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

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

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

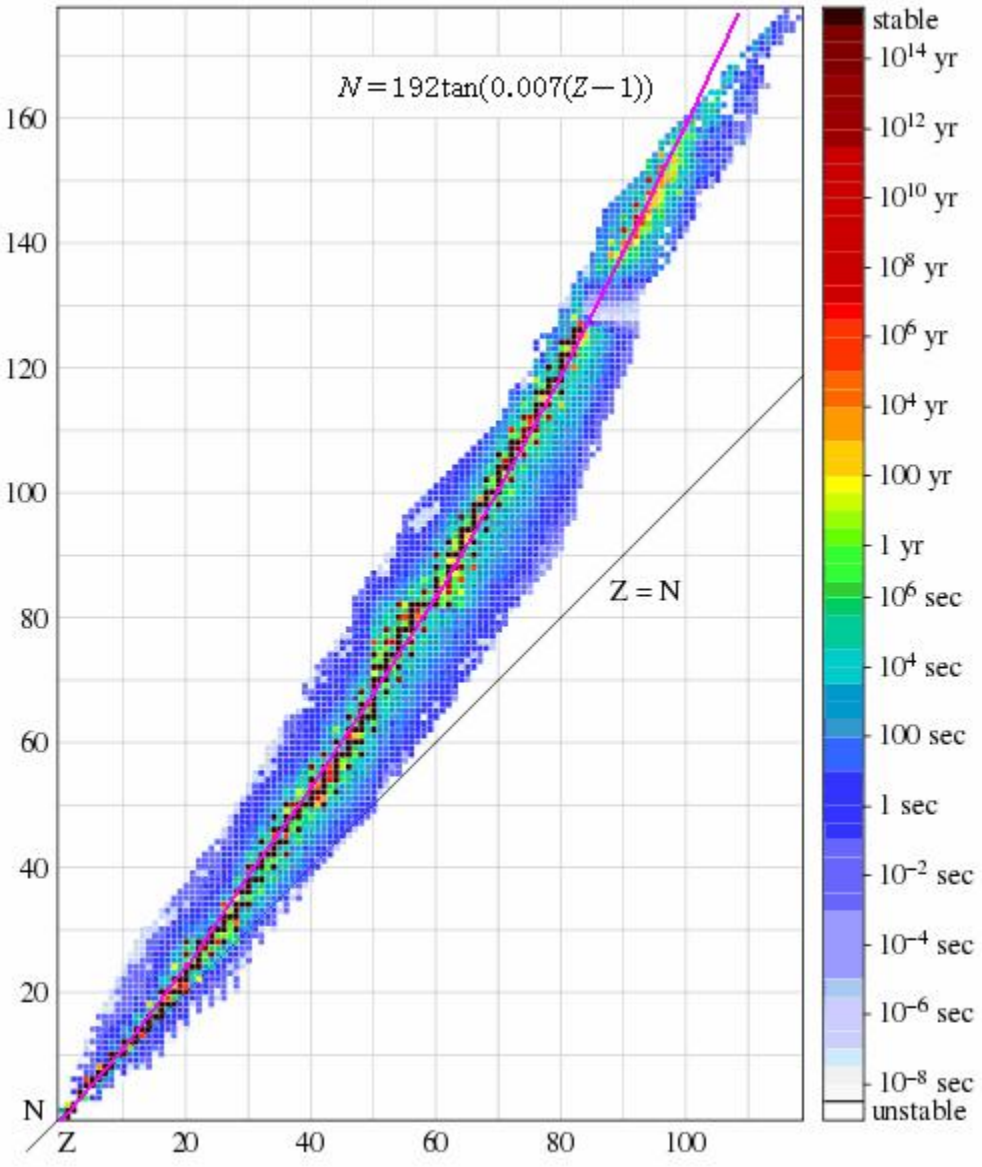

Fig.1 The comparison result figure between the curve of the tendency equation and the experimental distribution data points of the stable nuclides

· 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

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

where A_{N} is the number of nucleons in nucleus.

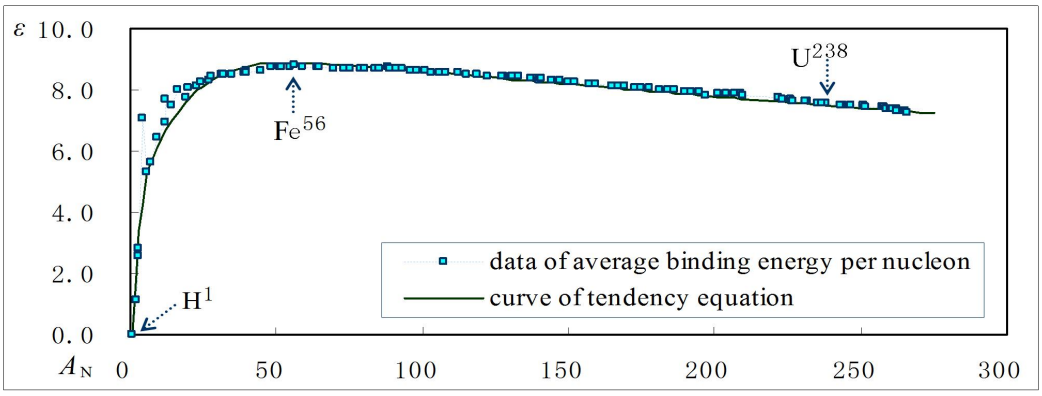

Fig. 2　Curve figure of tendency equation of average binding energy per nucleon (or specific binding energy) of stable nuclide

3　An equation of the nuclear binding energy E_{N}（MeV）is

$$E_{\mathrm{N}} = A_{\mathrm{N}}\varepsilon = 9.5A_{\mathrm{N}}\frac{\exp[0.040(A_{\mathrm{N}}-1)]-\exp[-0.50(A_{\mathrm{N}}-1)]}{2\cosh[0.041(A_{\mathrm{N}}-1)]}. \qquad (3)$$

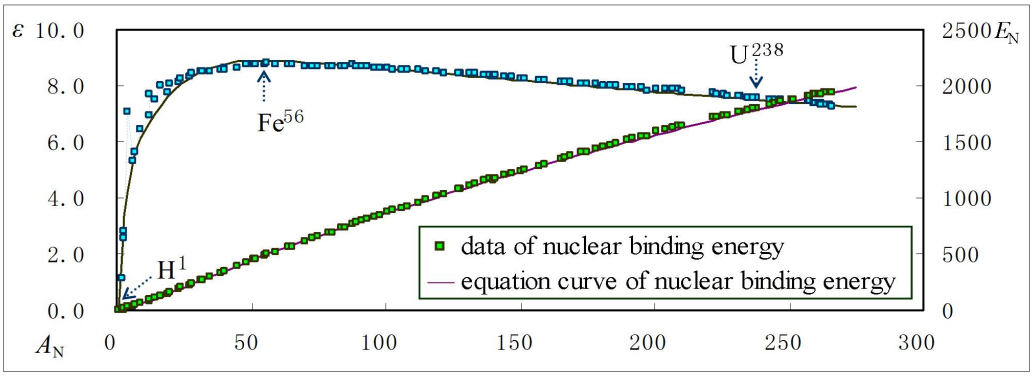

Fig. 3　Curve figure of tendency equation of stable nuclear binding energy[3]

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

$$\begin{cases} E_{\mathrm{Ntmax}} = 3498.34\mathrm{MeV}; \\ A_{\mathrm{Nt}} = 998，Z_{\mathrm{t}} = 192，N_{\mathrm{t}} = 806。 \end{cases} \qquad (4)$$

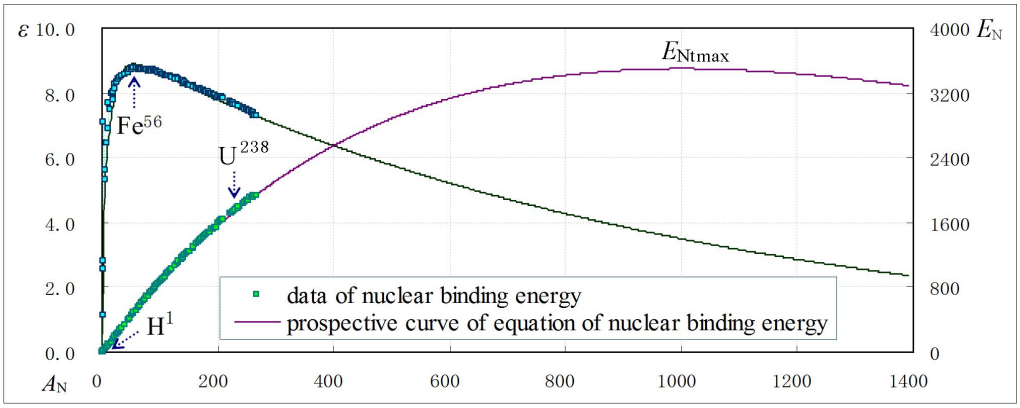

Fig.4 Prospective curve and its theoretical maximum position figure of tendency equation of the nuclear binding energy[3]

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

$$\varepsilon = 9.5\frac{\exp[0.040(A_{\mathrm{N}}-1)]-\exp[-0.50(A_{\mathrm{N}}-1)]}{2\cosh[0.041(A_{\mathrm{N}}-1)]}[1+\exp[-0.155(A_{\mathrm{N}}-1)]\cos^2(0.25\pi A_{\mathrm{N}})] \quad (5)$$

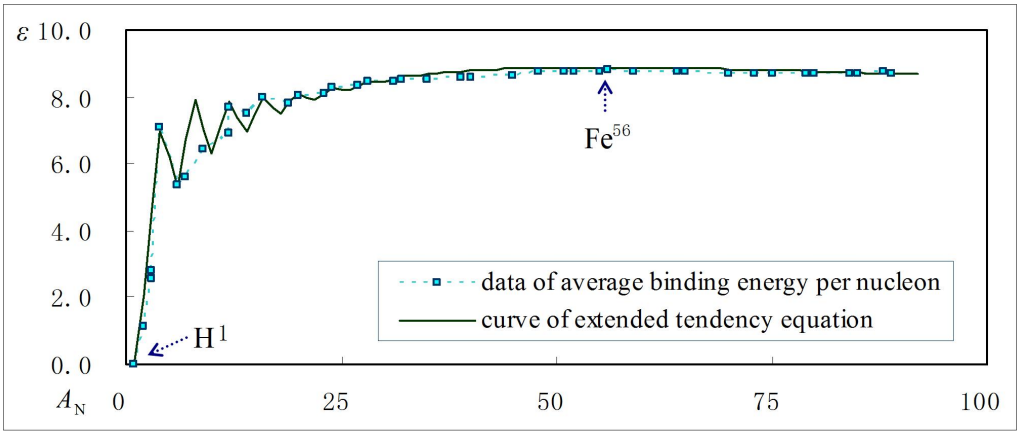

Fig. 5 Local curve figure of the unilateral refinement extended tendency equation of average binding energy per nucleon (or specific binding energy) of stable nuclide

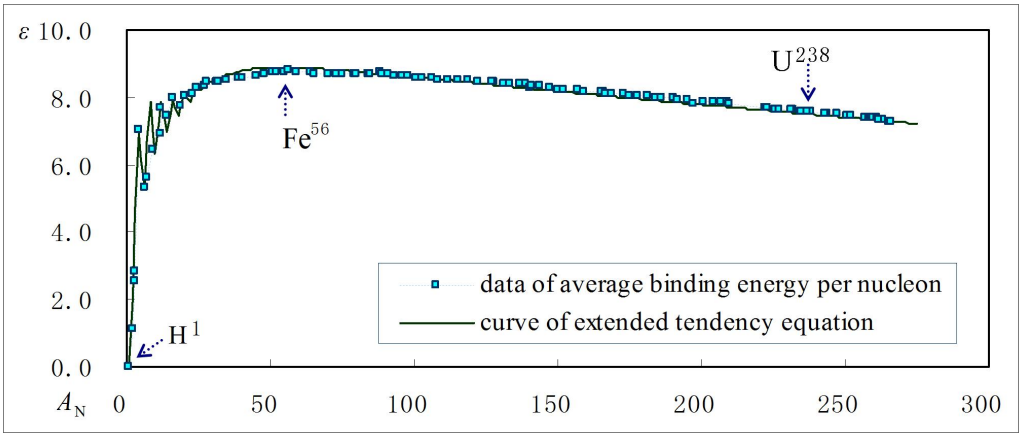

Fig. 6 Curve figure of the unilateral refinement extended tendency equation of average binding energy per nucleon (or specific binding energy) of stable nuclide

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

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

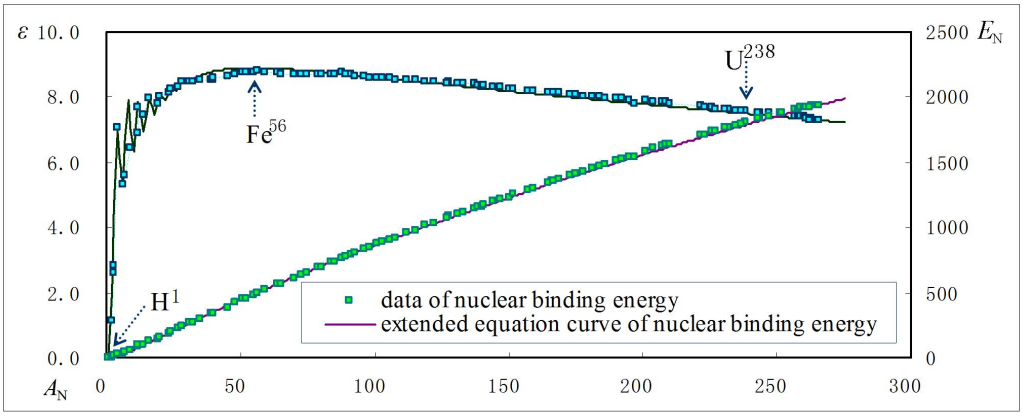

Fig. 7 Curve figure of unilateral refinement extended tendency equation of stable nuclear binding energy

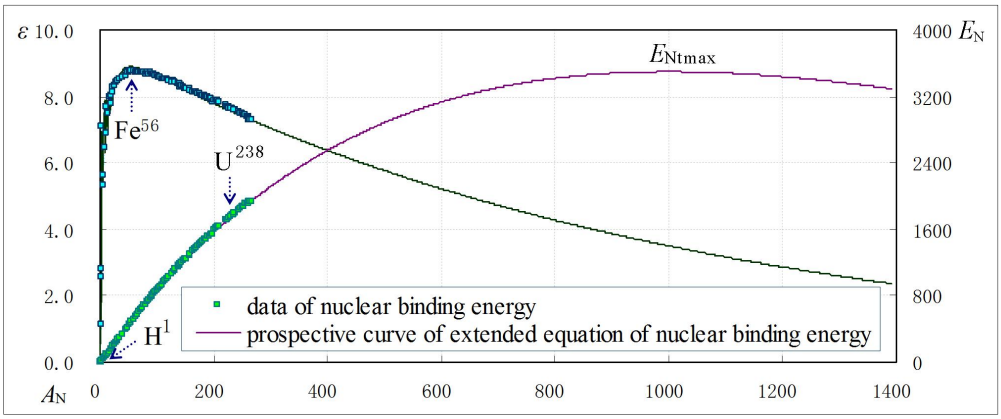

Fig. 8 Prospective curve and its theoretical maximum position figure of unilateral refinement extended tendency equation of the nuclear binding energy[3]

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

$$\varepsilon = 9.5\frac{\exp[0.04(A_N-1)]-\exp[-0.50(A_N-1)]}{2(0.00108A_N+1)\cosh[0.04(A_N-1)]}[1+\exp[-0.155(A_N-1)]\cos^2(0.25\pi A_N)] \quad (7)$$

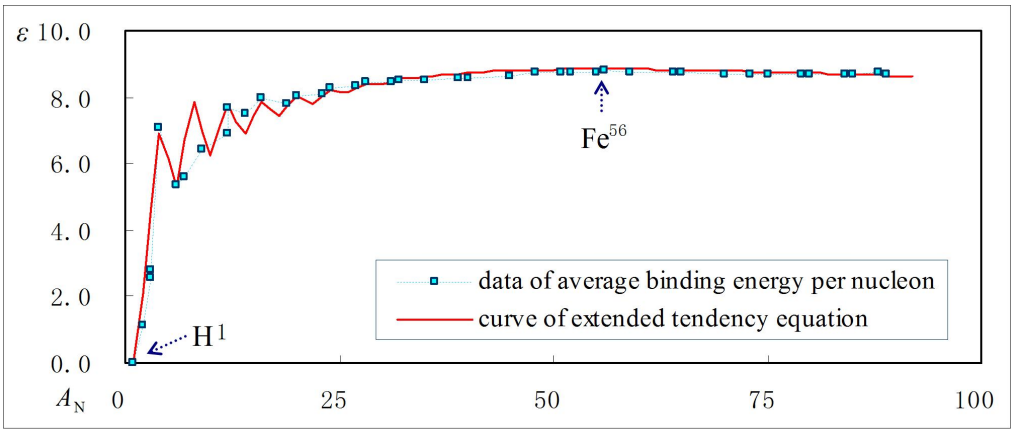

Fig. 9 Local curve figure of the unilateral refinement extended tendency equation of average binding energy per nucleon (or specific binding energy) of stable nuclide (when b_A= 0.00108A_N+1)

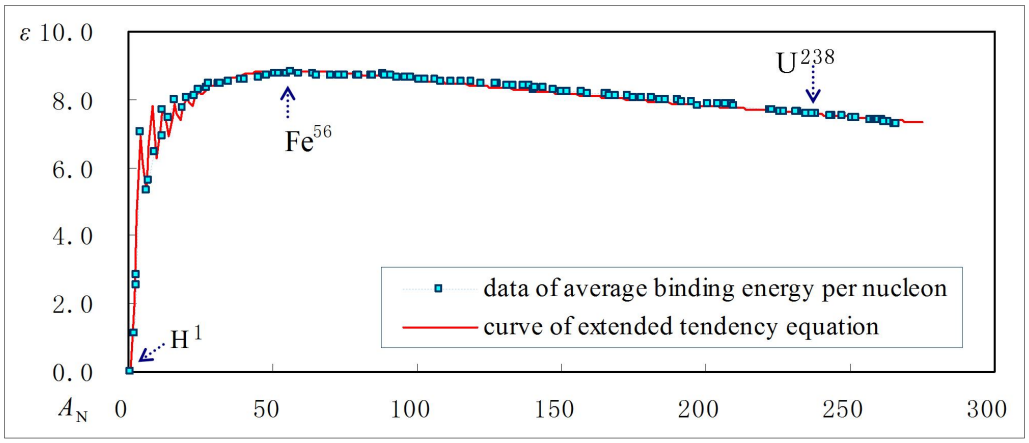

Fig.10 Curve figure of the unilateral refinement extended tendency equation of average binding energy per nucleon (or specific binding energy) of stable nuclide (when b_A= 0.00108A_N+1)

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

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

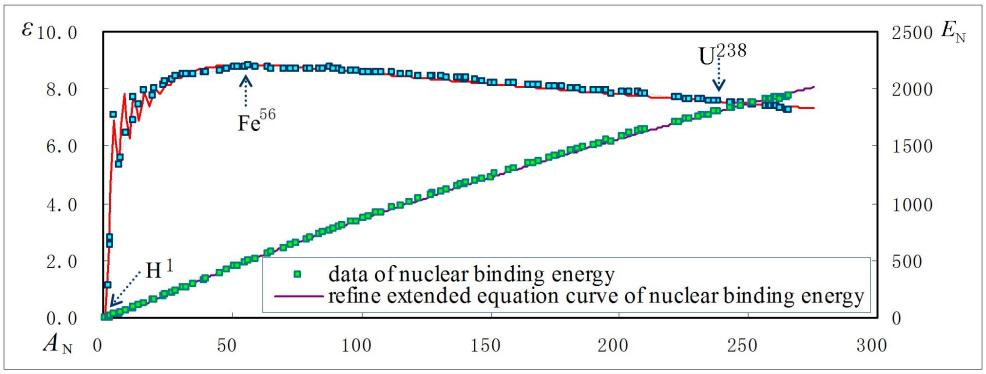

Fig.11 Curve figure of unilateral refinement extended tendency equation of stable nuclear binding energy(when b_A= 0.00108A_N+1)

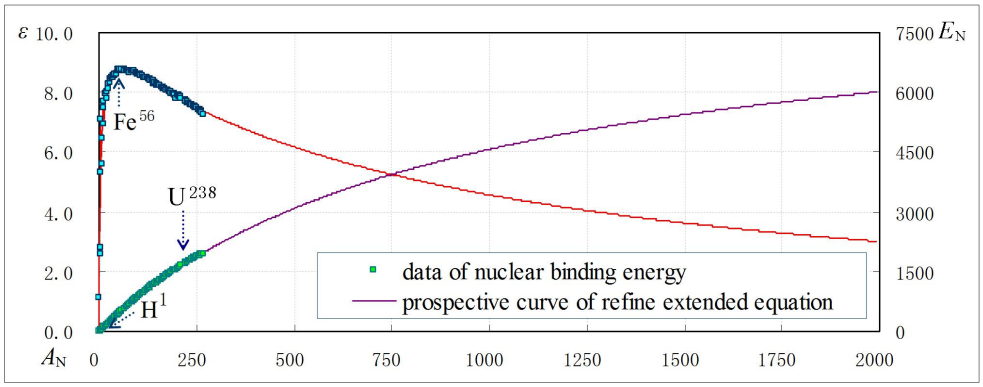

Fig. 12 Prospective curve figure of unilateral refinement extended tendency equation of the nuclear binding energy[4] (when b_A= 0.00108A_N+1 and 1≤A_N≤2000)

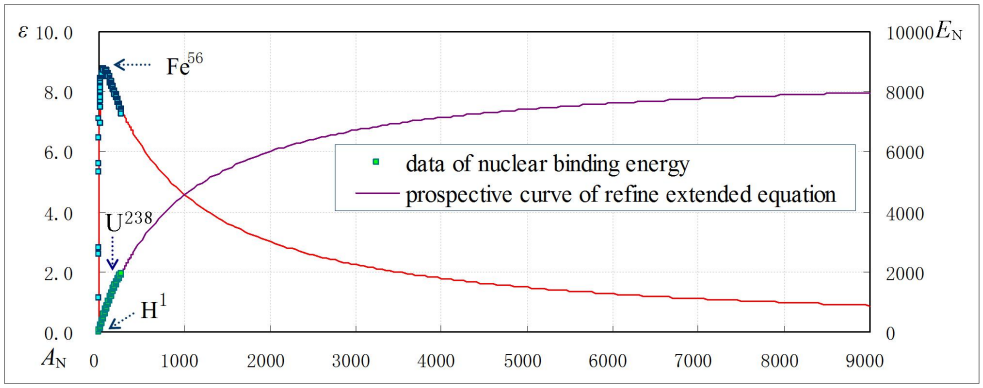

Fig. 13 Prospective curve figure of unilateral refinement extended tendency equation of the nuclear binding energy[4] (when b_A= 0.00108A_N+1 and 1≤A_N≤9000)

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

$$A_{selog} = [13.1\exp(-0.017A_N)-1.4][1-\exp(-0.025A_N)\cos^2[12^{-1}\pi(A_N-8)]] + [0.5+\exp(-0.015A_N)][\cos[38^{-1}\pi(A_N-56)]+\cos(2^{-1}\pi A_N)], \quad (9)$$

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

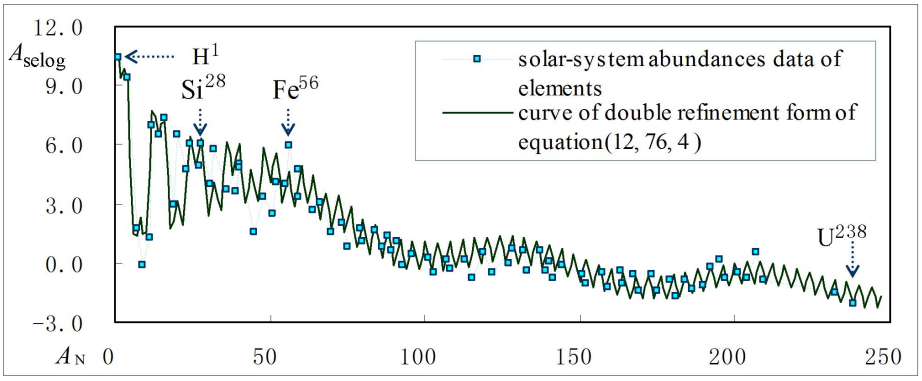

Fig. 14 Curve figure of double refinement form of tendency equation of abundances data of elements in Solar System(when T_{Aw}=12)

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

$$A_{selog}=[14.1\exp(-0.018A_N)-1.2][1-\exp(-0.018A_N)\cos^2[14^{-1}\pi(A_N-9)]]$$
$$+[0.5+\exp(-0.015A_N)][\cos[38^{-1}\pi(A_N-56)]+\cos(2^{-1}\pi A_N)]$$
$$+[0.5+\exp(-0.2A_N)]\cos[11^{-1}\pi(A_N-56)]. \quad (10)$$

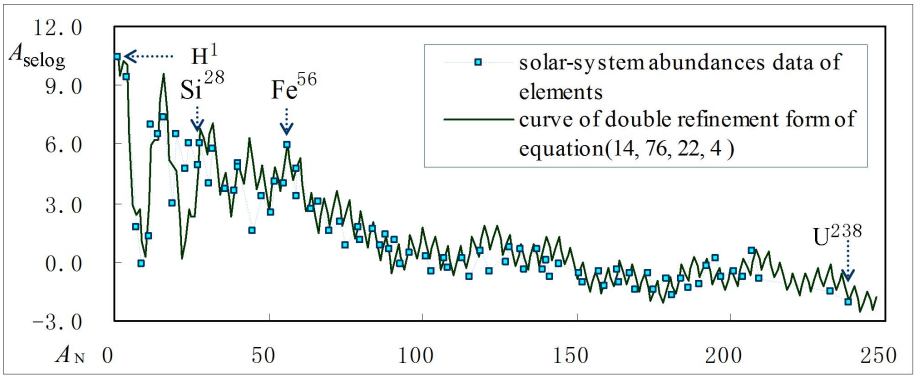

Fig.15 Curve figure of double refinement form of tendency equation of abundances data of elements in the Solar System (when T_{Aw}=14) [3]

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

$$A_{selog}=[14.0\exp(-0.024Z)-3.2][1-\exp(-0.02Z)\cos^2[6^{-1}\pi(Z-4)]]$$
$$+0.5[\cos[14^{-1}\pi(Z-26)]+\cos(\pi Z)]. \quad (11)$$

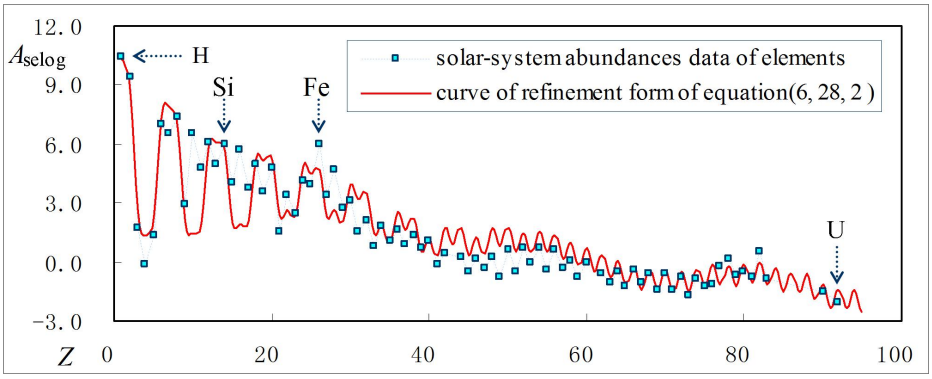

Fig. 16 Curve figure of refinement form of tendency equation of abundances data of elements in Solar System(when T_{Zw}=6)

And the double refinement form of tendency equation is

$$A_{selog}=[13.3\exp(-0.026Z)-2.8][1-\exp(-0.045Z)\cos^2[6^{-1}\pi(Z-4)]]$$
$$+[0.5+\exp(-0.06Z)][\cos[14^{-1}\pi(Z-26)]+\cos(\pi Z)]. \quad (12)$$

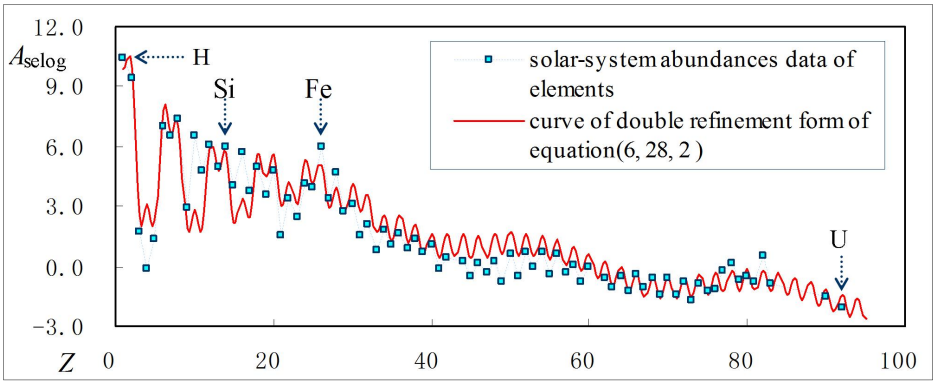

Fig. 17 Curve figure of double refinement form of tendency equation of abundances data of elements in the Solar System (when T_{zw}=6) [4]

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