GSI - FAIR Colloquium

Main Lecture Hall (SB1 1.120), 64291 Darmstadt, Planckstraße 1

Tuesday, May 31, 2016
16:30 Uhr (Tee ab 16:00)

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Tokamak and Stellarator – the two concepts of magnetic confinement

Nuclear fusion could play a major role in the energy mix during the second half of this century. The advantages of nuclear fusion, in particular for base load power stations, are obvious: the fuel is nearly unlimited and widely available, and - in contrast to fission - there is no possibility of a runaway reaction or meltdown.

For a fusion reactor, matter has to be heated up to extremely high temperatures: more than 100 million degrees - about a factor of 10 hotter than the sun's core. At these temperatures the material is fully ionized. The charged particles can be confined by magnetic fields, which are also able to provide the required efficient heat insulation. For magnetic fusion reactions to be self-sustaining, the thermal insulation has to be a factor of 100 better than that of polystyrene - at temperatures, where the velocity of particles approaches one fifth of the velocity of light!

After more than 50 years of research, fusion has advanced to the decisive step on the way to a power plant: the international tokamak experiment ITER is designed to demonstrate the feasibility of net energy production from nuclear fusion reactions. In a joint enterprise by 7 partners (the EU, Japan, Russia, USA, China, the Korean Republic and India) - ITER is currently been built in Cadarache, France.

The tokamak concept as realized in ITER is by far the most advanced confinement configuration. It however requires the continuous flow of an electric current in a donut-shaped plasma. In present devices this plasma current is driven by a transformer, and can therefore be maintained only over a certain time, which – in a reactor – could amount to some hours. A thermal storage would provide for continuity of the electric power production during the short time interval needed to recharge the transformer.

An alternative to the tokamak is the stellarator, which has a considerably more complex magnetic configuration, but is intrinsically stationary without any need of external current drive. The complex magnetic field of a stellarator requires careful optimization to ensure sufficiently good confinement properties. The first optimized stellarator of sufficient size to proof that the stellarator concept has the potential for a power plant, Wendelstein 7-X, has recently been built up in Greifswald, Germany. It has recently started plasma operation.

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