Polarized Fusion
Can polarization help to increase the energy output of fusion reactors?

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The option to use polarized fuel for coming fusion reactors is discussed since many years [1]. For example, the total cross section of the fusion reactions $d + t \rightarrow {}^4He + n$ or ${}^3He + d \rightarrow {}^4He + n$ is increased by a factor of about 1.5, if the spins of both incoming particles are aligned. This can be used to increase the energy gain up to a factor 10, depending on the design of the different reactor types. In addition, the differential cross section is not uniform any more which allows a more simpler design of the plasma cooling. But before polarized fuel can be used for energy production, a number of questions must be answered. In this talk an overview on various activities in this field of research will be given:

1. Compared to the above mentioned reactions the d-d fusion reactions are more complicated. Up to now the influence on the differential and the total cross section for the double-polarized case is theoreticaly predicted but never proofed. In a collaboration between the PNPI in Gatchina, Russia, the University of Ferrara, Italy, and the FZ Jülich, Germany, the spin-dependence of the d-d fusion reactions will be measured with a polarized deuteron beam at energies below 100 keV on a polarized deuterium jet target.

2. Beside the magnetic confinement fusion inertial fusion with laser heating is tested at several experiments. One of the important questions here is the lifetime of the polarization of the primary particles in the induced laser plasma. In collaboration between the University of Düsseldorf and the FZ Jülich it will be tested to accelerate polarized ${}^3He^{2+}$ ions from a polarized ${}^3He$ gas jet with the laser beam. If the polarization of the ${}^3He$ atoms will survive in the ions the feasibility of ongoing experiments is shown.

3. When polarized fusion might be a reasonable option for energy production than the question of polarized fuel production will become important. This problem is solved for ${}^3He$ and seems to be within reach for tritium. But for deuterium the situation is unclear. One option might be the production and storage of polarized D_2 molecules which was investigated in the last years in FZ Jülich.

References

[1] H. Paetz gen. Schieck, Eur. Phys. J. A **44**, 321 (2010).