Fusion and the physics behind magnetic confinement

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Fusion — the energy source of the sun and the stars, is one non-fossil option as a future energy source, which offers the prospect of meeting the requirements of operational safety, environmental compatibility and sustainability. A short introduction into fusion and the concept of a fusion power plant will be given.

My lectrue will mostly deal with the major physics aspects of two toroidal magnetic confinement concepts — the tokamak and the stellarator. Many tokamaks are in operation or newly built in the Asian fusion programme e.g. JT-60 U in Japan, KSTAR in Korea, EAST in Rep. of China, SST-1 in India; a large stellarator with superconducting coils, LHD, is operated in Japan.

A major next step in the tokamak development is the realisation of ITER in Europe as a joint project of 7 partners. ITER will be the first fusion device to produce energy in a larger scale. The next stellarator device in Europe is Wendelstein7-X under construction in Greifswald, Germany.

The alternative physics characteristics of these two concepts of magnetic confinement — tokamaks and stellarators, their advantages and disadvantage and their complementarities will be presented. The major physics topics to be discussed are confinement properties determined by collisional and turbulent transport processes, aspects of self-organisation in the dynamical behaviour of the plasma and the role of dimensionality for confinement.

The present status of fusion research will be summarized.