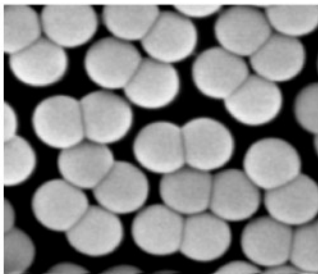


## More information?

- Attend a class (always a good start) and/or talk to the lecturer ...
- Check out the new master's student pages  
<http://students.uu.nl/en/science/experimental-physics>, or
- eMail us at [raimond.Snellings@cern.ch](mailto:raimond.Snellings@cern.ch) or [g.a.blab@uu.nl](mailto:g.a.blab@uu.nl).
- Call the International Office on (030) 253 7000  
or visit [www.uu.nl/qdesk](http://www.uu.nl/qdesk)



**Soft condensed matter** systems are materials which deform easily under the influence of external fields such as electric fields, shear, or gravity. They contain structures that are much larger than atomic or molecular dimensions. Their dynamics is governed by thermal fluctuations. We study the *physics of soft matter model systems* and, using these insights, *synthesize new micro-structured materials* from them.

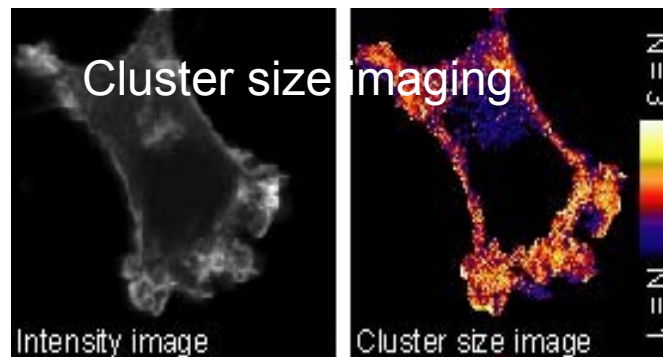
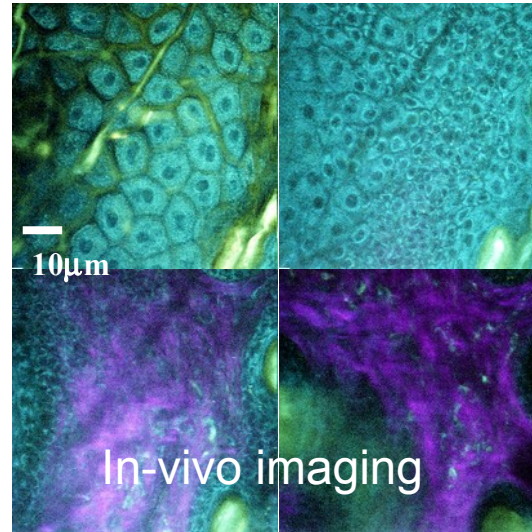
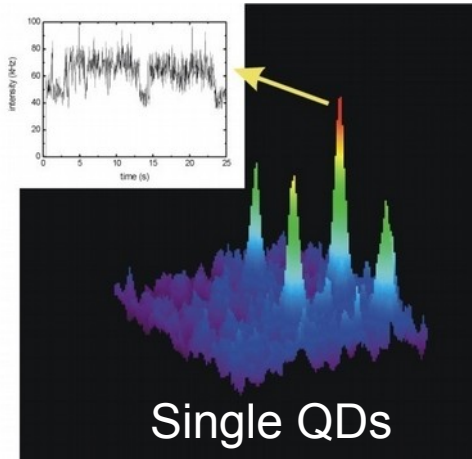


Synthesis of new colloids  
Photonic crystals  
Confocal microscopy  
Scattering & Diffraction  
**Computer simulations**  
Optical tweezers

more information:  
[www.colloid.nl](http://www.colloid.nl)



The **Molecular Biophysics** group works on the application and development of novel fluorescence based imaging methods that use advanced light sources, non-linear excitation methods and contrast based on fluorescence spectroscopy.



Confocal microscopy  
Single molecule microscopy  
Nanoparticle spectroscopy and microscopy  
Non-linear microscopy  
Imaging of molecular interactions  
In-vivo imaging



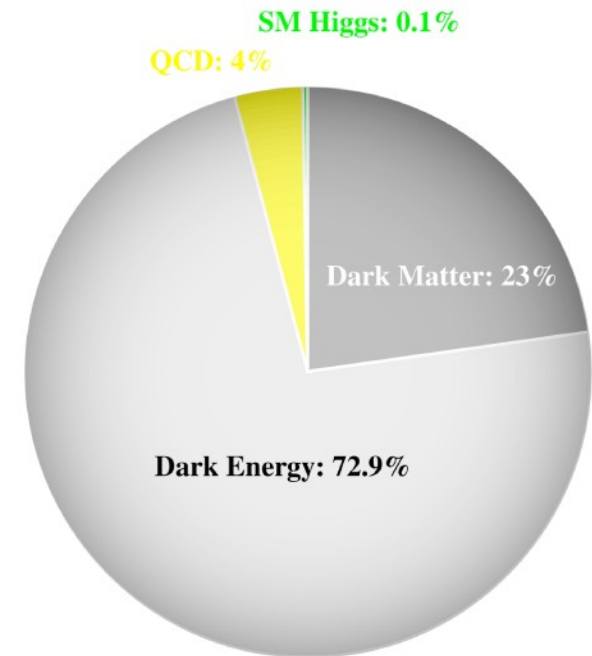
See:  
<http://www.biophysicsutrecht.nl>  
or <http://www.BlabLab.nl>



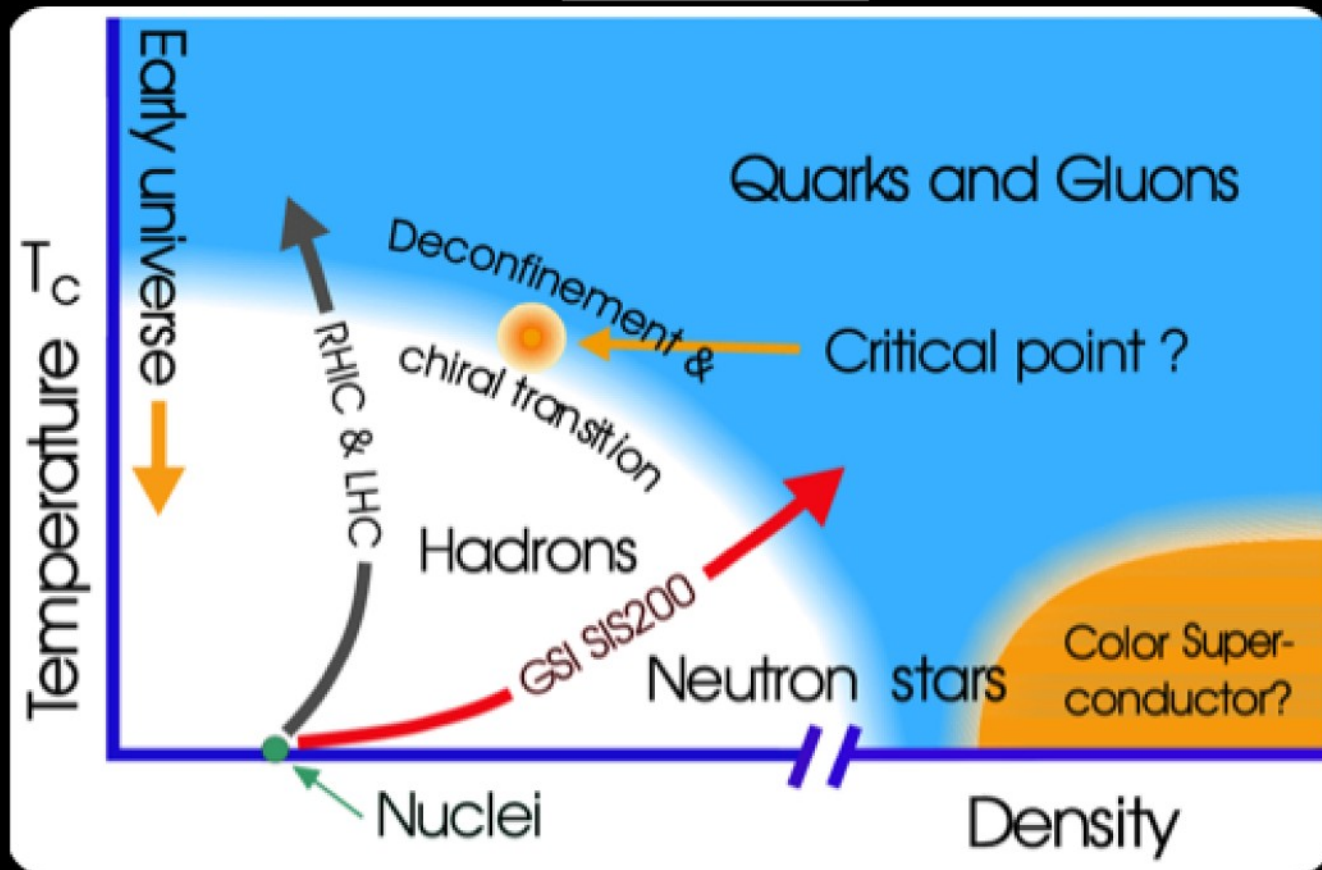


## Research in the SAP group at Utrecht?

- What is the universe made of?
- Elementary particles make up 0.1% of the mass of the universe
  - SM Higgs mechanism
- Composite particles (hadrons) can account for 4%
  - QCD chiral symmetry breaking
- Dark Matter 23%
- Dark Energy 72.9%
- The 4% are still not understood very well and the other 96% are a complete mystery!



# create matter at extreme conditions to understand non-perturbative QCD



Based on Krishna Rajagopal and Frank Wilczek: Handbook of QCD

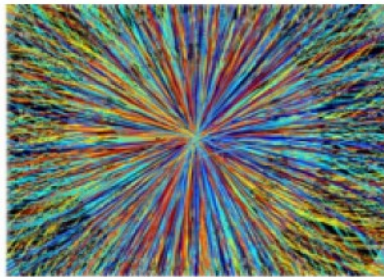


# The Large Hadron Collider

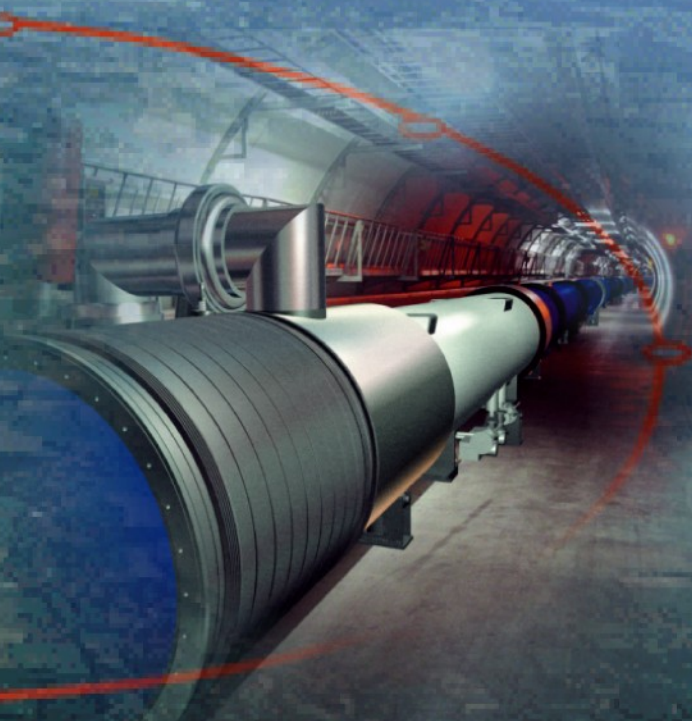
LHC now fully fledged heavy metal collider - physicsworld.com

## LHC now fully fledged heavy metal collider

Nov 8, 2010 [13 comments](#)



Courtesy: CERN









# The ultra-fast, the ultra small and the ultra cold

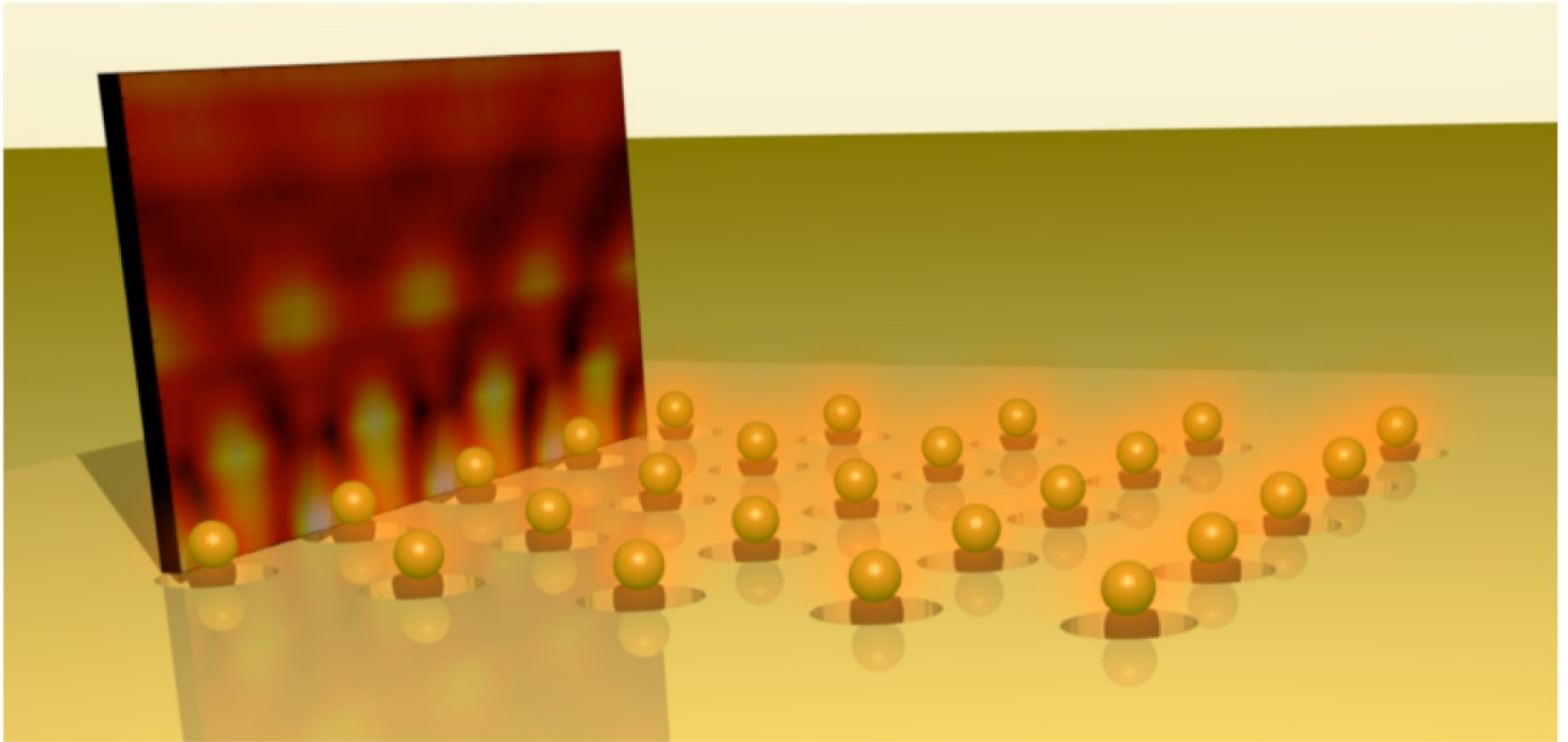


- Nanoplasmonics - Dr. D. van Oosten
- Bose-Einstein condensation - Prof. dr. P. van der Straten





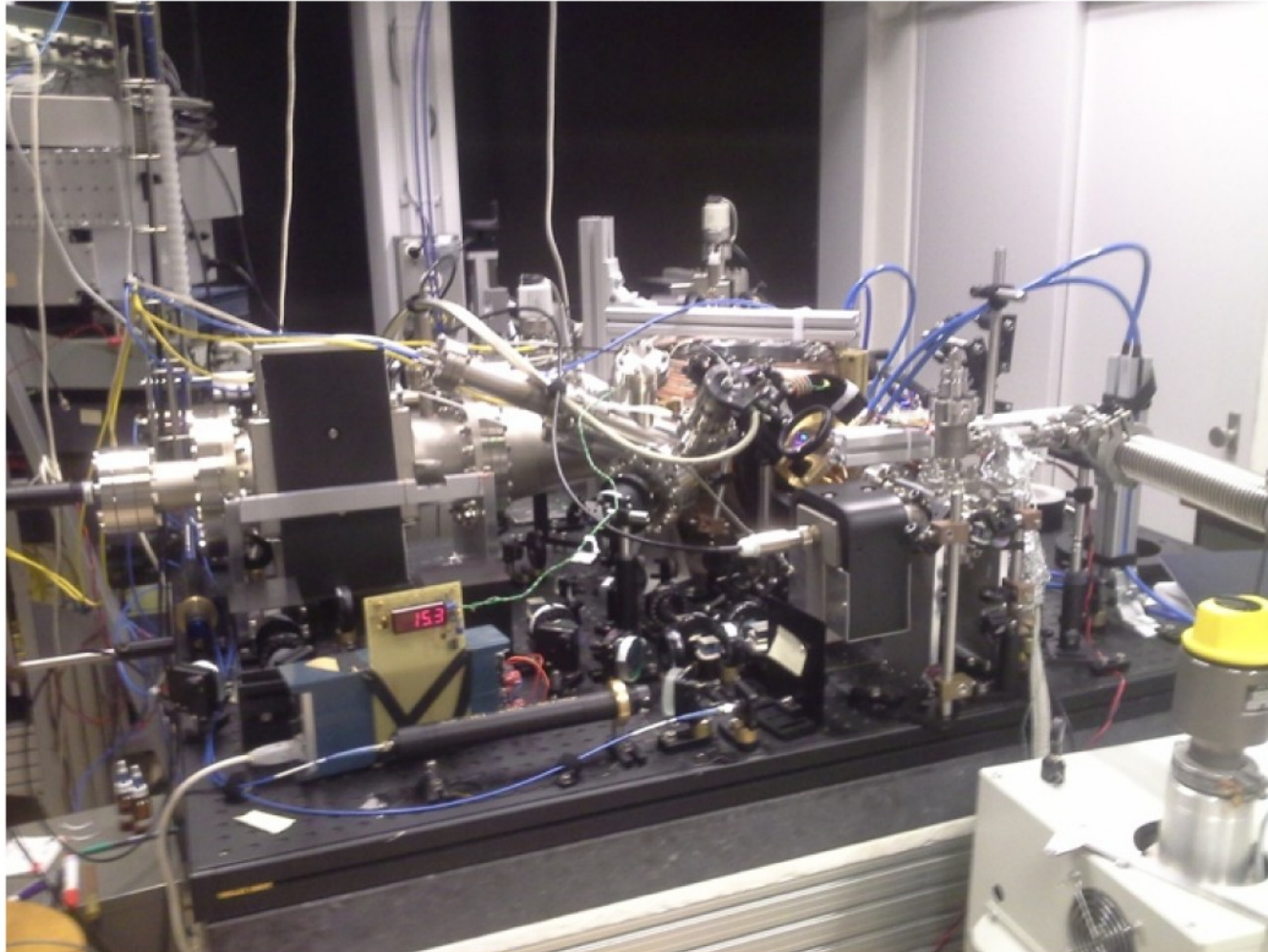
# Nanoplasmonics





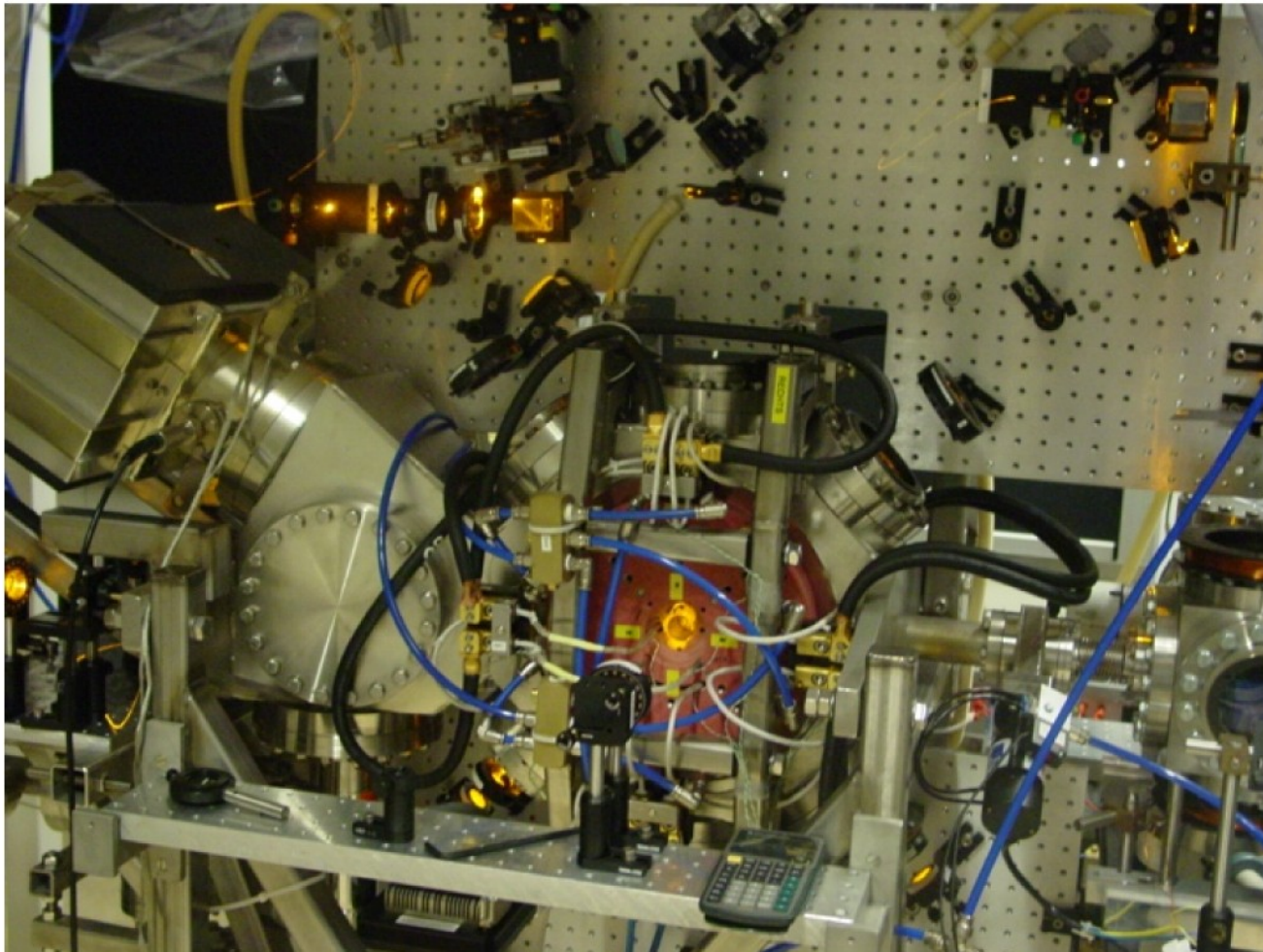


# Nanoplasmonics





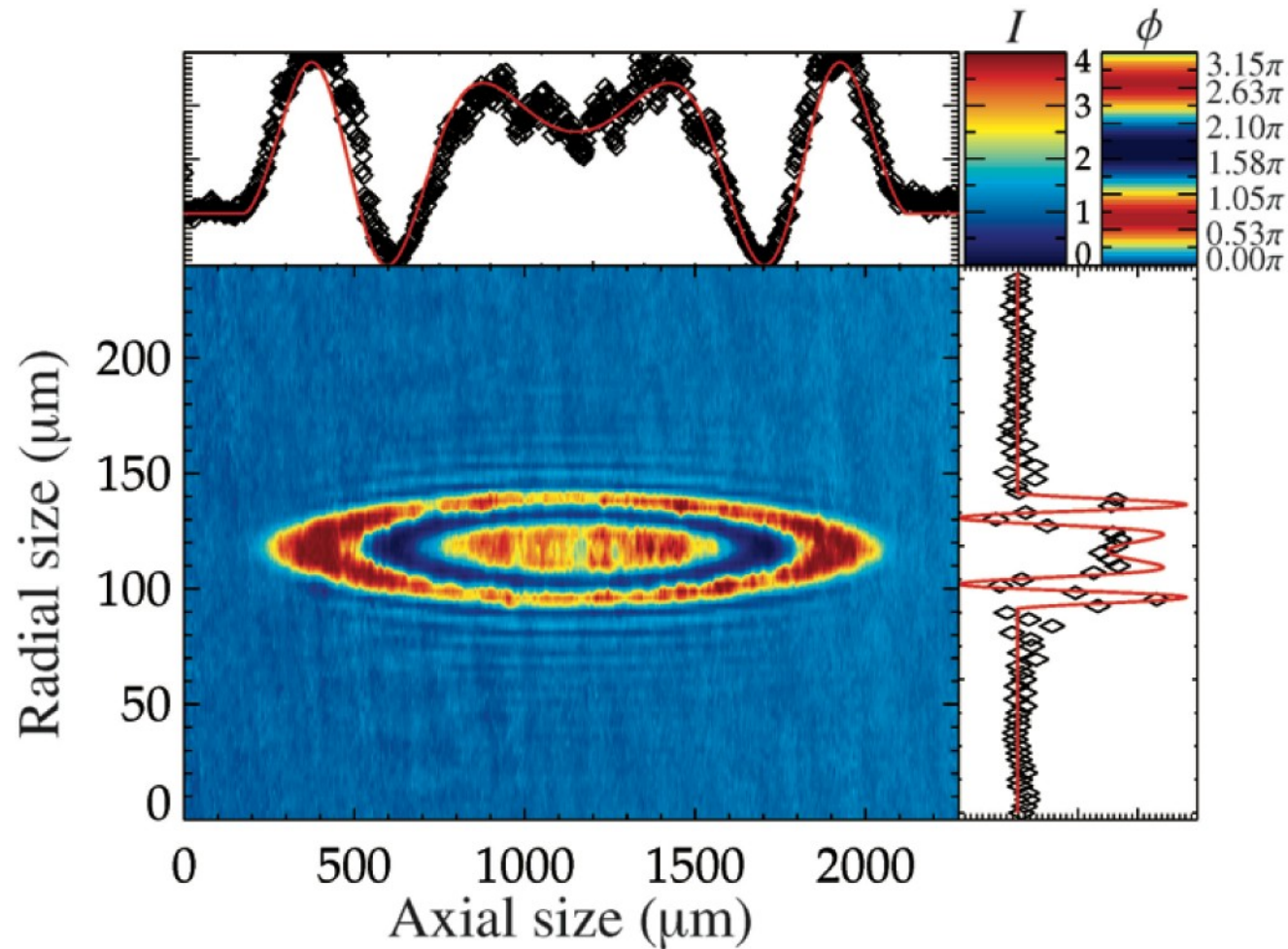
## Bose-Einstein condensation







## Phase contrast microscope







## Faraday waves in BEC

