Evaluation of beam-beam fusion reaction rate including localized beam profile in tokamak plasma

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Many D-D fusion reaction experiments have been performed in tokamaks and helicals. D-D fusion reaction rate is used to evaluate energetic particle confinement. In many studies, they use homogenuous beam ions distribution to evaluate D-D fusion reaction rate and they dismiss localized effect. This is why experimental results are different from simulation results. In this study, we consider D-D fusion reaction rate between energetic beam ions with localized effect in tokamak. D-D fusion reaction is shown below.

\[ D + D \rightarrow T(1.01\text{MeV}) + p(3.03\text{MeV}) \]
\[ D + D \rightarrow ^3\text{He}(0.82\text{MeV}) + n(2.45\text{MeV}) \]

We need NBI heating as an additional heating for self-ignition condition. We put energetic particles (deutriums) from NBI into the tokamak perpendicularly for the magnetic field, particles exchange their charges with bulk plasmas(deutriums) and they are locally trapped inside banana orbit by magnetic mirror effect. They distributed in a weak magnetic field side on the torus. Because of this, inhomogeneous distribution of D-D reaction rate between beam ions occurs. Then, we finally evaluate D-D reaction rate between beam ions with localized effect occurred in tokamak.

We use GNET code that solves five dimensional drift kinetic equation to evaluate D-D reaction rate.