Experimental Physics

Physics of Light and Matter

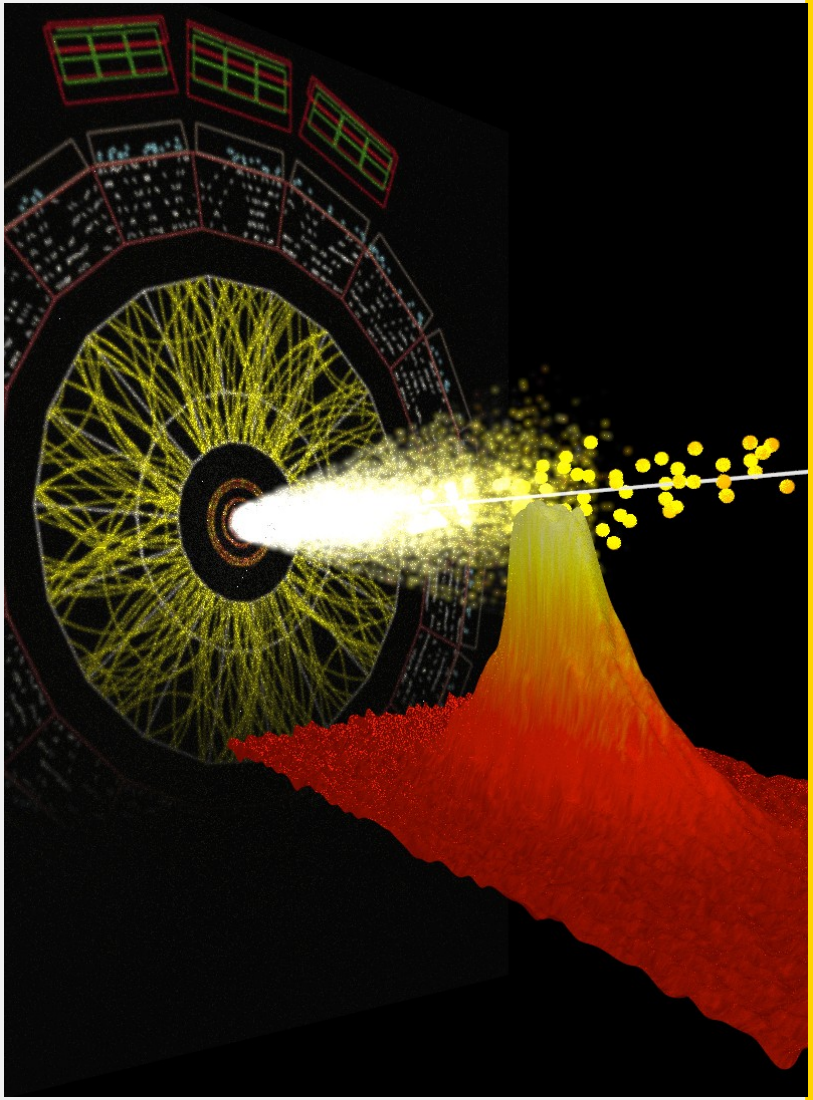
Some core facts about the programme:

- 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.



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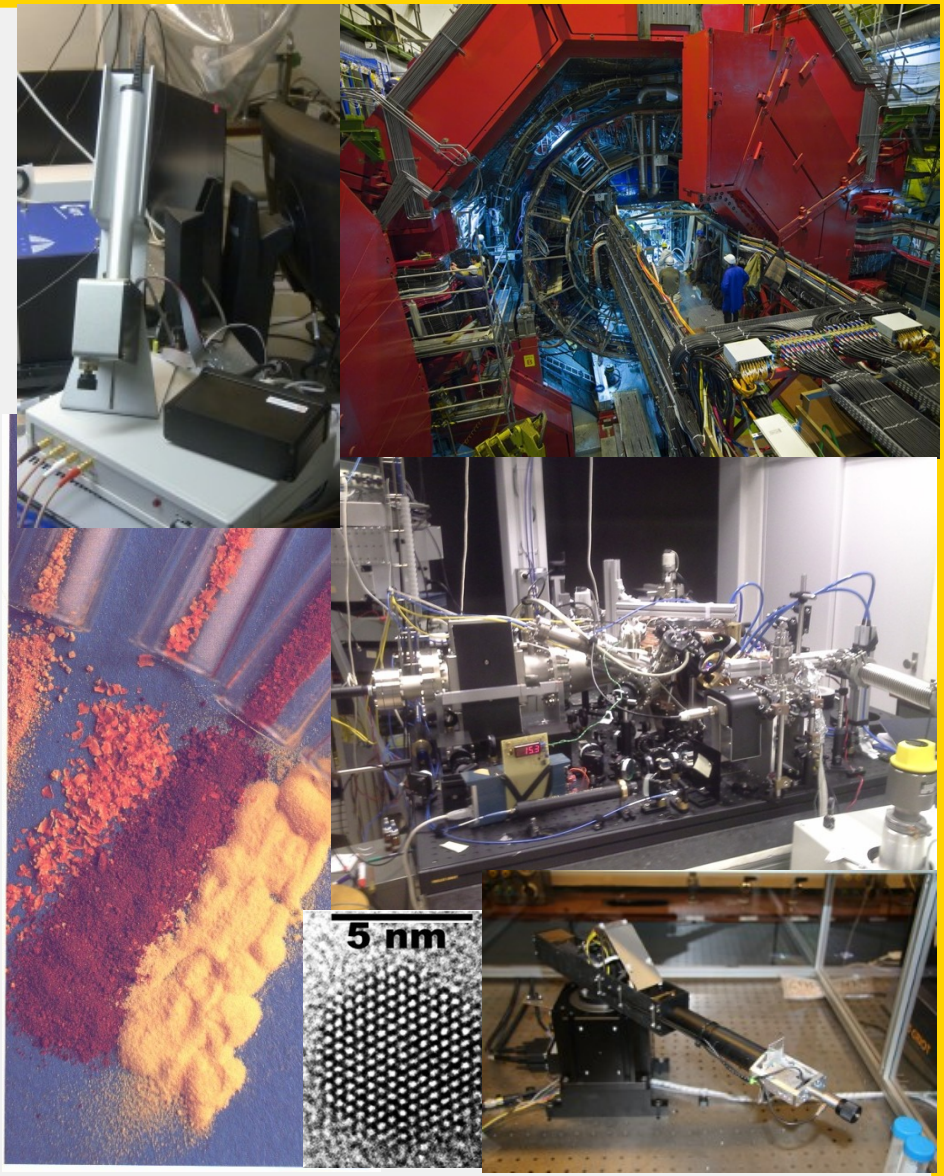
Aim of the programme

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.



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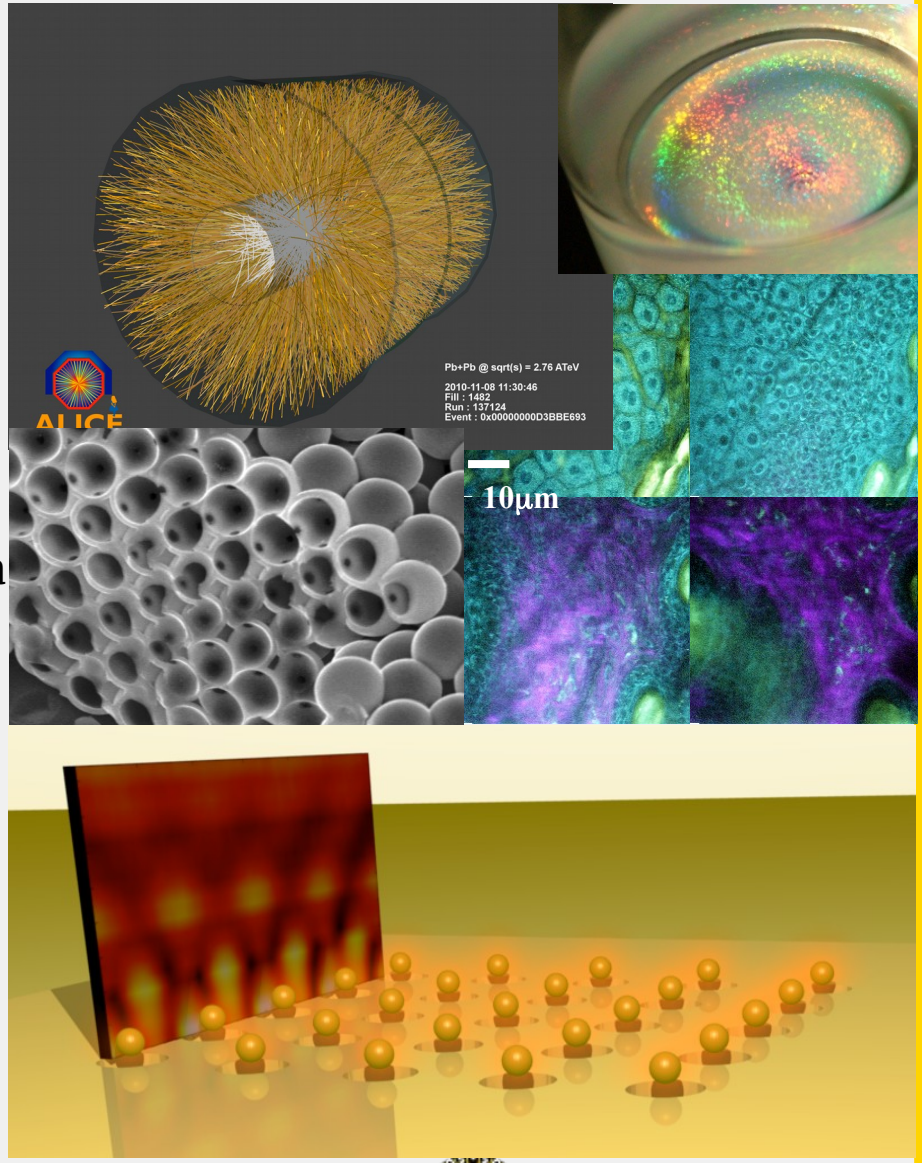
Academic context

- 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!



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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)

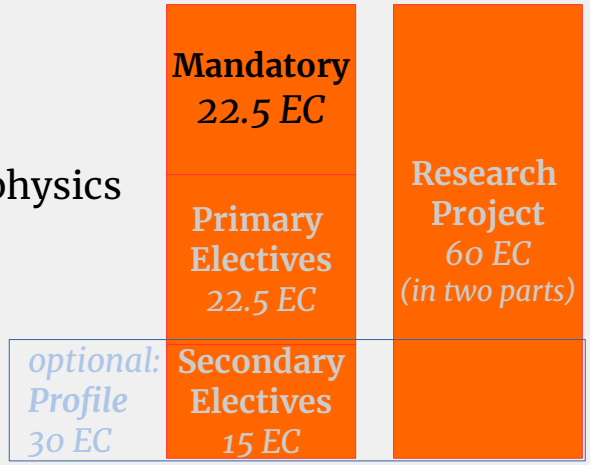
Programme structure

- **Core Mandatory Courses** (choose three out of 4)

  ✔ Introduction (0.5 EC) Dilemmas of the Scientist (0.5 EC)

  - **Particle Physics I**
    The standard model: fundamentals of modern particle physics
    In collaboration with UvA, VU Lectures
    Monday and Wednesday at Nikehf (Amsterdam)
  - **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)



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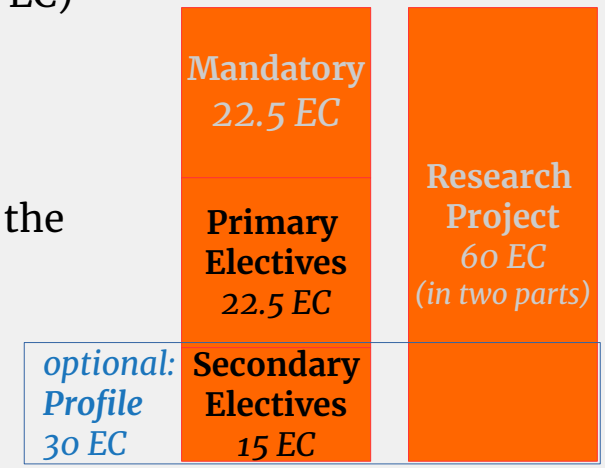
Programme structure

- 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 three **"profiles"** (30 EC) available for students of Experimental Physics:
    - Profile Complex Systems
    - Educational Profile
    - Applied Data Science Profile
- Thesis Research Project (60 EC)



Profiles can be done within the 120 EC of the programme:

15 EC from secondary electives and
15 EC from thesis research

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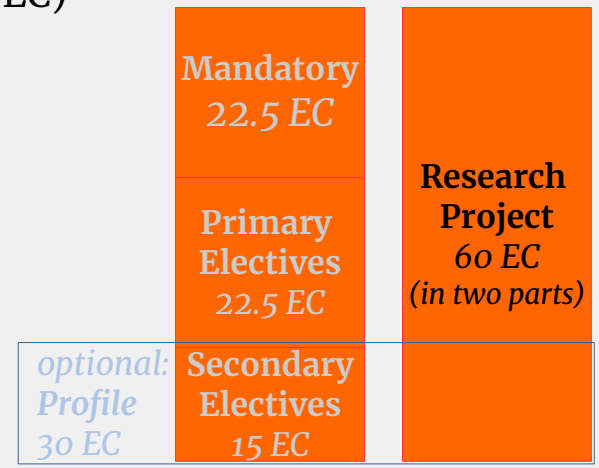
Programme structure

- 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 be examined by **two** local staff members who are responsible for your thesis work to ensure fair grading!



The research project is ...
- split in two parts of 15 EC and 45 EC,
- each part will be graded:
  - the first part pass/fail;
  - the second part with a **total grade** based on the **for the whole project**
- each part has to be finished on time!

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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 coordinator.exph@uu.nl.
- Call the International Office on (030) 253 7000
  or visit www.uu.nl/qdesk

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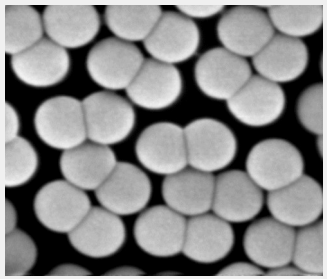
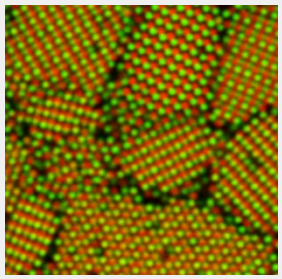
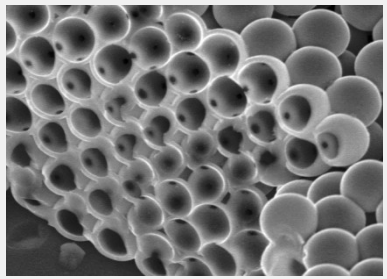
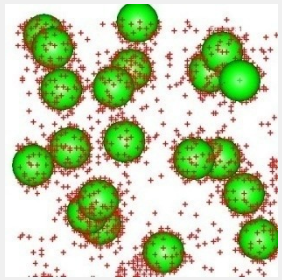
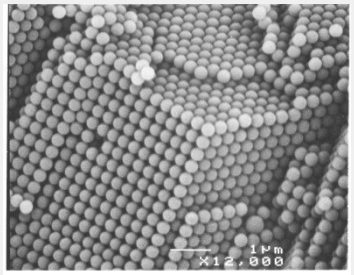
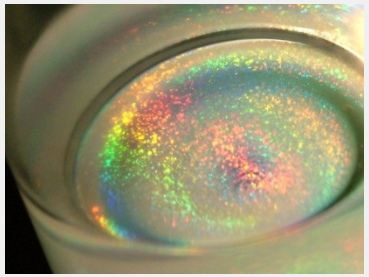
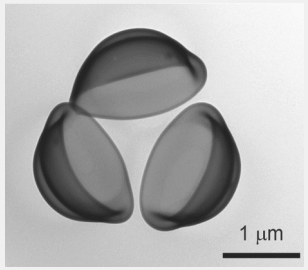
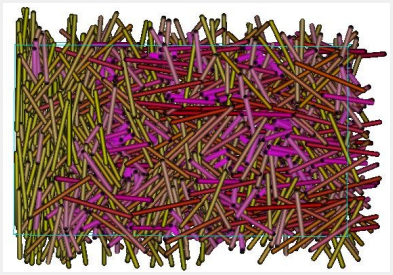
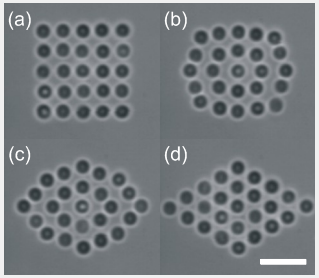
Soft condensed matter systems are materials which deform easily under the influence of external fields such as electric fields, shear, or gravity. They contain structures that are much larger than atomic or molecular dimensions. Their dynamics is governed by thermal fluctuations. We study the *physics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

Synthesis of new colloids

Photonic crystals

Confocal microscopy

Scattering & Diffraction

Computer simulations

Optical tweezers

more information:

www.colloid.nl

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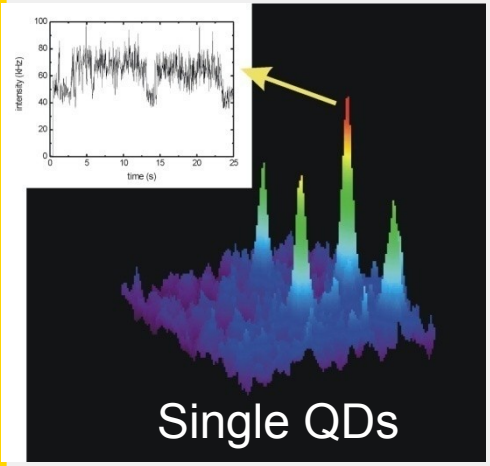
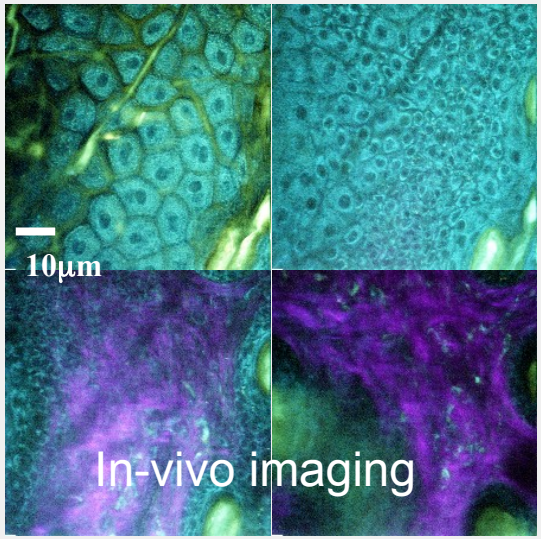
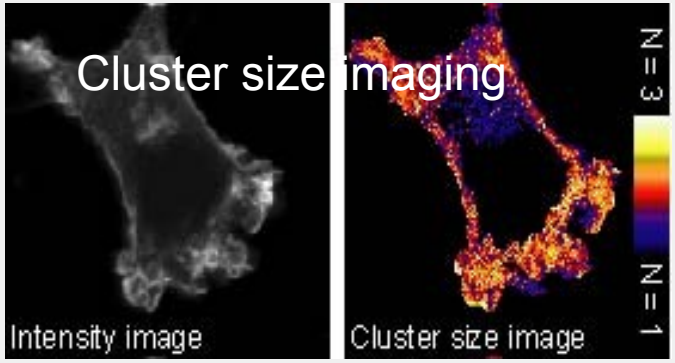
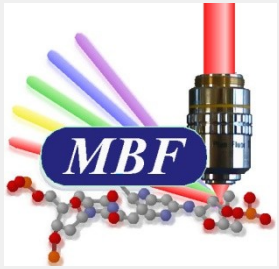
The Molecular Biophysics group works on the application and development of novel fluorescence based imaging methods that use advanced light sources, non-linear excitation methods and contrast based on fluorescence spectroscopy.





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





For more information, see:
http://www.biophysicsutrecht.nl
or http://www.BlabLab.nl

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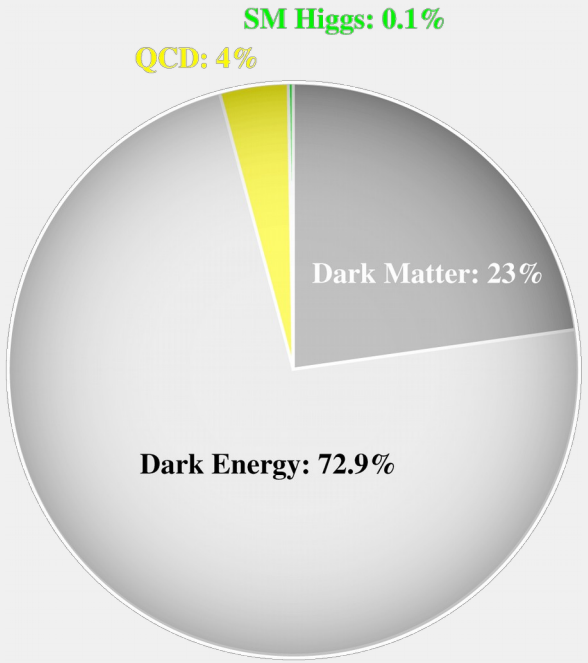
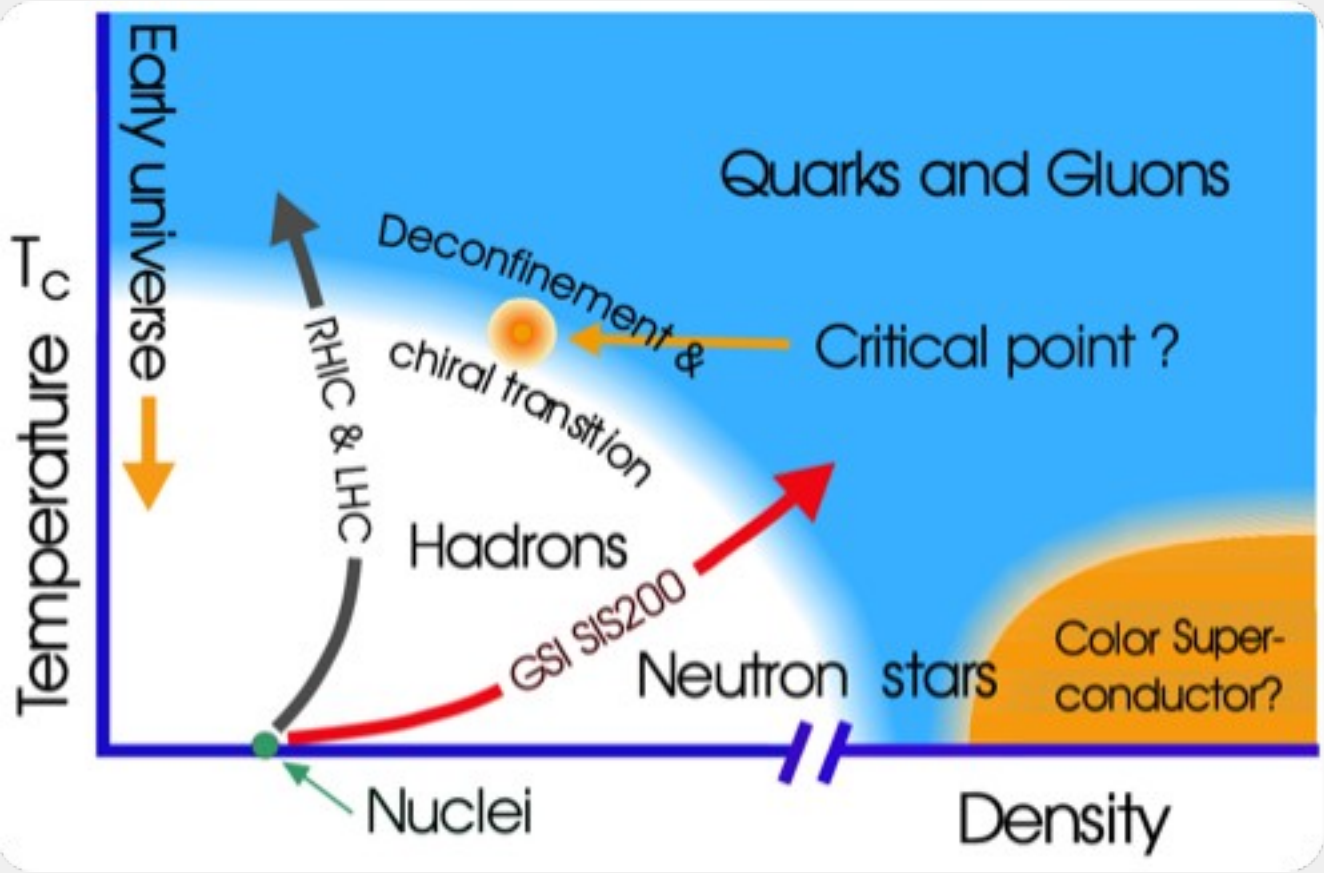
Research in the SAP group at Utrecht?

- 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

What happens when you heat and compress matter to very high temperatures and densities?



Based on Krishna Rajagopal and Frank Wilczek: Handbook of QCD

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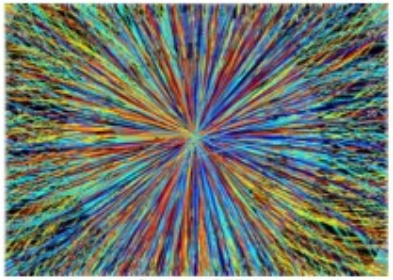
The Large Hadron Collider

LHC now fully fledged heavy metal collider – physicsworld.com

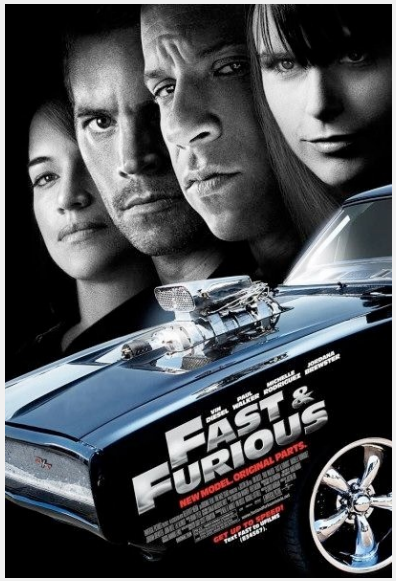
LHC now fully fledged heavy metal collider

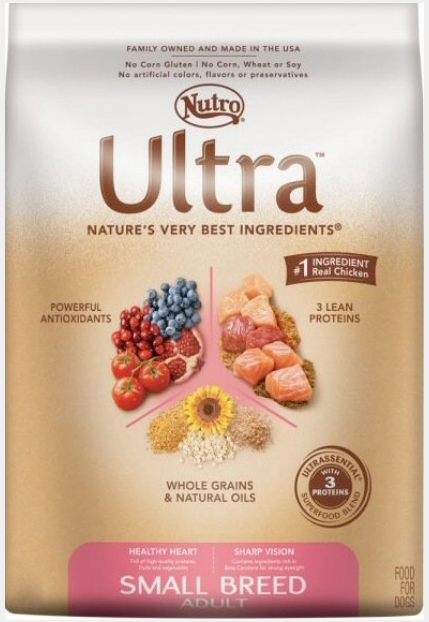
Nov 8, 2010 13 comments



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

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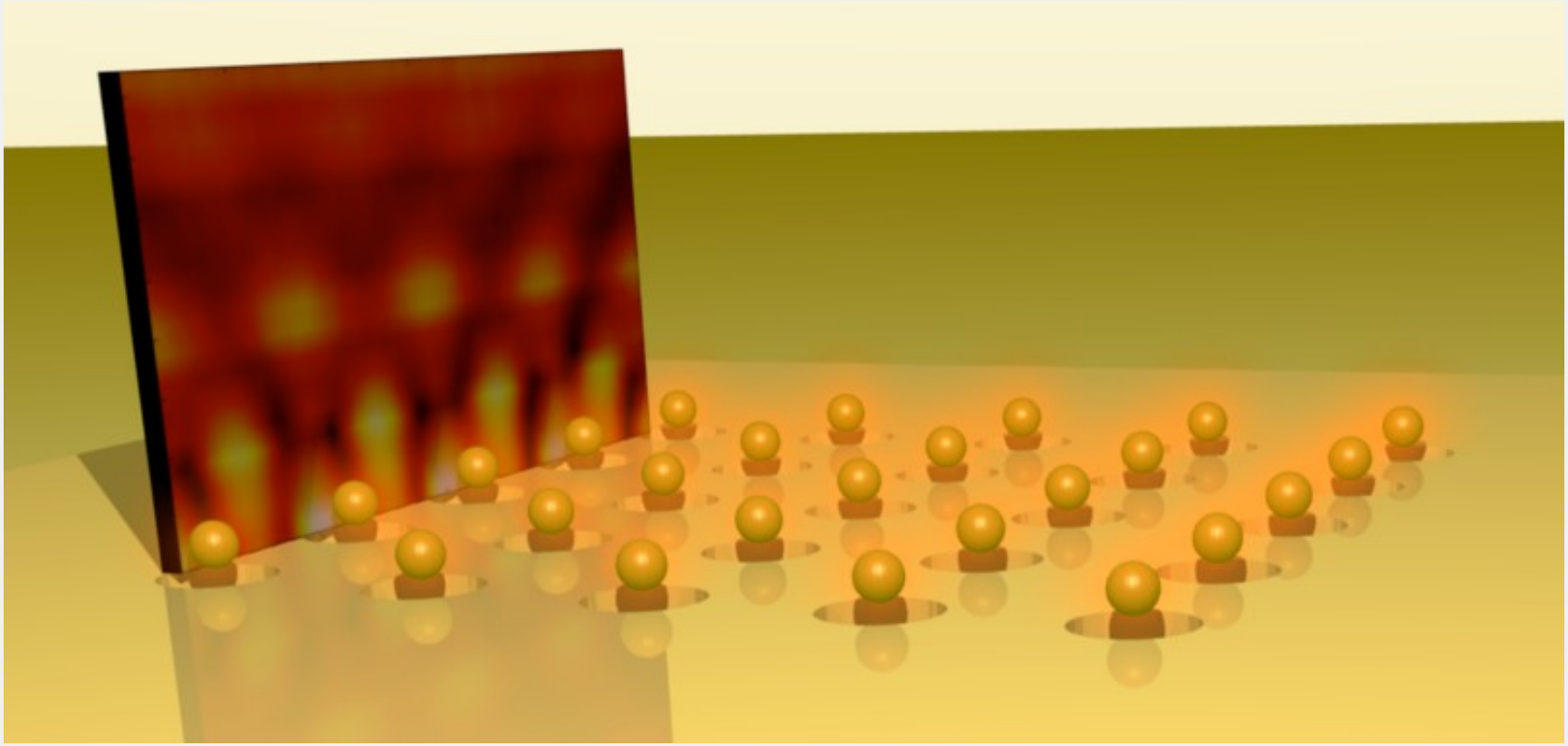
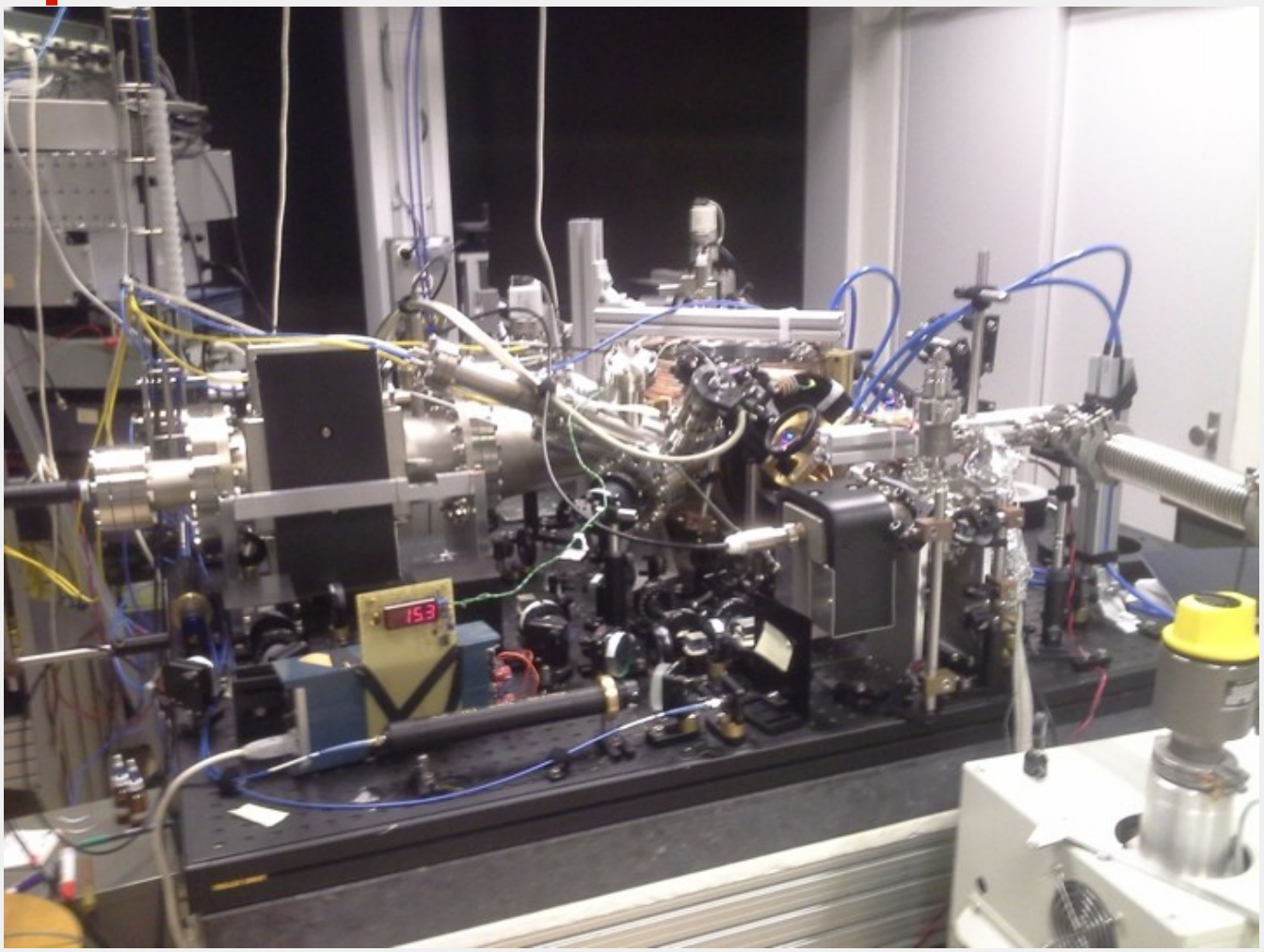
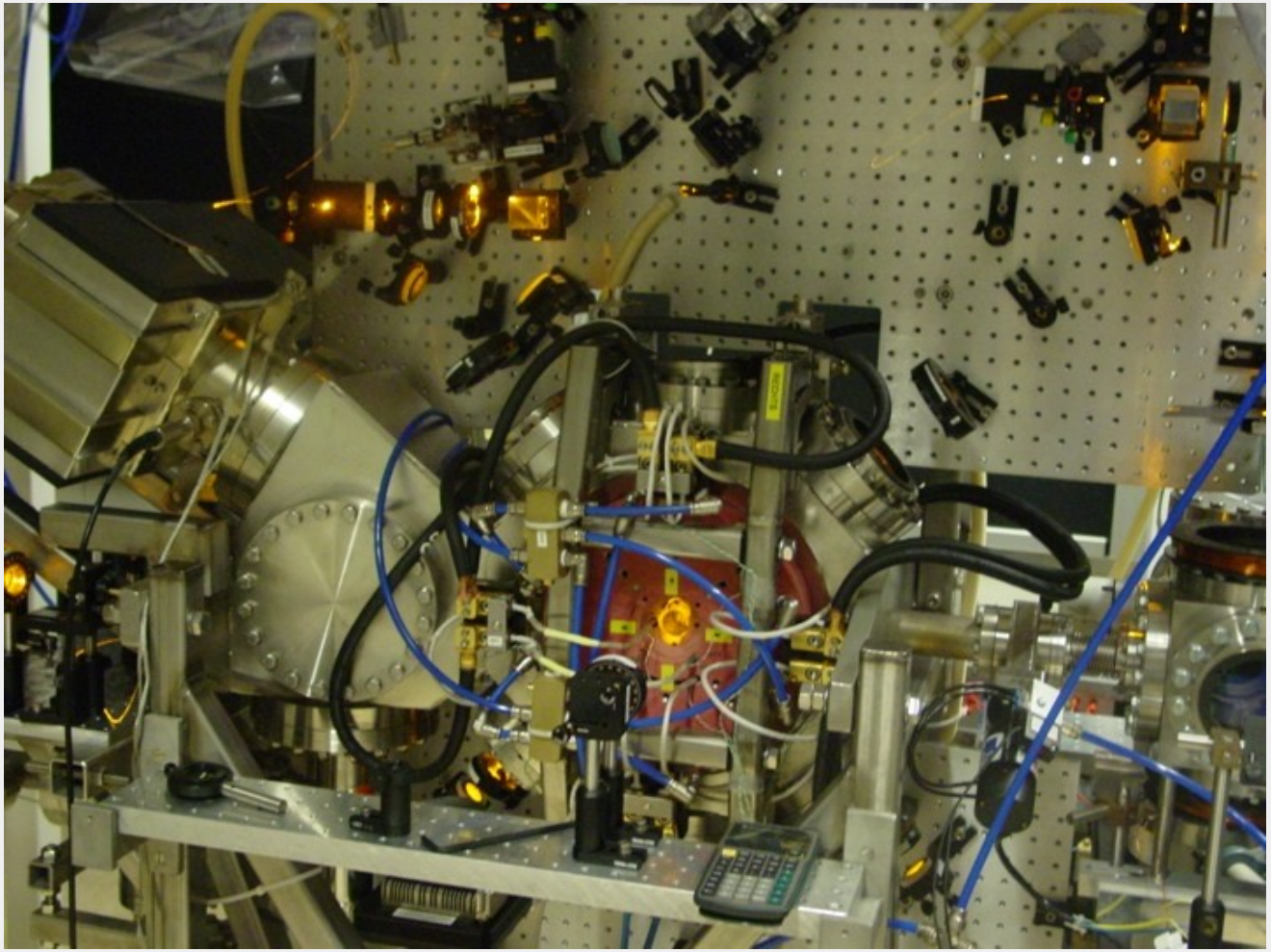
Nanoplasmonics



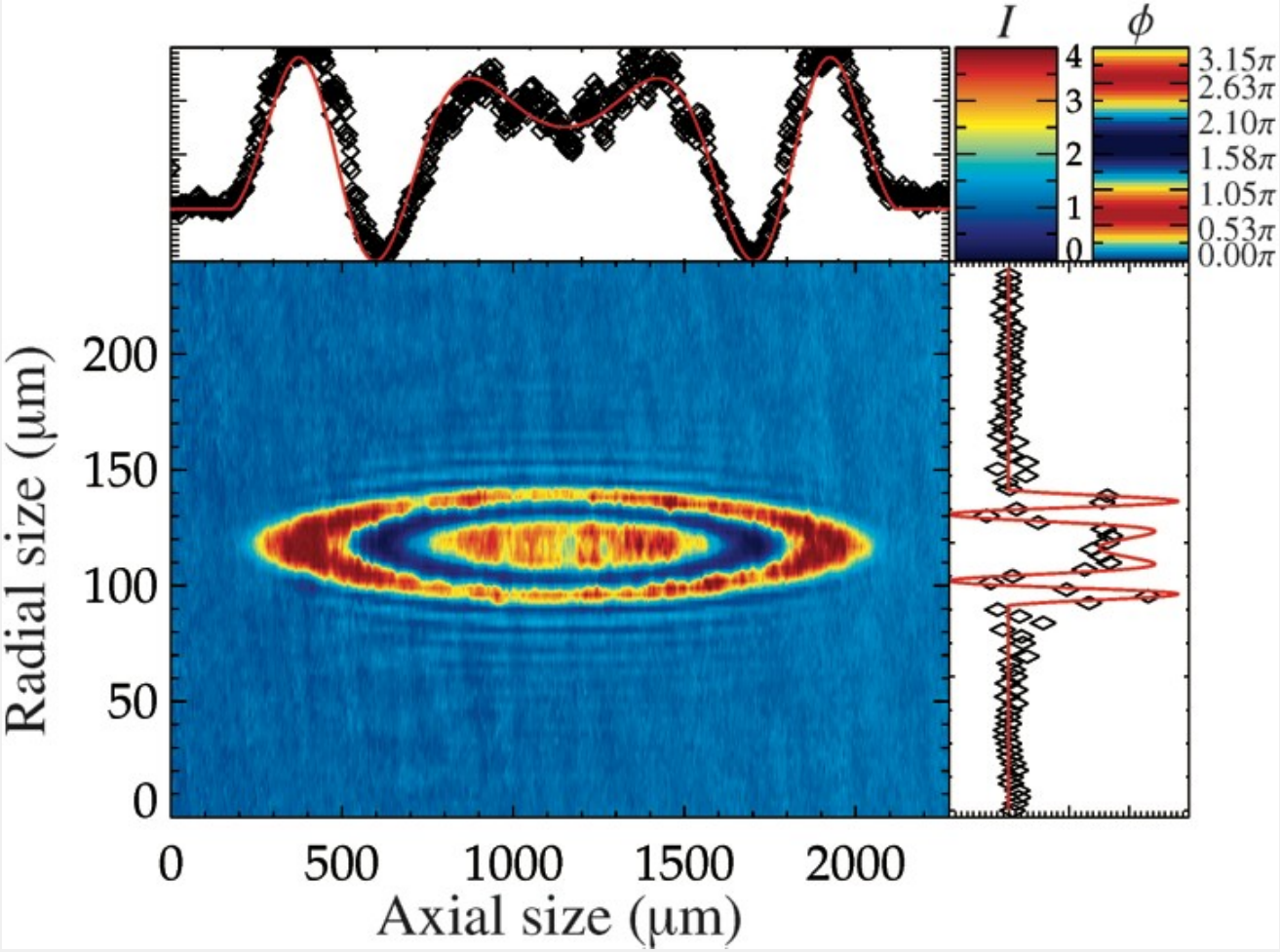
Nanoplasmonics



Bose-Einstein condensation



Phase contrast microscope



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Faraday waves in BEC