EFFECT OF NUCLEAR ELASTIC SCATTERING ON ION HEATING IN THERMONUCLEAR PLASMAS

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An intense neutral beam injected into thermonuclear plasmas plays important role in various stages of fusion reactor operations. The beam particles slow down, deposit most of their energy via Coulombic collisions, and create a tail (non-Maxwellian component) in velocity distribution function of the same ion species as the one injected. It is well known that for suprathermal ions, Nuclear Elastic Scattering (NES) by thermal ions contributes to the slowing-down process. According to the recent scaling up of the fusion experimental devices, the use of beam energy more than 1 MeV is considered. In this case, NES effect on the slowing down process of injected beam particles may be important to understand device performance during plasma heating operations. The purpose of this paper is to estimate quantitatively NES effect on neutral-beam-injection (NBI) plasma heating.

NES is a non-Coulombic, large-energy-transfer (LET) scattering process. Devany & Stein[1] first pointed out the necessity of taking account the contribution of the nuclear-forces, including their interference with the Coulomb process, to ion-ion scattering. Recently we have derived the energy loss rate of high-energy ions due to NES, including the LET knocking-up of background ions from thermal to higher energy range[2], and using the derived expression we have estimated NES effect on the fraction of beam energy deposited to ions. We subsequently performed more detailed analysis by means of the Boltzamann-Fokker-Planck calculation [3]. In this paper we further estimate NES effect on the T (d,n)^{4}He fusion reactivity. It is shown that when the beam energy is higher than 1 MeV, the NES effect on NBI heating becomes appreciable.

[1] Devany, J.J. and Stein, M.L., Nucl. Sci. Eng. **46** (1971) 323.
[2] Matsuura, H., Nakao, Y., Kudo, K., Nucl. Fusion, **39** (1999) 145.
[3] Matsuura, H., Nakao, Y., (Proc of TOFE16), to be published in Fusion Sci. Tech.