THE GOOD, THE BAD AND THE UGLY IN FUSION ENERGY

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In a magnetic confinement fusion reactor, such as a tokamak, there are a number of highly energetic particle species, which require special consideration. These are fast ions, runaway electrons and fast neutrons.

Fast ions have an important role in thermonuclear fusion. They are good in the sense that they contribute to plasma heating, thus helping maintain the necessary conditions for fusion reactions [1]. The sources for fast ions are the fusion reactions themselves and auxiliary heating. Proper confinement of these ions is essential for a successful fusion reactor.

Tokamak plasmas are not inherently stable, but may disrupt and cause the bulk plasma to suddenly cool down [2]. Somewhat counter-intuitively, this can allow some electrons to reach very high, even relativistic, energies (1-100 MeV). These so called runaway electrons grow avalanche-like in number and can cause serious damage if a fully developed runaway beam gets diverted to material structures. To avoid such incidents, it is crucial to understand how these mischievous runaways are born.

Fast neutrons, born in fusion reactions, carry most of the energy released in the reaction and are useful in transporting the energy to the coolant [3]. However, they can also cause activation of wall materials. Therefore, it is important to understand how they behave and how their ugly negative effects can be minimized.

Fusion energy research is entering an era where experiments will operate on the threshold of a full scale fusion reactor. Therefore, it is increasingly important to understand the behaviour of all these high energy species in the plasma. This can be pursued using simulation codes, such as the Monte Carlo based ASCOT code. Here we review the possibilities and challenges that fast particles pose and how ASCOT is used to tackle these issues.

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