International cooperations

Europe is seeing the establishment of a significant research site at FAIR. One at which the worlds of science and education are able to network at international level, thus also fostering a global cultural exchange. More than 3,000 scientists and engineers from all over the world already work at FAIR.

Facility for Antiproton and Ion Research

The UNILAC and the SIS 18-ring of the existing facility (blue) serve as injectors for the new facilities of the FAIR complex (red), such as the SIS 100/300 accelerator rings (double synchrotron), the super fragment separator, the storage rings and the various experimental areas.

Realization of the facility

FAIR is being constructed in several stages. The modularized start version is being financed by Germany together with partner states and costs more than 1 billion euros (price level 2005). Additional partial systems are still being researched and developed, and still have to be financed. The start version in itself, however, does allow all the FAIR scientific collaborations to conduct unique research and offers considerable potential for ground-breaking discoveries.

More than 3,000 scientists from about 50 countries in Europe and overseas will use the facility for their experiments.

Contact:
FAIR – Facility for Antiproton and Ion Research in Europe GmbH
Planckstr. 1
64291 Darmstadt
Germany

VAT-ID: DE 275 595 927
Commercial Registry, District Court Darmstadt, HRB 88372
Phone: +49 6159 71 1877
Fax: +49 6159 71 3916
E-mail: publicrelations@fair-center.eu
Web: www.fair-center.eu
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What happens in the interior of planets?
Protons and neutrons in the atomic nuclei are called hadrons. Their building blocks are quarks, which are kept together by the strong force. Gluons, which take their name from the word „glue“, are identified as mediators of the strong force.

Questions to be solved:
- How do quarks interact?
- Which combinations of quarks exist?
- Why are hadrons heavier than the sum of the masses of their constituents?

Experiments at FAIR in the fields of hadron and nuclear physics such as PANDA (antiProton ANihilation at DArmstadt) with high precision antiproton beams will help to find answers.

Key questions are:
- To what extent can nuclear matter be compressed?
- At which densities and temperatures will hadrons dissolve into quarks and gluons?

In the laboratory, nuclear matter can be heated and compressed via high-energy nucleus-nucleus collisions. A detector for measuring particles emerging from this extremely hot and dense matter (CBM-Compressed Baryonic Matter) will help to tackle these fundamental questions.

What are the properties of nuclear matter?
The cores of neutron stars contain - as was also the case in the early universe - matter at extreme energy densities. Here quarks and gluons are not expected to be confined in hadrons but to move freely in a so-called quark-gluon plasma.

What holds the world together?

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How are the heavy elements made?
The NUSTAR facility at FAIR

It is assumed that chemical elements heavier than iron originate from collapsing stars or stellar collisions. The underlying processes depend on the nuclear forces and symmetries in rare isotopes.

To investigate the Nuclear Structure, Astrophysics und Reactions (NUSTAR) with intensive secondary beams of such rare isotopes experiments using the Super-Fragment-Separator (FRS) and a series of complimentary detector set-ups are foreseen. They should clarify relevant details of the nuclear configuration of the various isotopes. In addition, a better understanding of the abundance of the heavy elements, new knowledge about the interior of neutron stars and other unsolved astrophysical puzzles are expected.

Atomic, Plasma and Applied Physics at FAIR

Physicists call the fourth state of aggregation plasma. This is a gas made of electrically charged particles.

Hot plasmas at low pressure are already well-known. Plasmas at high pressure and low temperatures as they exist in the interior of large planets, for example, still require investigation on a wider scale, however. Plasma physics experiments at FAIR will provide the latest findings in this field.

The heavy ions available at FAIR will also be used to investigate the impact of cosmic radiation on inter-planetary flights for both astronauts and spacecraft components.

Ultra-strong electromagnetic fields occur in highly-charged heavy ions and can be further increased in experiments with fast heavy ions passing each other. The new project will open up unique opportunities for these areas of research and for quantum electrodynamics tests at ultra-strong fields.

The PANDA detector at FAIR

The CBM detector at FAIR

The NUSTAR facility at FAIR

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