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Modelling γ-spectrum from d-t collisions: potential for industrial applications

Motivated by possible industrial fusion applications of the γ-rays accompanying d-t collisions I present the first model calculations of the minor branching ratio of the $d+t$ reaction, $d+t \rightarrow \alpha+n+\gamma$. The model exploits the most relevant physics feature – spin conservation in electric dipole transitions – which leads to a peculiar mechanism of this reaction: γ-emission via bremsstrahlung from an intermediate α-n state. As a consequence of the bremsstrahlung, the γ-spectrum contains non-zero contributions at all energies thus making inclusive $dt\gamma$ cross section measurements sensitive to the low-energy cutoff of the detected γ-events. Comparison of the model predictions to existing $d + t \rightarrow \alpha + n + \gamma$ measurements in accelerators, employing cutoffs of 13 and 14 MeV, and inertial confinement fusion facilities, with a low-limit cutoff of 0.4 to 10 MeV, suggests a possible contradiction between results from these two types of experiments. The model predictions agree well with accelerator measurements and corroborate the cutoff dependence observed in inertial confinement experiments. The model predictions are sensitive to the wave function details inside the short-range area of the α-n interaction, with uncertainty comparable to that of available experimental data, but become model-independent below 4-5 MeV. This part of the γ-spectrum features a previously unexpected rise, which below 0.5 MeV surpasses the main 17 MeV γ-peak in strength. The reactivity of the $d + t \rightarrow \alpha + n + \gamma$ branch strongly depends on the d-t plasma temperature, which opens the possibility of advanced plasma temperature diagnostics.

Author: TIMOFEYUK, Natalia

Presenter: TIMOFEYUK, Natalia

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