§32. Analytical Curve Fitting for Maxwellian Reactivities

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We have obtained analytical expressions for Maxwellian reactivities for $D\,^3He$, DT and DD fusion reactions. The curve fitting temperature range is 1 to 10^3 keV.

In the course of fusion studies based on the fluid model, Maxwellian reactivities $<\sigma v>$ are necessary to be expressed by an appropriate function of temperature.

Hively [1] have derived analytical expression for the Maxwellian reactivities based on the Miley's [2] data. Hively's [1], however, assumed that plasma temperature is in the range of

$$1 \leq T \leq 80\,(keV). \tag{1}$$

Recent development of plasma confinement and presence of high energy particles due to ICRF or NBI, analytical expression for fusion reactivity applicable for more wide temperature rage are necessary.

We have developed analytical expression for the Maxwellian reactivities based on the IAEA INDC(International Nuclear Data Committee)[3] data in the temperature range

$$1 \leq T \leq 10^3\ (keV) \tag{2}$$

For $D\,^3He$ and DT reactions, we have used the fitting curve

$$<\sigma v> = \exp\left[x_1 - \frac{x_2}{T^{x_5}} + \frac{x_3}{T + x_4},\right] \tag{3}$$

and for DD reactions

$$<\sigma v> = \exp\left[x_1 - \frac{x_2}{T^{x_5}} + \frac{x_3 T}{(T^2 + x_4)^2}.\right] \tag{4}$$

The parameters x_1, x_2, x_3, x_4, x_5 are determined to minimize the summation of square of the difference between INDC [3] data and analytic expressions.

The results are summarized as follows (in MKS unit and temperature is in keV unit) :

$$\left.\begin{array}{l} x_1 = -47.5344110196866 \\ x_2 = 31.7637123677497 \\ x_3 = 2834.98815816765 \\ x_4 = 376.385839543112 \\ x_5 = 0.283487437573054 \end{array}\right\} \text{for } D\,^3He \tag{5}$$

$$\left.\begin{array}{l} x_1 = -48.8036943048839 \\ x_2 = 18.4196950318015 \\ x_3 = 919.951872254701 \\ x_4 = 134.784947832626 \\ x_5 = 0.353178933944180 \end{array}\right\} \text{for } DT \tag{6}$$

$$\left.\begin{array}{l} x_1 = -48.9285638675734 \\ x_2 = 15.5178022138113 \\ x_3 = 3892.58911898736 \\ x_4 = 323.308906855479 \\ x_5 = 0.339577876992143 \end{array}\right\} DD(pt) \tag{7}$$

$$\left.\begin{array}{l} x_1 = -48.9747658959232 \\ x_2 = 15.5892514122928 \\ x_3 = -476254.746545044 \\ x_4 = 19509.6334066843 \\ x_5 = 0.360891452129311 \end{array}\right\} DD(n\,^3He) \tag{8}$$

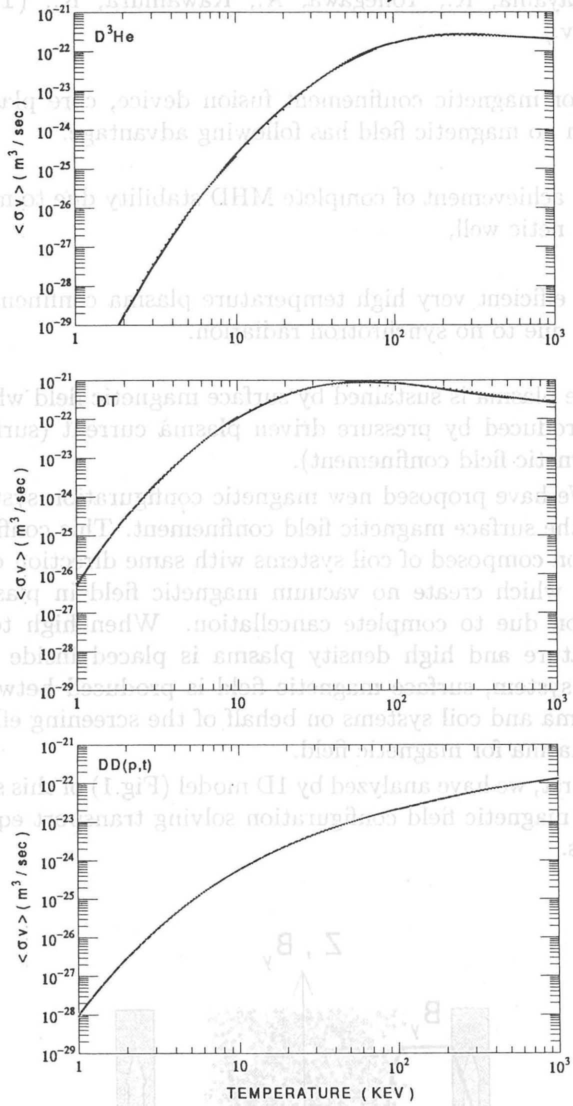

Fig.1 Maxwellian fusion reactivity for $D\,^3He$, DT and $DD(pt)$. ($DD(n\,^3He)$ curve is very close to the one for $DD(pt)$). Solid lines express the analytical expressions and small dots represent the INDC's data[3].

References

[1] HIVELY,L.M., Nuclear Fusion, **17** (1977) 873

[2] MILEY,G.H., TOWNER, H., and IVICH,N., University of Illinois Report C00-2218-17 (1974)

[3] R.Feldbacher, Nuclear Reaction Cross Sections and Reactivity Parameter Library and Files, INDC(AUS)-12/G, vers.1 (IAEA International Nuclear Data Comittee,1987).