Tendency equation and curve of stable nuclides

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1 An tendency equation of the relation between neutrons and protons in nucleus is

$$N = 192\tan[0.007(Z-1)]\,, \quad (1)$$

or

$$Z = 1 + 143\arctan[0.0052N]\,, \quad (2)$$

where N is the number of neutrons and Z is the number of protons in nucleus.

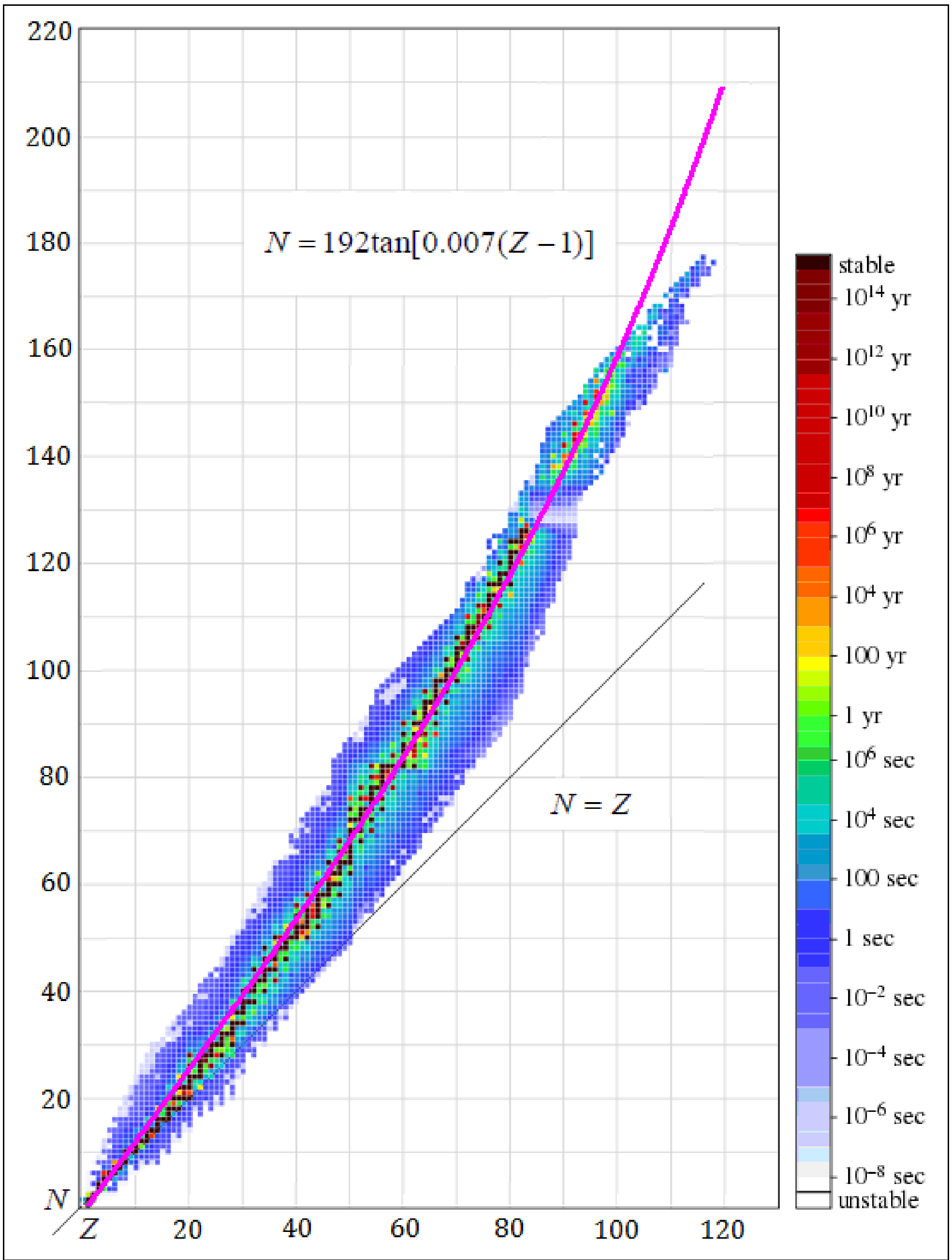

Fig.1 The comparison result figure between the curve of the tendency equation $N(Z)$ and the experimental distribution data points of the stable nuclides

▪ point of the stable nuclide data[1] — curve of the tendency equation[2, 3]

Z (atomic number): number of protons N: number of neutrons

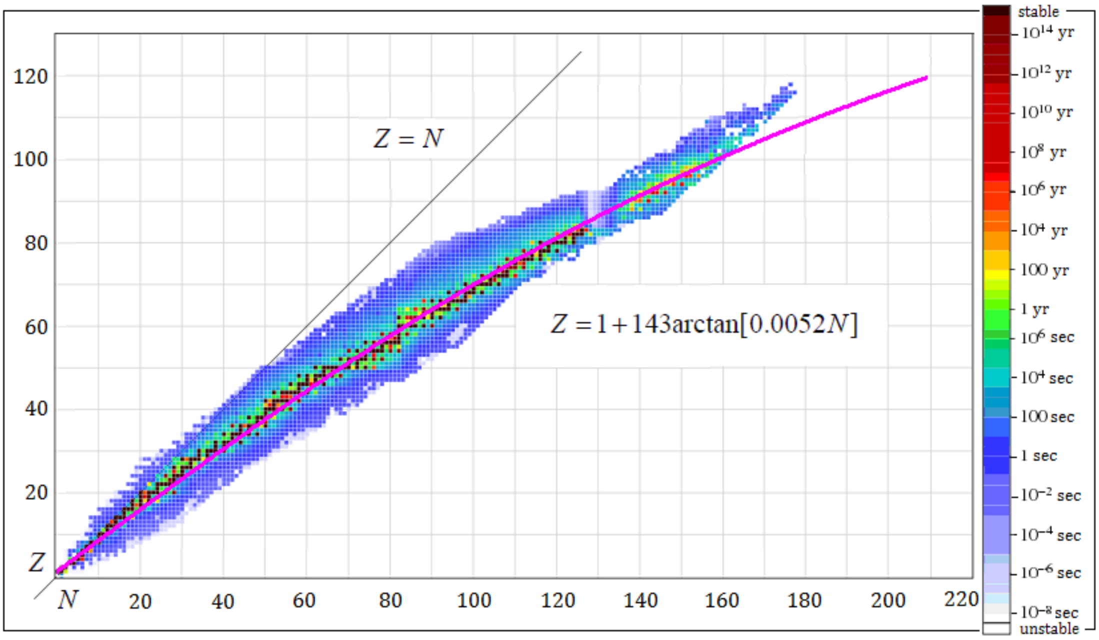

Fig.2A The comparison result figure between the curve of the tendency equation $Z\,(N)$ and the experimental distribution data points of the stable nuclides

▪ point of the stable nuclide data[1]   curve of the tendency equation[2, 3]

Z (atomic number): number of protons N: number of neutrons

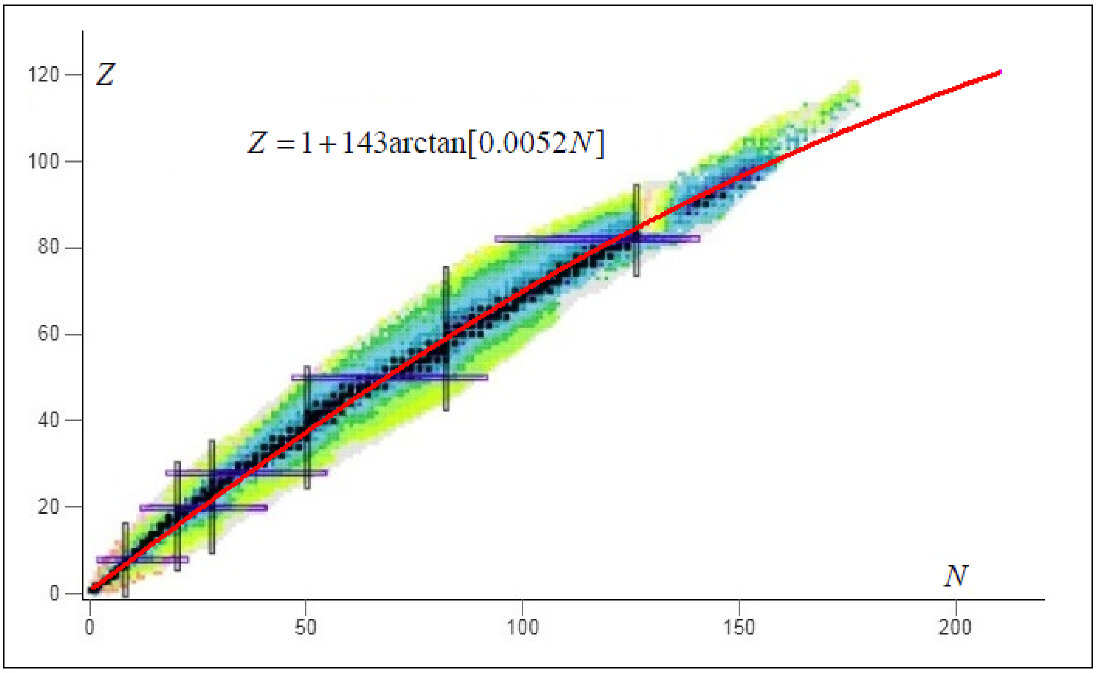

Fig.2B The comparison result figure between the curve of the tendency equation $Z(N)$ and the experimental distribution data points of the stable nuclides

▪ point of the stable nuclide data[1]   curve of the tendency equation[2, 3]

Z (atomic number): number of protons N: number of neutrons

2 A tendency equation of average binding energy per nucleon (or specific binding energy) ε (MeV) of stable nuclide is

$$\varepsilon = 9.5\frac{\exp[0.040(A_N - 1)] - \exp[-0.50(A_N - 1)]}{2\cosh[0.041(A_N - 1)]}, \qquad (3)$$

where A_N is the number of nucleons in nucleus.

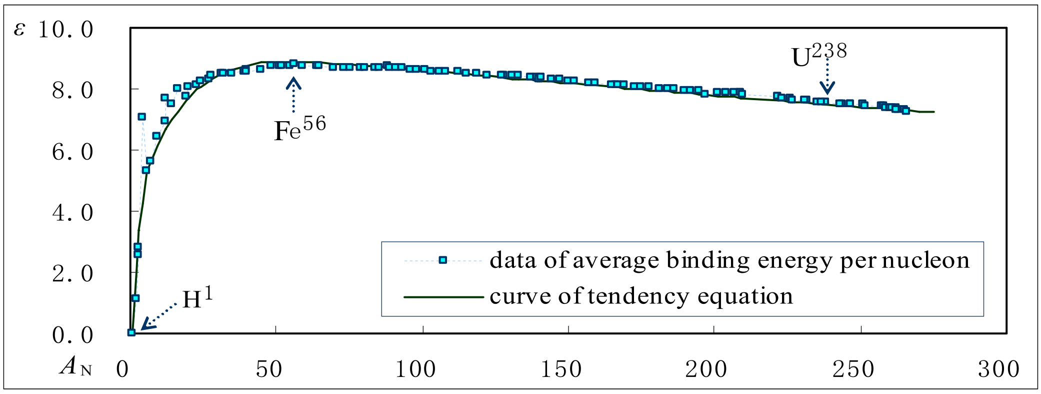

Fig. 3 Curve figure of tendency equation of average binding energy per nucleon (or specific binding energy) of stable nuclide

3 An equation of the nuclear binding energy E_N (MeV) is

$$E_N = A_N\varepsilon = 9.5A_N\frac{\exp[0.040(A_N - 1)] - \exp[-0.50(A_N - 1)]}{2\cosh[0.041(A_N - 1)]}. \qquad (4)$$

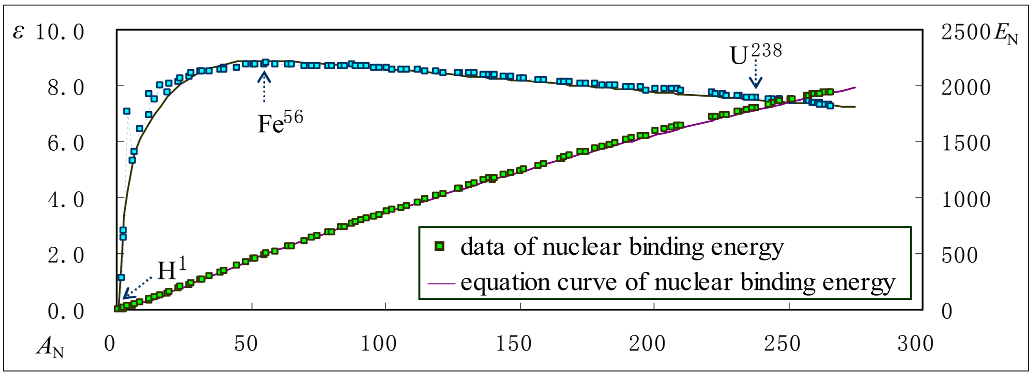

Fig. 4 Curve figure of tendency equation of stable nuclear binding energy[3]

4 A theoretical maximum E_{Ntmax} of the nuclear binding energy E_N and its corresponding nucleon number A_{Nt}, proton number Z_t and neutron number N_t are

$$\begin{cases} E_{Ntmax} = 3498.34\text{MeV}; \\ A_{Nt} = 998, \ Z_t = 192, \ N_t = 806 \text{。} \end{cases} \qquad (5)$$

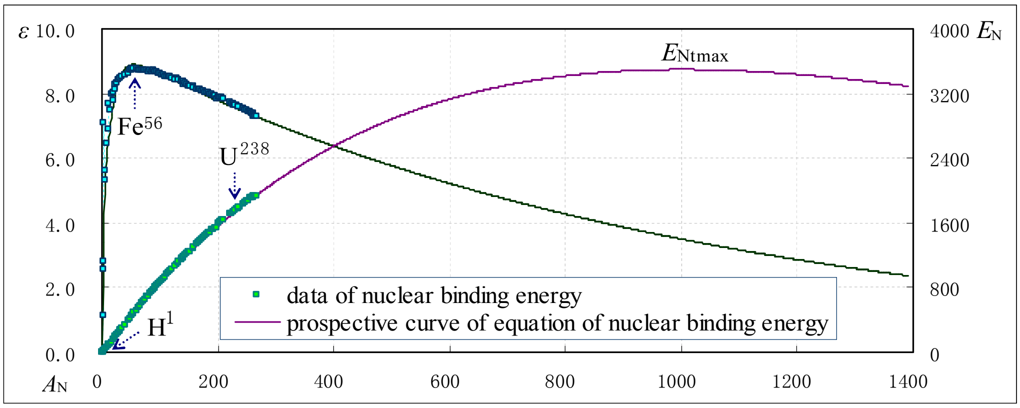

Fig.5 Prospective curve and its theoretical maximum position figure of tendency equation of the nuclear binding energy[3]

5 An unilateral extended tendency equation of average binding energy per nucleon (or specific binding energy) ε (MeV) of stable nuclide is

$$\varepsilon = 9.5\frac{\exp[0.040(A_{\rm N}-1)]-\exp[-0.50(A_{\rm N}-1)]}{2\cosh[0.041(A_{\rm N}-1)]}[1+\exp[-0.155(A_{\rm N}-1)]\cos^2(0.25\pi A_{\rm N})] \,. \quad (6)$$

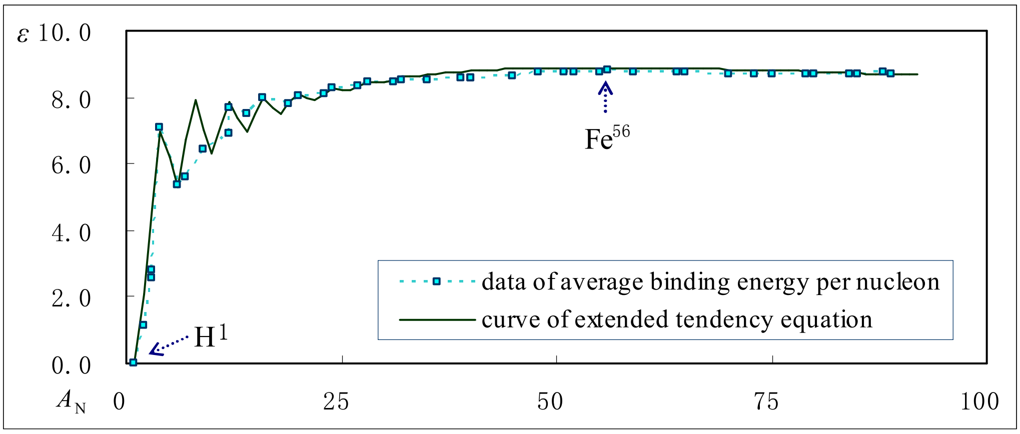

Fig. 6 Local curve figure of the unilateral refinement extended tendency equation of average binding energy per nucleon (or specific binding energy) of stable nuclide

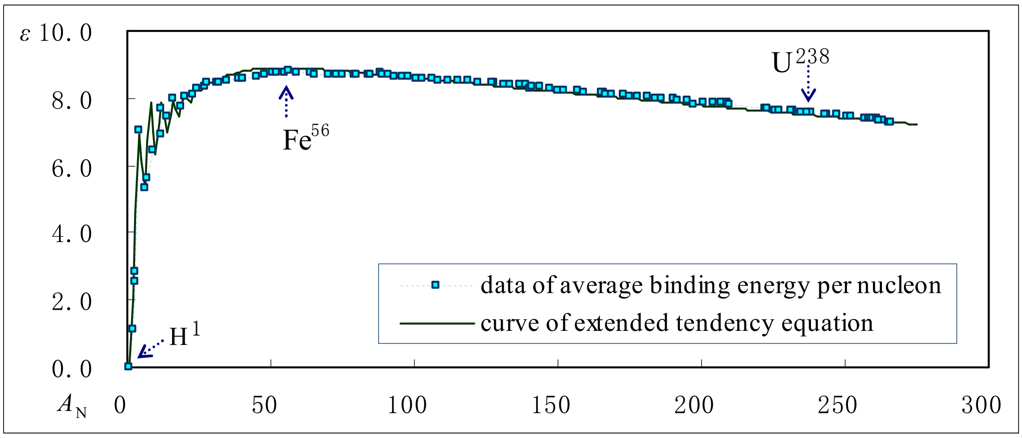

Fig. 7 Curve figure of the unilateral refinement extended tendency equation of average binding energy per nucleon (or specific binding energy) of stable nuclide

6 An unilateral extended tendency equation of the nuclear binding energy $E_{\rm N}$ (MeV) of stable nuclide is

$$E_{\rm N} = 9.5A_{\rm N}\frac{\exp[0.040(A_{\rm N}-1)]-\exp[-0.50(A_{\rm N}-1)]}{2\cosh[0.041(A_{\rm N}-1)]}[1+\exp[-0.155(A_{\rm N}-1)]\cos^2(0.25\pi A_{\rm N})] \,. \quad (7)$$

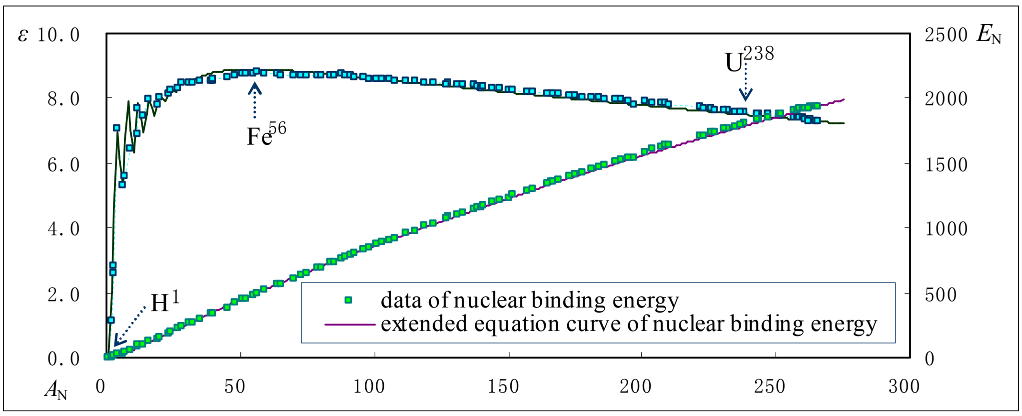

Fig. 8 Curve figure of unilateral refinement extended tendency equation of stable nuclear binding energy

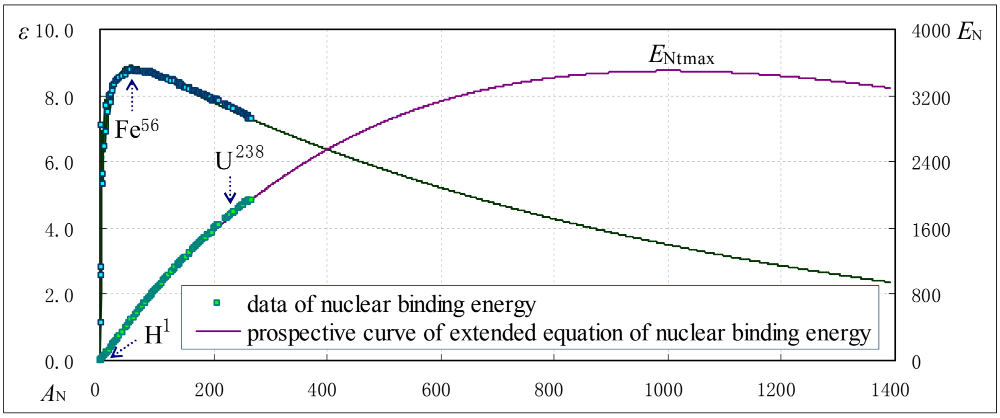

Fig. 9 Prospective curve and its theoretical maximum position figure of unilateral refinement extended tendency equation of the nuclear binding energy[3]

7 An unilateral extended equation with the tendency proportion function b_A of average binding energy per nucleon (or specific binding energy) ε (MeV) of stable nuclide is

$$\varepsilon = 9.5\frac{\exp[0.04(A_N - 1)] - \exp[-0.50(A_N - 1)]}{2(0.00108A_N + 1)\cosh[0.04(A_N - 1)]}[1 + \exp[-0.155(A_N - 1)]\cos^2(0.25\pi A_N)] \,. \quad (8)$$

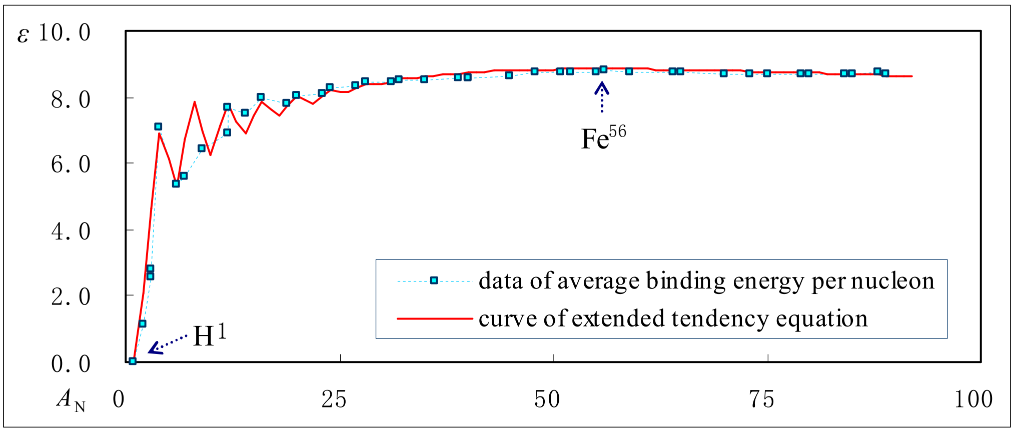

Fig.10 Local curve figure of the unilateral refinement extended tendency equation of average binding energy per nucleon (or specific binding energy) of stable nuclide (when $b_A = 0.00108A_N + 1$)

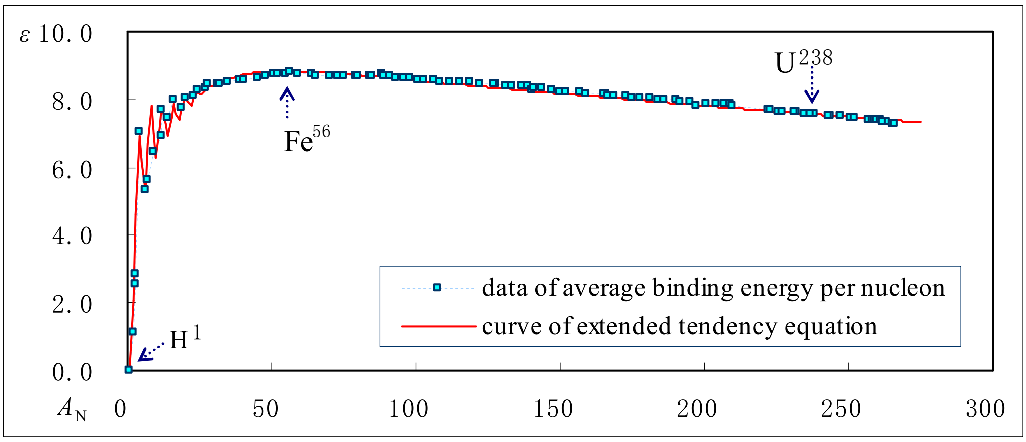

Fig.11 Curve figure of the unilateral refinement extended tendency equation of average binding energy per nucleon (or specific binding energy) of stable nuclide (when $b_A = 0.00108A_N + 1$)

8 An unilateral extended tendency equation of the nuclear binding energy E_N (MeV) of stable nuclide is

$$E_N = 9.5A_N \frac{\exp[0.04(A_N-1)] - \exp[-0.50(A_N-1)]}{2(0.00108A_N+1)\cosh[0.04(A_N-1)]}[1+\exp[-0.155(A_N-1)]\cos^2(0.25\pi A_N)] \,. \quad (9)$$

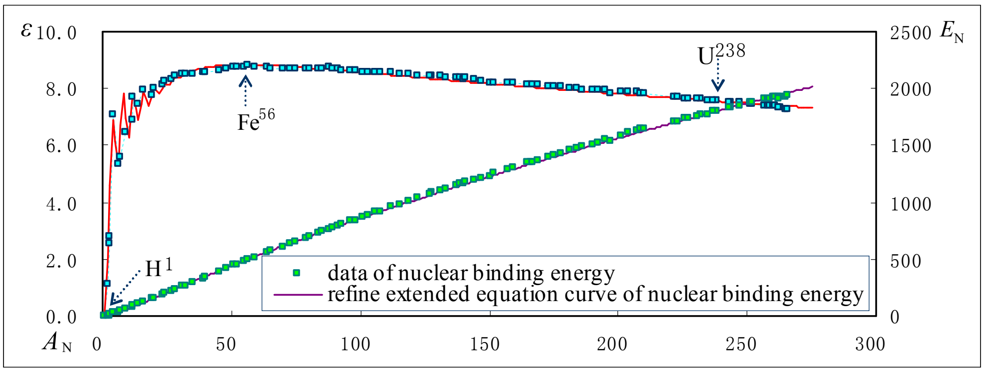

Fig.12 Curve figure of unilateral refinement extended tendency equation of stable nuclear binding energy(when b_A= 0.00108A_N+1)

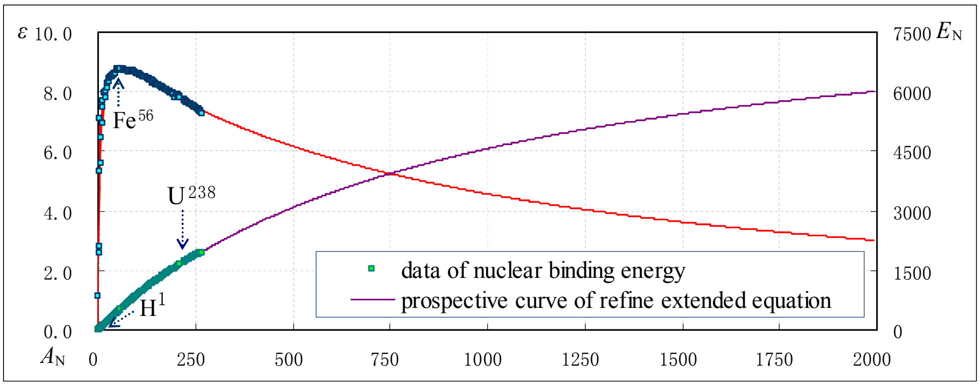

Fig. 13 Prospective curve figure of unilateral refinement extended tendency equation of the nuclear binding energy[4] (when b_A= 0.00108A_N+1 and $1 \leqslant A_N \leqslant 2000$)

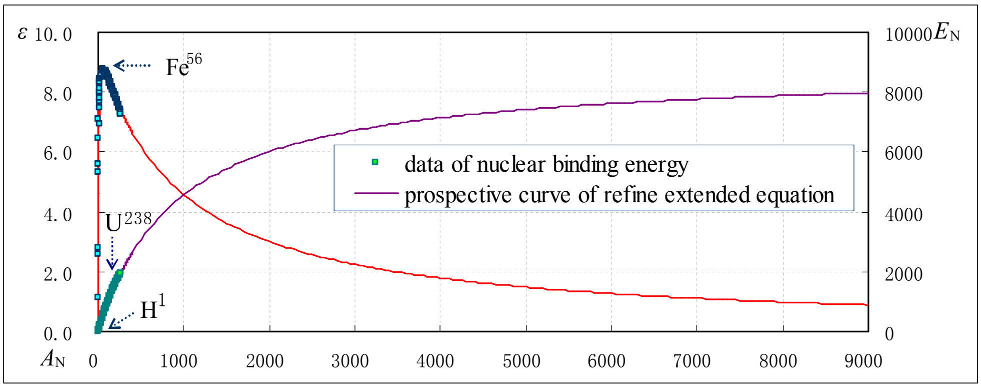

Fig. 14 Prospective curve figure of unilateral refinement extended tendency equation of the nuclear binding energy[4] (when b_A= 0.00108A_N+1 and $1 \leqslant A_N \leqslant 9000$)

9 The tendency equation of abundances of elements in the Solar System, when the unilateral refine extended period $T_{\mathrm{Aw}}=12$, then the tendency relationship equation between A_{selog} and the nucleon number A_{N} is

$$A_{\mathrm{selog}}=[13.1\exp(-0.017A_{\mathrm{N}})-1.4][1-\exp(-0.025A_{\mathrm{N}})\cos^2[12^{-1}\pi(A_{\mathrm{N}}-8)]] +[0.5+\exp(-0.015A_{\mathrm{N}})][\cos[38^{-1}\pi(A_{\mathrm{N}}-56)]+\cos(2^{-1}\pi A_{\mathrm{N}})], \quad (10)$$

where $A_{\mathrm{selog}}=\log_{10}A_{\mathrm{se}}$, A_{se} (atoms/10^6 atoms Si) is abundances of elements in Solar System.

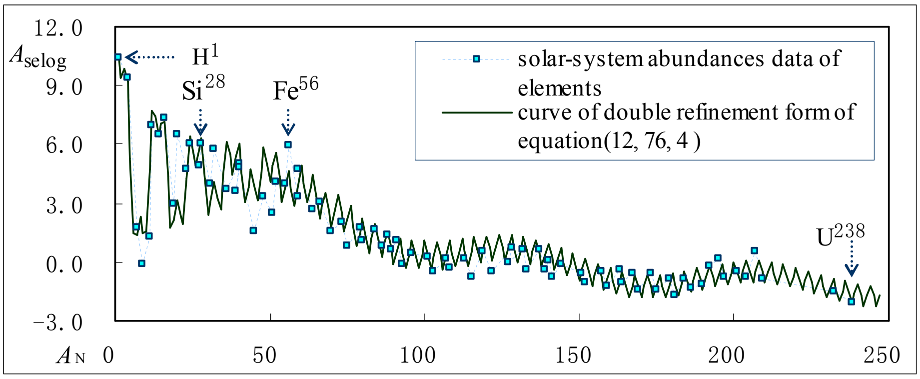

Fig. 15 Curve figure of double refinement form of tendency equation of abundances data of elements in Solar System(when T_{Aw}=12)

And when $T_{\mathrm{Aw}}=14$, we have

$$A_{\mathrm{selog}}=[14.1\exp(-0.018A_{\mathrm{N}})-1.2][1-\exp(-0.018A_{\mathrm{N}})\cos^2[14^{-1}\pi(A_{\mathrm{N}}-9)]] +[0.5+\exp(-0.015A_{\mathrm{N}})][\cos[38^{-1}\pi(A_{\mathrm{N}}-56)]+\cos(2^{-1}\pi A_{\mathrm{N}})] +[0.5+\exp(-0.2A_{\mathrm{N}})]\cos[11^{-1}\pi(A_{\mathrm{N}}-56)]. \quad (11)$$

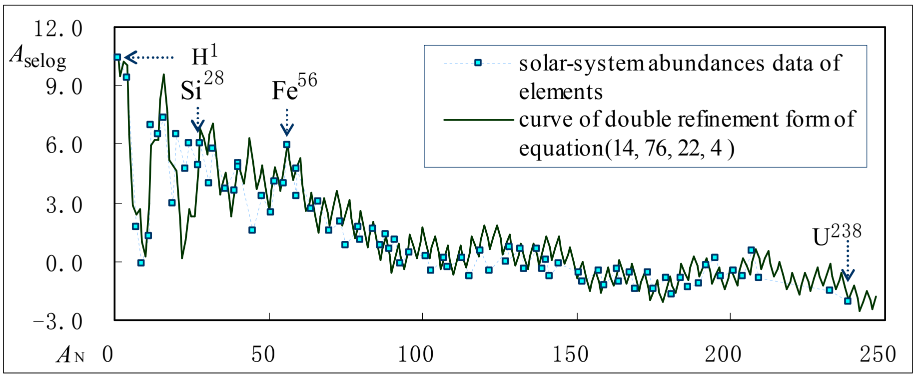

Fig.16 Curve figure of double refinement form of tendency equation of abundances data of elements in the Solar System (when T_{Aw}=14) [3]

A parallel computing direction about the tendency equation of abundances of elements in Solar System, when the unilateral refine extended period $T_{\mathrm{Zw}}=6$, then the tendency relationship equation between A_{selog} and the atomic number Z is

$$A_{\mathrm{selog}}=[14.0\exp(-0.024Z)-3.2][1-\exp(-0.02Z)\cos^2[6^{-1}\pi(Z-4)]] +0.5[\cos[14^{-1}\pi(Z-26)]+\cos(\pi Z)]. \quad (12)$$

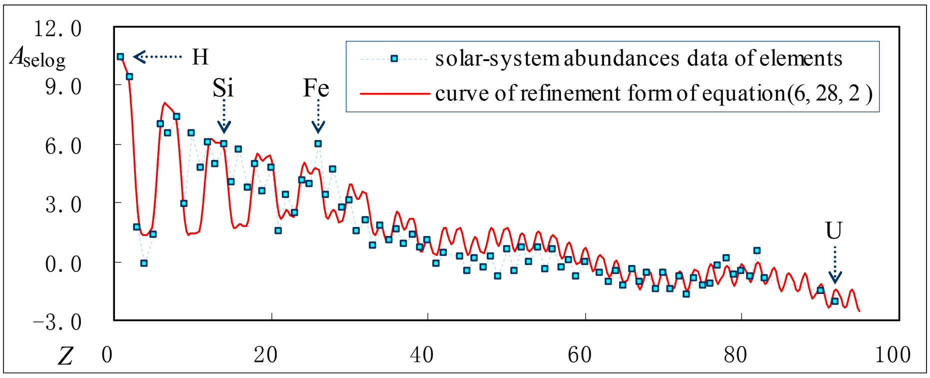

Fig. 17 Curve figure of refinement form of tendency equation of abundances data of elements in Solar System(when T_{Zw}=6)

And the double refinement form of tendency equation is

$$A_{\mathrm{selog}} = [13.3\exp(-0.026Z) - 2.8][1 - \exp(-0.045Z)\cos^2[6^{-1}\pi(Z-4)]] + [0.5 + \exp(-0.06Z)][\cos[14^{-1}\pi(Z-26)] + \cos(\pi Z)]. \quad (13)$$

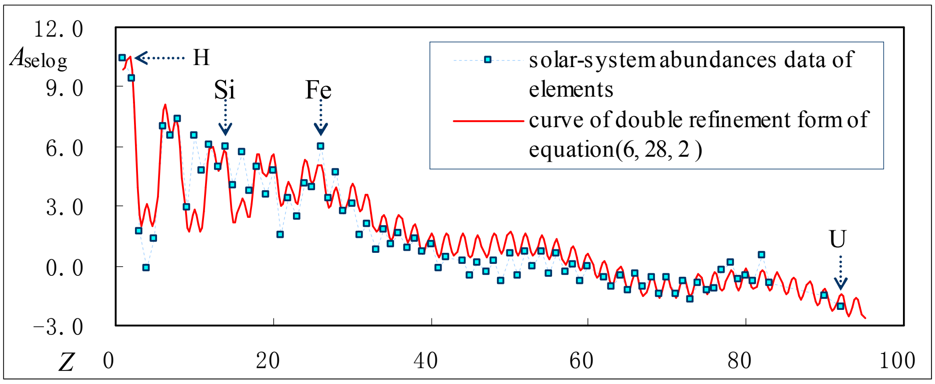

Fig. 18 Curve figure of double refinement form of tendency equation of abundances data of elements in the Solar System (when T_{Zw}=6) [4]

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