JAERI-M
87-088

ANALYSIS OF THE MASS FORMULA DEPENDENCE OF SPALLATION PRODUCT DISTRIBUTION

June 1987

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編集兼発行　日本原子力研究所
印　　刷　山田軽印刷所

JAERI-M 87-088

Analysis of the Mass Formula Dependence of Spallation Product Distribution

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(Received May 25, 1987)

A new version of a spallation reaction simulation code NUCLEUS has been developed by incorporating the newly revised Uno & Yamada's mass formula. The mass formula dependence of the spallation product distribution has been investigated by comparing the new results with those calculated by the original version which uses the combination of the Cameron's mass formula and the mass table compiled by Wapstra et al. Detailed differences between these two mass formulas are shown in the comparisons of mass excess values. The distributions of spallation products of a uranium target nucleus bombarded by high energy (0.38-2.9 GeV) protons have been calculated with the new and original versions of NUCLEUS. The calculated results show that there is no significant discrepancy in the non-fission component of cumulative product yields such as the mass distribution and the number of emitted neutrons but in the fission component Uno & Yamada's mass formula reproduces the measured data obtained from thin foil experiments significantly better, especially in the neutron excess side, than the Cameron's one.

Keywords: Spallation, Evaporation, Fission, Proton, Pion, Neutron, Nucleon, Intranuclear Cascade, Spallation Products, Residual Nucleus, Compound Nucleus, Mass Formula, Neutron-deficient Nuclide, Neutron-excess Nuclide, Accelerator Breeding, Transmutation, High Energy Nuclear Reaction, Monte Carlo Method

スポレーション核反応生成物の質量公式依存性の解析

日本原子力研究所東海研究所原子炉工学部
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（1987年5月25日受理）

スポレーション核反応シミュレーション・コードNUCLEUSを改良し，宇野＆山田の質量公式を用いて核破砕反応計算を行える版を新たに開発した。従来のNUCLEUSでは，Wapstraの質量表やCameronの質量公式を用いて計算していたが，この新しい版の併用により，質量公式のスポレーション生成物計算に対する影響を比較しながら議論できるようになった。質量公式自身の差については，核種の超過質量の計算値によって示す一方，両質量公式を用いて高エネルギー陽子（0.38～2.9 GeV）とウラン原子核の反応生成物の計算を行った。その結果，生成核種の質量分布や放出粒子数など積分的な量については，両公式で有意な差は見られないが，核分裂生成物など個々の生成量，特に中性子超過核の場合については，宇野＆山田の式の方がCameronの式より実験データをよりよく再現することが明らかになった。

東海研究所：〒319－11　茨城県那珂郡東海村白方字白根2－4

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1. Introduction

In the nuclear spallation reaction of a heavy nucleus bombarded by high energy protons, almost all kinds of nuclides are produced due to the vehemence of the reaction. Although most of them will decay to stable nuclides in a short time, it is very important in the research of the transuranic waste transmutations that the accumulation of nuclides with long lifetime can be estimated as acculately as possible.

In the assessment of the feasibility of the idea of transmuting the transuranic wastes by using spallation reactions, it is necessary to show that the storage time of transuranic wastes can be significantly shortened from the practical point of view. It is very interesting and important also from the pure nuclear physics point of view to investigate the details of spallation reaction and the decay mechanism of a strongly excited nucleus.

In our previous Monte Carlo calculations performed by using the NUCLEUS code,[1] the spallation reactions of a uranium nucleus were studied for incident proton energies of 0.38, 1, 2 and 2.9 GeV. It has been found that in the comparisons of charge dispersion curves the agreements are not satisfactory enough with the measurements reported by G. Friedlander et al. [2], in particular, for the neutron excess wings of the curves.[1] The computational scheme employed in the NUCLEUS code is essentially the same as that of the NMTC/JAERI code [3], except that NUCLEUS simulates only the intra-nuclear cascade and the competition between high energy fission and particle evaporations. In both codes the binding energies of particles emitted during the reaction are calculated with the combined use of the Cameron's mass formula and the mass table compiled by Wapstra et al., in the same way as in the original NMTC code.[4]

On the other hand, Uno and Yamada have developed a new mass formula by utilizing recent experimental mass data to predict masses of unknown nuclides far from stability with greater reliability.[5] In the nuclear spallation a lot of nuclides, which often appear far apart from stability, are produced. This fact suggests that the use of new mass formula will improve the accuracy of our calculations.

A new version of NUCLEUS has been developed by incorporating the newly revised Uno & Yamada's mass formula. The mass formula dependence of spallation product distribution has been investigated by using the original and new versions of NUCLEUS. In the calculations both with the original NUCLEUS and NMTC/JAERI, some product nuclides near the neutron or proton drip line are often lost in counting the Monte Carlo events due to dimensional restriction in the code and the repulsion criterion for the events outside the current nuclide chart. These restrictions are removed in the new version of NUCLEUS to avoid the counting loss of nuclides which are unknown as yet experimentally.

First, we briefly outline the calculational method of nuclear spallation reaction and describe in more detail two mass formulas. Secondly calculated results are shown, in comparison with experiments when measured values are available, for mass excess values, mass distributions, spallation product yields and the number of emitted particles. Finally we give a conclusion and discuss some problems to be further investigated.

2. Calculational method

2.1 Theoretical model of nuclear spallation reaction

A nucleus bombarded by a sufficiently energetic particle, such as a proton with the energy of hundreds to thousands MeV, undergoes a complicated destruction process, i.e., so-called spallation. The theoretical models used in a Monte Carlo code NUCLEUS [1] for simulating the spallation reaction are essentially the same as those in NMTC / JAERI [3]. For the sake of clear understanding of the role of the nuclear mass formula in the spallation calculation, a brief description of the theoretical models and the computational method is given in the following. We use the two step model which consists of the intranuclear cascade and the subsequent competing decay by the high energy fission or particle evaporation.

When a high energy particle is injected into a heavy nucleus, the intranuclear cascade of nucleons, pions and knocked-on particles are computed as the first step of the nuclear reaction. In the present model a nucleus is assumed to be a sphere of a degenerate Fermi gas, in which the two body collision model [6] gives a good approximation to the collision processes during the intranuclear cascade in the energy range higher than about 100 MeV. The characteristics of nuclear matter are determined by the distributions of nucleon density, momentum and potential energy. At each nucleon-nucleon collision event the relativitistic conservations in a particle's energy and momentum are checked and it is examined also if Pauli's exclusion principle admits the scattered Fermions. Pion production cross sections are calculated using the Isobar model. [7] At the instant when the intranuclear cascade has ceased, the residual nucleus remains in the strongly excited state of the excitation energy as high as hundreds MeV.

In the second the highly excited residual nucleus decays selecting the path to the evaporation or the nuclear fission as the subsequent process according to the fission probability based on the Bohr-Wheeler theory with the level density parameters [8] fitted to Ilinov's experimental data.[9] A semi-empirical combination of the Gaussian and folded - Gaussian distributions is used to determine masses of fission fragments, and their charges are selected from the Pik - Pichak & Strutinskii distribution. [8],[10] The evaporation calculation is carried out for neutron, proton, deuteron, triton, helium 3 and alpha particle emitted from an excited residual nucleus or excited fission fragments, using the Weisskopf model which is based on the statistical theory for a degenerate Fermi gas. The evaporation probability P_x of a particle x with the kinetic energy ε from the excited compound nucleus is given as

$$P_x = (2S_x + 1)\, m_x\, \varepsilon\, \sigma_{CX}(\varepsilon)\, \omega(E), \qquad (1)$$

where

S_x : *particle x's spin,* m_x : *particle x's mass,*

σ_{CX} : *inverse reaction cross section,*

E : *(excitation energy of compound nucleus)* $- \varepsilon - Q_x$,

Q_x = *particle x's binding energy* ,

$\omega(E)$: *level density in a nucleus with energy E* ,

where $\omega(E)$ is formulated by Hurwitz and Bethe as the following :

$$\omega(E) = \omega_0 \exp\left(2\sqrt{a\,(E - \delta)}\right),$$

where

a : *level density parameter,* $= \frac{A}{10}$ *in our calculation* ,

δ : *pairing energy correction* ,

A : *mass number of a compound nucleus* .

The mass excess is defined as $M(A,Z)=M-A$, where M and A are the mass and mass number, respectively, Z being the atomic number. If we define the mass number, atomic number and mass excess of the particle x as $AEP(x)$, $ZEP(x)$ and $EXMASS(x)$, respectively, as follows,

$AEP(1) = 1$, $ZEP(1) = 0$, $EXMASS(1) = M(1, 0)$,

$AEP(2) = 1$, $ZEP(2) = 1$, $EXMASS(2) = M(1, 1)$,
$AEP(3) = 2$, $ZEP(3) = 1$, $EXMASS(3) = M(2, 1)$,
$AEP(4) = 3$, $ZEP(4) = 1$, $EXMASS(4) = M(3, 1)$,
$AEP(5) = 3$, $ZEP(5) = 2$, $EXMASS(5) = M(3, 2)$,
$AEP(6) = 4$, $ZEP(6) = 2$, $EXMASS(6) = M(4, 2)$,

the binding energy Q_x is calculated by the following equation,

$$Q_x = M(A - AEP(x),\ Z - ZEP(x)) + EXMASS(x) - M(A,Z) . \qquad (2)$$

In the present work we adopted two different mass formulas, Cameron's [3],[11] and Uno & Yamada's [12],[13] to examine their effects in the Monte Carlo simulation of nuclear spallation reactions.

2.2 Cameron's mass formula

In NUCLEUS and NMTC/JAERI codes the $M(A,Z)$ value is taken from the Wapstra and Huizenga mass table . For nuclides not included in the table, Cameron's mass formula [11], fitted to the Wapstra and Huizenga mass table, is used to calculate the binding energy of an emitted particle. The main part of the following description in this section is the excerpt from Ref.(11), but some expressions are changed to be consistent with our definitions.

The Cameron's mass formula is written in the following symbolic form in MeV energy units :

$$M(A,Z) = 8.367\ A - 0.783\ Z + E_v + E_s + E_c + E_{ex} + S(Z,N) + P(Z,N), \tag{3}$$

where the subscripts v,s,c and ex denote volume, surface, Coulomb and Coulomb exchange energies, respectively. The first two terms on the right-hand side give the mass excess of the neutrons and protons in the nucleus. $S(Z,N)$ and $P(Z,N)$ represent the empirical shell corrections and pairing energies.

The volume energy term is expressed as the sum of the volume saturation and the volume symmetry energies ;

$$E_v = \alpha\ (1 - \frac{\beta}{\alpha}\frac{(A-2Z)^2}{A^2})\ A, \tag{4}$$

where α and β are constants to be determined, values of which are given later in Eq.(10).

As seen in a trapezoidal radial model of the nucleus such as shown in Fig. 1, the nuclear radius R is defined as the distance from the center to the point at which the nuclear density has 50 % of the central value ρ_0. The half skin thickness z is set to a constant, 1.5×10^{-13} cm. The Stanford results [14] are then fitted by the formula

$$R = 1.112\ A^{1/3}\ (1 - \frac{0.62025}{A^{2/3}}) \times 10^{-13}\ cm. \tag{5}$$

As it seems appropriate to take the sphere of radius R as the reference surface of nucleus, it is assumed that the surface energy is proportional to the area of this reference surface. Feenberg [15] pointed out that the surface energy should also contain a symmetry energy contribution. Therefore the surface energy is written in the form :

$$E_s = \gamma \left(1 - \frac{\varphi}{\gamma}\frac{(A-2Z)^2}{A^2}\right)\left(1 - \frac{0.62025}{A^{2/3}}\right)^2 A^{2/3} , \tag{6}$$

where γ and φ are constants to be determined, values of which are given also in Eq. (10).

The Coulomb energy E_c was obtained for the nuclear model of Fig. 1 by well-known methods.[16] The result is

$$E_c = 0.779 \frac{Z(Z-1)}{A^{1/3}}\left(1 - \frac{1.5849}{A^{2/3}} + \frac{1.2273}{A} + \frac{1.5772}{A^{4/3}}\right) . \tag{7}$$

The Coulomb exchange energy arises from the correlation in the motion of protons in the nucleus. Since it is a small term, it was decided to adopt the calculation of Bethe and Bacher [16] for the nuclear model. The result is

$$E_{ex} = -0.4323 \frac{Z^{4/3}}{A^{1/3}}\left(1 - \frac{0.57811}{A^{1/3}} - \frac{0.14518}{A^{2/3}} + \frac{0.49597}{A}\right) . \tag{8}$$

The terms $S(Z,N)$ and $P(Z,N)$ were determined empirically as described in the following. Equation (3) without the shell correction and pairing energy terms is referred to as the reference mass formula :

$$M(A,Z)_{ref} = 8.367\, A - 0.783\, Z + E_v + E_s + E_c + E_{ex} . \tag{9}$$

The coefficients β nd φ were determined by a least squares procedure in which the properties of the actual valley of beta stability at many points were substituted into the equation which was obtained by differentiating Eq. (9) with respect to Z and setting the resulting equation to zero. The remaining two constants α and γ were determined also by a least-squares fit of the reference mass formula to experimental mass excesses. The resuling values were given as follows :

$$\beta = -31.4506\ MeV\ , \quad \varphi = 44.2355\ MeV\ , \tag{10}$$

$$\alpha = -17.0354\ MeV\ , \quad \gamma = 25.8357\ MeV\ .$$

The differences between the masses calculated from Eq. (9) with the constants given above and the 89 odd-odd masses are plotted in Fig. 2.[11] Equation (9) is considered to give a relatively good fit to the trend of the mass over the entire mass range shown. The trend seen in Fig. 2, however, shows quasi-periodic deviations increasing with A. This indicates that corrections should be made to the reference mass formula. Following the procedure of Green and Edwards [17], Cameron assumed that the shell correction and pairing energies can be written as independent functions of the neutron and proton numbers ;

$$S(Z,N) = S(Z) + S(N), \qquad P(Z,N) = P(Z) + P(N). \tag{11}$$

The functions $S(Z)$,$S(N)$,$P(Z)$ and $P(N)$ were determined in the following way. The odd-even effect in neutron and proton binding energies was attributed to the pairing energy. Therefore, the residual energy differences between pairing-corrected reference masses and measured masses were assumed to be smooth functions of the neutron and proton numbers. The following quantities were formed from Wapstra-Huizenga masses ;

$$\Delta = M(A,Z)_{meas} - M(A,Z)_{ref}\ . \tag{12}$$

The shell corrections were then approximately given by

$$S(Z,N) = \Delta(Z,N) - P(Z,N)\ , \tag{13}$$

where trial quantities $P(Z,N)$ were assumed to be the pairing energies of Newton [18] as the first approximation. Proton and neutron effects were separated by forming shell correction differences, which (for protons) are

$$\delta S(Z) = S(Z) - S(Z-1) \tag{14}$$

$$= \Delta(Z,N) - \Delta(Z-1,N) - P(Z,N) + P(Z-1,N) \ . \qquad (15)$$

These differences were weighted inversely as the squares of the errors in them, and weighted averages of those were computed over the whole region of values of N for each Z and smoothed. The average differences $\delta S(N)$ were calculated similarly. These smooth differences were summed to form $S(Z)$ and $S(N)$, and the analysis was inverted to obtain empirical values for $P(Z)$ and $P(N)$. These in turn were to improve $\delta S(Z)$ and $\delta S(N)$. The final step in the empirical determinations was to form the quantities :

$$\Delta(Z,N) - P(Z,N) - S(Z,N) \ . \qquad (16)$$

The functions $\delta S(Z)$ and $\delta S(N)$ were adjusted in a manner that the weighted averages of $\Delta(Z,N)$ should approach zero as closely as possible. Final results are shown in Fig. 3 (a) and (b). These functions seem to be quite smooth except for discontinuities at shell edges. Extrapolations of the shell correction differences to higher nucleon numbers are shown as dashed lines in Fig. 3. These extrapolations are based on the assumptions of a closed proton shell at Z = 126 and a closed neutron shell at N = 184.

2.3 Uno & Yamada's mass formula

The main part of the following description in this section is also the excerpt from Ref.(12), and some expressions are changed to be consistent with our definitions. In Uno' & Yamada's mass formula [5],[12],[13],[19], the mass formula for the nuclide with Z protons and N neutrons is given as the following form :

$$M_E(Z,N) = M_{Eg}(Z,N) + P_Z(N) + Q_N(Z) - \Delta M_{odd\text{-}odd}(A) \qquad (17)$$

Here , $M_{Eg}(Z,N)$ is a smooth function of Z and N representing the gross feature of the nuclear mass surface.[20] The gross term corresponds to the reference mass formula in Section 2.2. The terms $P_Z(N)$ and $Q_N(Z)$ are the proton and neutron shell terms, respectively. The last term is a small correction for odd–odd nuclei.

The gross part $M_{Eg}(Z,N)$ is expressed in MeV as follows :

$$M_{Eg}(Z,N) = 7.68023A + 0.39120I + a(A)A + b(A)\,|I| + c(A)I^2/A$$

$$+ E_c(Z,N) - 14.33 \times 10^{-6}\, Z^{2.39}\,, \tag{18}$$

where $A=N+Z$, $I=N-Z$,

$$a(A) = a_1 + a_2\, A^{-1/3} + a_3\, A^{-2/3} + a_4\, A^{-1}\,, \tag{19}$$

$$b(A) = b_1\, A^{-2/3}\,,$$

$$c(A) = c_1 + c_2\, A^{-1/3} + c_3\, A^{-2/3} / (1 + c_4\, A^{-1/3})\,.$$

The Coulomb energy $E_c(Z,N)$ is taken as that for the trapezoidal charge distribution similar to the one shown in Fig.1 :

$$E_c(Z,N) = \frac{0.864}{r_0} \left(\frac{R}{r_0}\right)^5 \left(1 + \frac{5}{6} q^2 + \frac{1}{2} q^3 + \frac{1}{6} q^4 - \frac{1}{42} q^5\right) \left(\frac{Z}{A}\right)^2$$

$$- \frac{0.66}{r_0} \left(\frac{Z}{A}\right)^{4/3} A\,, \tag{20}$$

where

$$q = \frac{z}{R}\,,$$

$$R = r_0 \left(\left(\sqrt{s} + \frac{A}{2} \right)^{1/3} - \left(\sqrt{s} - \frac{A}{2} \right)^{1/3} \right),$$

$$s = \left(\frac{A}{2}\right)^2 + \frac{1}{27} \left(\frac{z}{r_0}\right)^6\,,$$

The radius parameter r_0 is 1.13 fm and the half surface thickness z 1.5 fm. The last term in Eq. (18) is the binding energy of atomic electrons. The correction term for odd-odd nuclei is, on the average, expressed as [5]

$$\Delta M_{odd\text{-}odd}(A) = \frac{11719.21}{(A + 31.4113)^2} - \frac{1321495}{(A + 48.1170)^3}\,. \tag{21}$$

The shell terms $P_Z(N)$ and $Q_N(Z)$ are assumed to have the constant form

$$P_Z(N) = P_Z, \qquad Q_N(Z) = Q_N\,. \tag{22}$$

The values of the gross-part parameters, a_i, b_i, c_i were obtained through a procedure similar to that described in Ref. (5) as

$$a(A) = -17.080 + 30.138\ A^{-1/3} - 31.322\ A^{-2/3} + 24.192\ A^{-1}\ , \tag{23}$$

$$b(A) = 15.0\ A^{-2/3}\ ,$$
$$c(A) = 35.217 - 89.811\ A^{-1/3} + 92.940\ A^{-2/3}/(1 + 0.56912\ A^{-1/3})\ .$$

Actual values of the shell parameters, P_Z and Q_N, whose number amounts to about 250, were determined by a new statistical method proposed in Ref. (12). A brief description of the method is given below.

In determining the values of the shell parameters, only even-even and odd-A nuclei were used, excluding odd-odd ones because of the irregularity of their mass surfaces. The mass excesses of these nuclei were simply written as

$$M_E(Z,N) = M_{Eg}(Z,N) + P_Z + Q_N \tag{24}$$

in the case of the constant shell form. The sum of values of the shell parameters P_Z and Q_N should be determined to reproduce the difference between the experimental mass and the gross-part, $M_{Eexp}(Z,N) - M_{Eg}(Z,N)$, as accurately as possible. In order to divide the "experimental shell energies", $M_{Eexp}(Z,N) - M_{Eg}(Z,N)$, into the proton and neutron shell terms as $P_Z + Q_N$, an iteration method was used. First, Eq. (25) was computed with some initial guess values for Q_N's ;

$$y_Z(N) = M_{Eexp}(Z,N) - M_{Eg}(Z,N) - Q_N, \tag{25}$$

which is called the "experimental" proton shell energy. Next, the values of P_Z's were adjusted in such a way as to fit to the "experimental" proton shell energies. (STEP I) Using these values of P_Z's, the "experimental" neutron shell energy is computed as

$$M_{Eexp}(Z,N) - M_{Eg}(Z,N) - P_Z. \tag{26}$$

Again the values of Q_N's were adjusted so as to fit to the "experimental" neutron shell energies. (STEP II) The values of Q_N's thus obtained are generally different from those used in STEP I. These steps (I) and (II) were repeated until the parameter values converge.

The "intrinsic errors" were attached to the shell terms P_Z and Q_N, and denoted by α_Z and β_N, respectively, in the sense of standard deviation. Generally these intrinsic errors are different if Z's or N's are different. In addition the "extrinsic errors" coming from the uncertainties in the determination of the values of the shell parameters P_Z and Q_N were taken into accounts and denoted as ΔP_Z^{ext} and ΔQ_N^{ext} for the proton and neutron, respectively. The error of the "experimental" proton shell energy $y_Z(N)$ is written as

$$\eta_Z(N) = (\varepsilon_Z(N)^2 + \beta_N{}^2 + (\Delta Q_N^{ext})^2)^{1/2}, \tag{27}$$

where $\varepsilon_Z(N)$ is the error of $M_{Eexp}(Z,N)$. Thus the problem was reduced to the determination of P_{Z0} (the best value of P_Z), ΔP_Z^{ext}, and α_Z by comparison with $y_Z(N)$ and $\eta_Z(N)$. Similary, Q_{N0}, ΔQ_N^{ext}, and β_N were determined. Finally the theoretical error for the mass formula is experessed as

$$\delta M(Z,N) = (\alpha_Z{}^2 + \beta_N{}^2 + (\Delta P_Z^{ext})^2 + (\Delta Q_N^{ext})^2 + (\tfrac{1}{3}\, \Delta M_{odd\text{-}odd}(A))^2)^{1/2} . \tag{28}$$

In the final formula the root mean square of α_Z is 319 keV for even Z and is 398 keV for odd Z, and that of β_N is 326 keV for even N and is 341 keV for odd N. The most probable (best) values of the shell parameters, P_{Z0} and Q_{N0} are shown in Fig. 4 (a) and (b). These figures show marked dips at the magic numbers, 6, 14, 28, 50, 82 and 126, but not at the magic numbers 8 and 20. The separation of the P_{Z0} plot (and also of the Q_{N0} plot) into two lines is simply due to the even-odd effect. The intrinsic errors α_Z, β_N have fairly large fluctuations for some particular values of Z and N near magic number, as shown in Fig. 5 (a) and (b). The extrinsic errors in Fig. 5 (c) and (d) can be said rather small for all Z and N. Some shortcomings of the formula have been pointed out by Uno and Yamada themselves.[12] As for the charge symmetry of nuclear force, which should guarantee an approximate equality of P_Z and Q_N for $Z = N$ in the region of light nuclei (Z, N < 20), the new formula does not improve the old one. The steep decrease of P_Z with large Z and the steep increase of Q_N with large N, seen in Fig.4, indicate a shortcoming of the formula with the constant shell term.

For the sake of our own research work a computer program for computing the mass excesses by both mass formulas has been developed by us at JAERI.

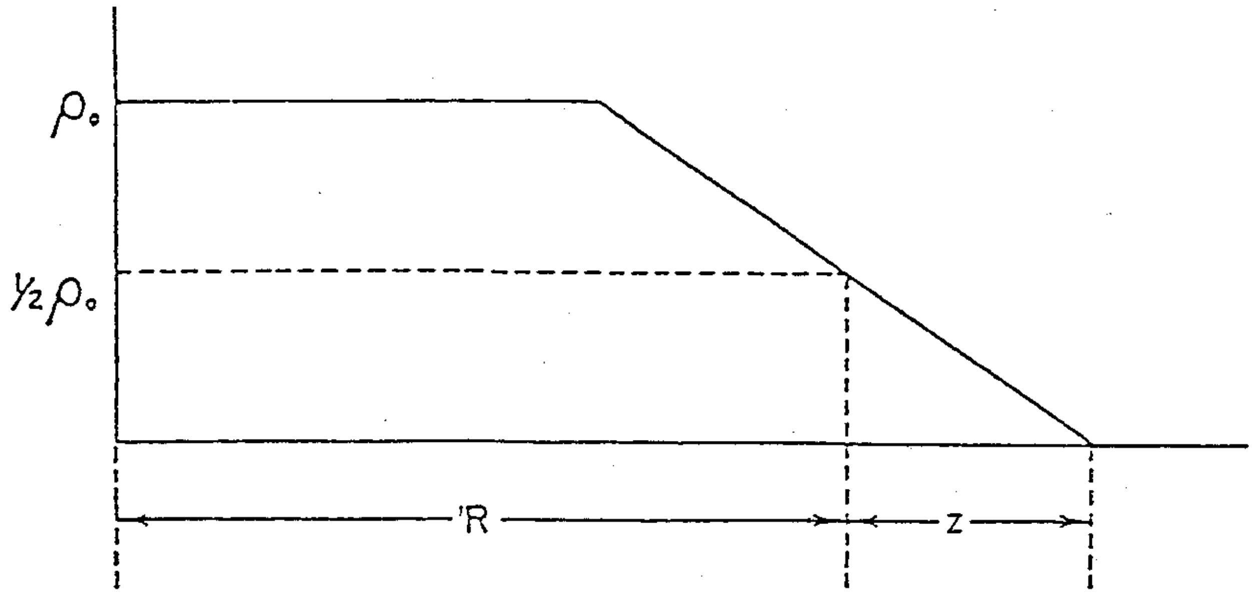


Fig.1 The trapezoidal radial model of the nucleus.(11)

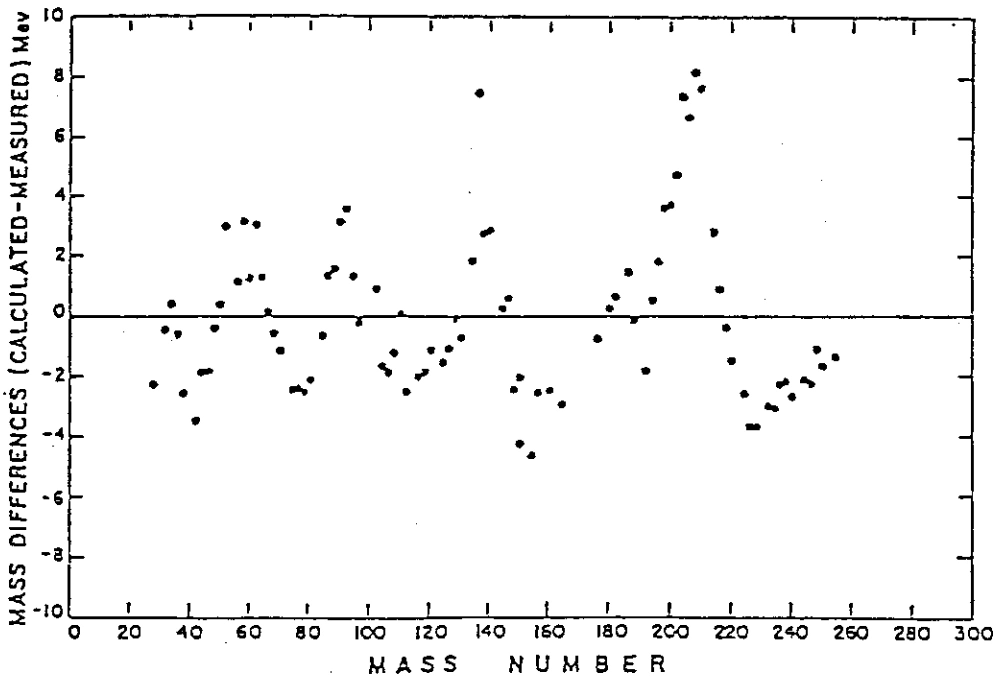
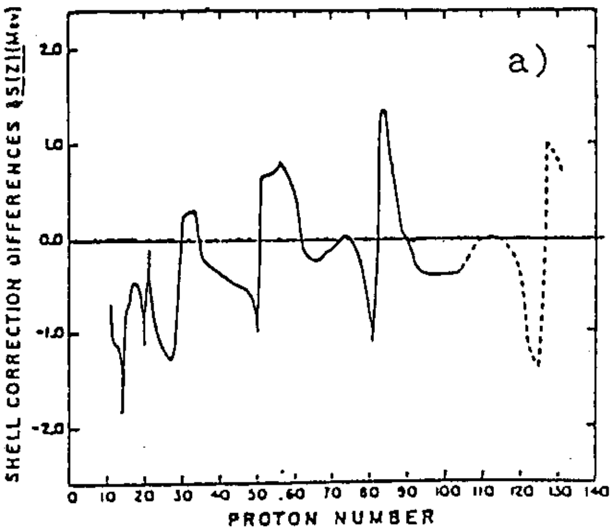


Fig.2 Comparison of 89 odd-odd mass excesses with the Cameron's reference mass formula.(11)



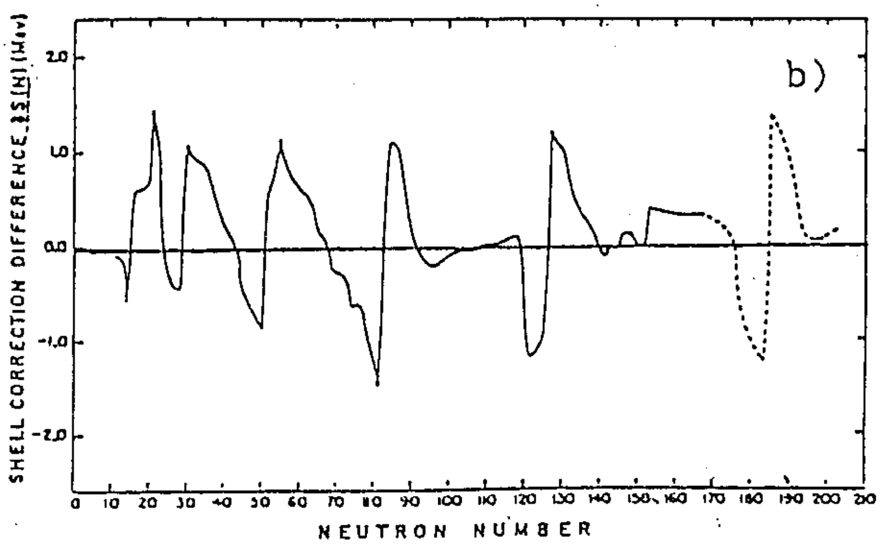


Fig.3 (a) Empirical shell correction differences for protons [11]
(b) Empirical shell correction differences for neutrons [11]

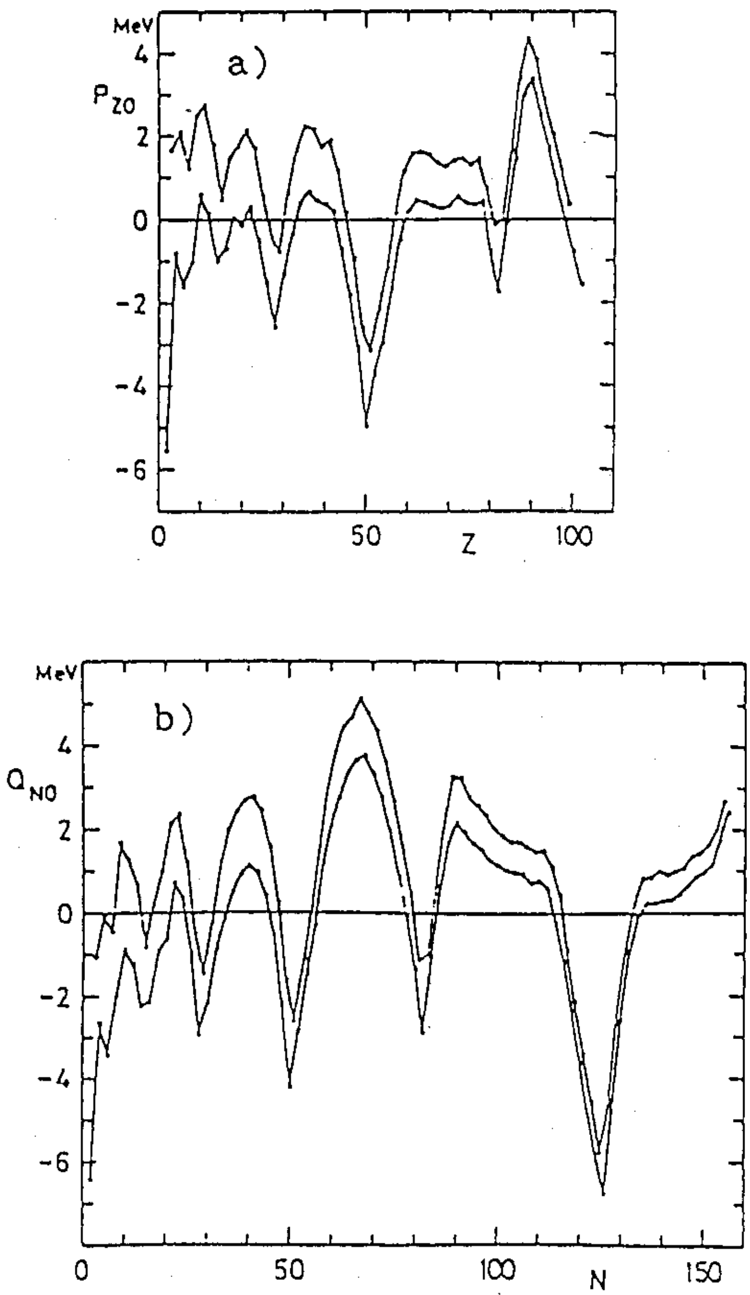


Fig.4 (a) The most probable (best) value of the proton shell term P_{Z0} plotted against Z [12]

(b) The most probable (best) value of the neutron shell term Q_{N0} plotted against N [12]

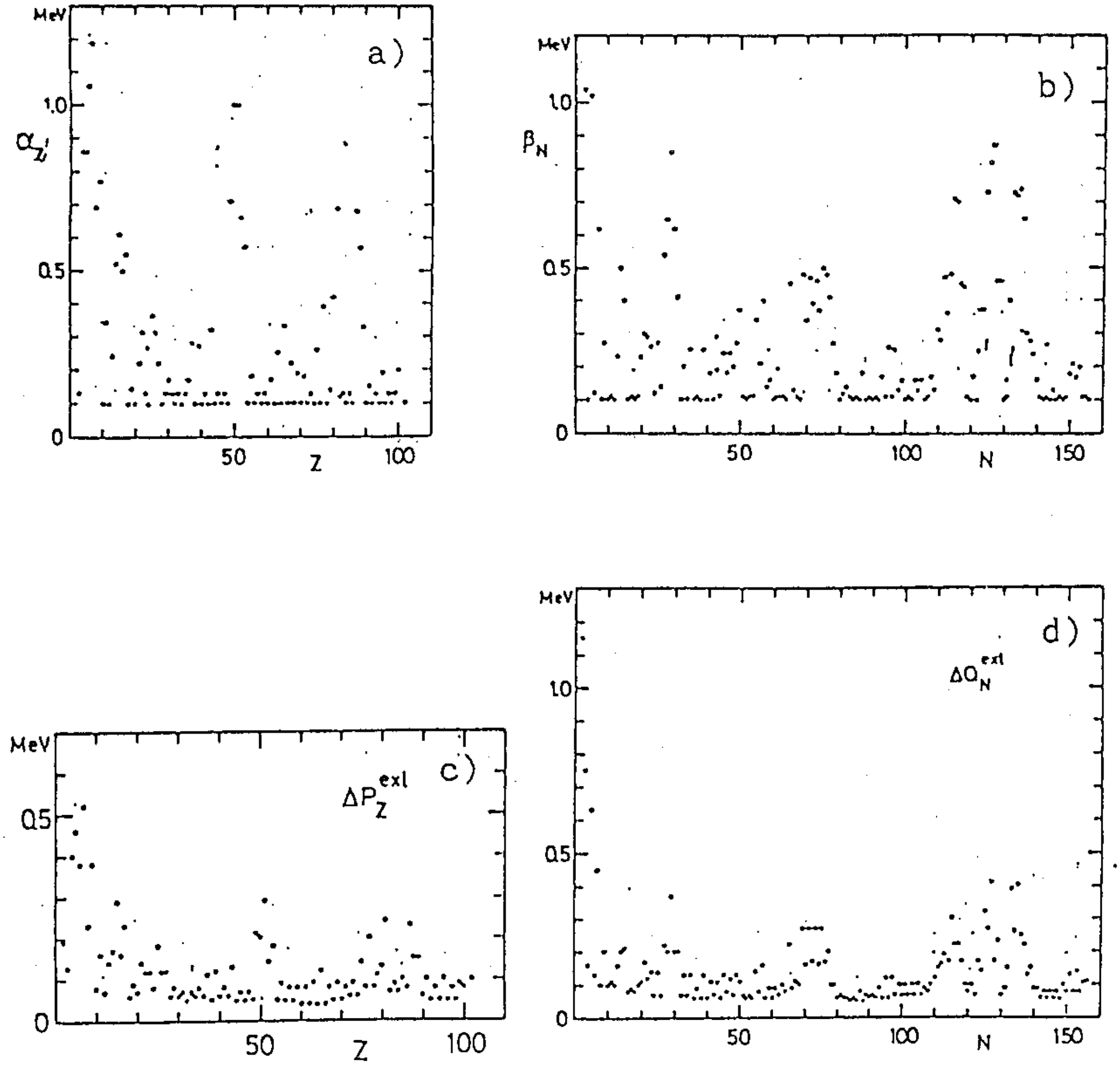


Fig.5 (a) The intrinsic error of the proton shell term α_Z plotted against Z [12]

(b) The intrinsic error of the neutron shell term β_N plotted against N [12]

(c) The extrinsic error of the proton shell term ΔP_Z^{ext} plotted against Z [12]

(d) The extrinsic error of the neutron shell term ΔQ_N^{ext} plotted against N [12]

6. 結　　論

サポートポスト構造の基礎的な振動特性を調べるために，垂直二次元振動試験体を用いた強制振動試験を行った。更に，試験結果をLagrangeの式より導出した振動方程式に基づく解析結果と比較・検討し，次のような結論を得た。

(1) サポートポスト構造の復元力特性は，転がり運動では正であるが，滑り運動では負の剛性となる倒壊型を示す。

(2) サポートポスト構造の減衰比は，ポストの支持質量の増加により低下する傾向がある。

(3) 滑り運動が生じたサポートポストは傾斜及び転倒し易くなる。

(4) サポートポスト構造の共振振動数は，Lagrangeの式を用いた解析結果に良く一致する。

(5) サポートポスト構造の転がりと滑り運動から成る非線形強制振動特性は，過渡応答波形より求まる減衰比を用いた解析結果によって良く表せる。

謝　辞

本研究の遂行に当たり，有益な御助言と御討論を頂いた日本原子力研究所動力炉開発・安全性研究管理部　佐野川好母部長並びに同燃料安全工学部プラント安全解析室　幾島毅主任研究員，及び同動力炉開発・安全性研究管理部多目的高温ガス実験炉設計室　伊与久達夫研究員に謝意を表する。

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3. Results and discussions

Analysis of the distributions of the products from the proton spallation reaction of a nucleus gives us a significant clue to investigate the nuclear physical processes governing the reaction. It is generally known that the products yielded in the nuclear spallation reaction consist mainly of residual nuclei in the evaporation stage of nuclear reaction, in the computer simulation of which the precision of the mass formula is crucial in getting good results. In order to make clear how important the mass formula is in predicting the spallation product distribution, we have performed the calculations of the distributions of spallation products as well as evaporated particles, using two mass formulas, i.e., Cameron's and Uno & Yamada's, and compared the results with measured data (reported in Friedlander et al.'s paper [(2)]) for the spallation of a uranium nucleus bombarded by protons from 0.38 to 2.9 GeV.

We begin the presentation of our computational results with a detailed numerical comparison of the two mass formulas. Next, before proceeding to the discussions of the spallation product distribution, we explain an important improvement of our computational code in counting the nuclide production events. In the last section, main results of our calculations are summarized and discussed.

3.1 Numerical comparison of the two mass formulas

The numerical values of mass excesses of nuclides calculated by both mass formulas are plotted in Fig. 6 for isotopes of an element each with even Z from 92 down to 30. As seen in Fig. 6 (a) for $Z = 92 \sim 86$, these parabolic curves are in the positive side and in a good agreement with each other, whereas for $Z = 84 \sim 72$ the old Cameron's formula gives values larger than the new Uno & Yamada's one in the neutron deficient side, and its discrepansy turns out to be more than 8 MeV for a nuclide with Z = 82, A = 183. In the range from Z = 70 to Z = 52, where the mass excesses have deeply negative values as seen in Fig. 6 (b), both curves are in better agreement than in the other ranges. Their maximum discrepancy is only less than 3 Mev for the neutron deficient nuclides far from the β stable line. In this case the new formula has values larger than the old one. In the lighter mass range for Z=50~30, they approach to positive values again as Z decreases, as shown in Fig. 6 (c). The new has larger values for almost all isotopes than the old, and their difference becomes larger than 9 MeV especially at the edge of the neutron deficient side.

3.2 Extended region of nuclide production

The distribution of produced nuclides on a neutron number versus proton number plane, the (N, Z) plane, gives us the clear image of their decay schemes. Figure 7 illustrates the region where the Monte Carlo events corresponding to spallation fragment productions are counted. The region between the fine lines with blacked circles is the counting region allowed in the NMTC code and adopted also in the old versions of NMTC/JAERI and NUCLEUS. Monte Carlo events which happen to be outside the region are discarded as unphysical events. Through our experiences in various calculations using NMTC/JAERI and NUCLEUS, we have noticed that the number of discarded events would not be so few as to be allowed to be discarded only because nuclides corresponding to such events are not on the chart of nuclide, considering the real possibility of the existence of nuclides unregistered on the chart. With this thought in mind we have extended the (N,Z) region to eliminate counting losses of the events. The bold lines represent the extended region incorporated in the new version of the NUCLEUS code. These restricted and extended regions forming a band shape have widths of 31 and 61 nuclides in the N direction, respectively. The line with open squares represents the domain where nuclides were produced actually in the extended region in the spallation calculation of a uranium target nucleus for 1 GeV incident protons. As seen from the figure, the domain of produced nuclides extends outside the old region. The nuclides on neutron deficient (N > 80) and neutron excess extreme sides (75 > N > 45) had been lost in the old calculations. The triangle Δ denotes a stable nuclide. The line marked by cross (x) representing the boundary within which there exist nuclides listed in the current Chart of Nuclides [21] is depicted for reference. The straight lines in the figure will be explained later.

3.3 Effects of the mass formula on the spallation product distribution

Figure 8 shows the mass yield distributions for a uranium nucleus calculated by the new mass formula. The peak and the plateau seen in the heavier mass region (A > 160) correspond to intranuclear cascade and non-fission evaporation products. The most remarkable feature seen in Fig. 8 (a) is a peak around A = 210 which has not been reported yet as the experimental data anywhere. The peak collapses gradually as the proton energy increases. The spires in the lightest mass region correspond to evaporated α , ^3He + t and d. A relatively flat distribution between them is mainly due to the high energy fission. These trends are in a good agreement with those [1] calculated by the old mass formula. So there seems no appreciable difference between the mass distributions of spallation products obtained by using both mass formulas. The numbers of emitted particles per incident proton and nucleus are summarized in Table 1 for the new formula with the use of the extended region of nuclides. The yield of neutrons from a uranium nucleus is maximum, about 17, at 2 GeV and decreases slightly over 2 GeV probably because of an increase of nuclear transparency for incident protons. The values obtained with the old version of the NUCLEUS code (with the old mass formula and the restricted region) are shown in the parentheses in the cases of 1 and 2 GeV protons. It is apparent that both values are in a good agreement except the numbers of emitted protons and deuterons. For making the amount of produced nuclides visible on the (N,Z) plane, its bird eye's view is depicted in Fig. 9 for the proton impinging on a uranium nucleus with incident energies of 0.38, 1, 2 and 2.9 GeV. Figures 9 (a) ~ (d) are pictures watched from the neutron excess side near the origin, where the fine structures of three typical components of non-fission products, fission products and evaporated particles appear more clearly than in the mass distribution shown in Fig. 8. Non-fission pruducts (after the intranuclear cascade and the subsequent evaporation) become a typical double-peaked distribution, the one of which locates near the position of a target nucleus (uranium). The other peak collapes gradually as the incident energy increases. Fission -product yields are smaller by two orders than non-fission ones. Figures 9 (e) ~ (h) , on the other hand, present the images viewed from the neutron deficient side for the same energies. It seems that the cliff on the neutron deficient side becomes slightly less steep than in the images of the original case [1], especially in the region of fission fragments for energies above 1 GeV.

The yields of spallation products for 1 GeV protons impinging on a uranium nucleus, calculated with the old mass formula and the restricted counting region and accumulated over the mass number range from 125 to 140, are plotted in Figs. 10 (a), (b) and (c) to compare our simulation results with the measured data [2]. The lack of smoothness in the calculated histogram shows that the number of histories (50,000 protons) in the Monte Carlo calculation is not sufficiently large. The value of N/Z for a stable nuclide in this mass range is about 1.4. Both product distributions are in better agreement on the neutron deficient side than on the neutron-excess side (N/Z > 1.5). A double-peaked distribution at energies above 1 GeV, corresponding to the neutron-excess and neutron-deficient nuclides, could not be reproduced correctly by the calculations. However, the distributions on the side of lower N/Z values are in agreement with each other. Discrepancy is remarkable at the neutron-excess side (N/Z > 1.5). In order to see if the discrepancy can be improved by using the new mass formula, we performed the same calculations for three cases of (a) the old mass formula and nuclide region, (b) the old mass formula and the extended region and (c) the new mass formula and the extended region. Prior to making discussions on the results shown in Fig. 11, let us see Fig. 7 again. Two parallel lines drawn from the upper left side to the lower right side denote the mass number range of 125 ~ 140 used for getting cumulative yields. The straight lines drawn radially from the origin have each value of N/Z written in the figure. The minimum value of N/Z below which spallation nuclides are scarcely produced may be considered to be 1.2. The domain surrounded by the parallel lines and the two radial lines with N/Z values of 1.5 and 1.6 exists in the restricted region. Therefore, in the present calculation the reason of variation of yields of produced nuclei in this domain may be purely attributed to the selection of a mass formula. The computational results with the old mass formula (Fig. 11 (a) and (b)) show the lack of some nuclides with the N/Z values larger than 1.5. The use of new formula (Fig. 11 (c)) has just resulted in redistributing the nuclides and produced the double-peaked distribution. These spallation products with mass $A = 125 \sim 140$ obtained by using the new mass formula are plotted also in Fig. 12 (a),(b) and (c) for the proton energies of 0.38, 1.0 and 2.9 GeV in order to compare our simulation results with the measured data [2]. Both calculated and measured product distributions are in a good agreement in the whole range of N/Z from 1.2 to 1.6 except in the case of 0.38 GeV protons. A double-peaked distribution in the curve representing the measured data at energies above 1 GeV, corresponding to the neutron-excess and neutron-deficient peaks, has been reproduced successfully by the present Monte Carlo calculation using the new mass formula. Quantitatively speaking, however, there are some discrepancies between our calculations and the measured data. The reasons of discrepancies may be attributed to both the experimental data processing and the computational methods. The portion of the experimental curve beyond the peak on the neutron-excess side does not show the measured data but is the plot of values extrapolated by using the measured cumulative yields and the left tail of the distribution is also the extrapolation except the case of Fig. 12 (a). As seen in Fig. 12 (a) it is apparent that the amount of neutron-deficient nuclides becomes relatively larger systematically in the calculation in comparison with the measurement in spite of use of the new mass formula. This fact reminds us that it may be necessary to examine the consistency between the mass and charge distribution probabilities used in the Monte Carlo sampling of the fission fragments, because the former has been derived semi-empirically [8] and the latter is the theoretical one based on the statistical model of the fission. [10]

Calculated results for heavy spallation nuclides show that a variety of nuclei, especially many neutron-deficient nuclides, are produced. Figure 13 shows mass product yields, calculated with the same conditions as in the cases shown in Figs. 11 (a), (b) and (c), for elements with even Z from 92 down to 84, close to the uranium nucleus bombarded by a 1 GeV proton. As seen from these figures, a comparatively large amount of neutron-deficient nuclides are produced from the intranuclear cascade and evaporation processes. The peak for each element appears in the neutron-deficient side far from the stable isotopes which exist in the right tail of each distribution, except a target uranium. Due to their short half lifetimes most of them will change to stable nuclides in due time. As for uranium isotopes, there is a sharp peak at A = 237 and it is higher by an order than other element peaks. In Fig. 13 (a) the tail of a peak for each element is cut off in the neutron deficient side due to the artificial limitation in counting the corresponding Monte Carlo events. Then we find that for the case of

(b) corresponding to the use of the old formula and the extended region, the counting loss has just been recovered and the tail of peaks appears in the reasonable form. By the use of th new mass formula and the extended region, the corrected peaks have become wider than the ones in the case of (b), as seen in Fig. 13 (c). As pointed out by Sato et al. [22], more unconfirmed kinds of nuclides can exist outside the region of nuclides listed in the current Chart of the Nuclides. It can be said, therefore, that the appearance of nuclides outside the Chart of the Nuclides in our calculations can be considered reasonable and the region of counting the Monte Carlo events should not be restricted.

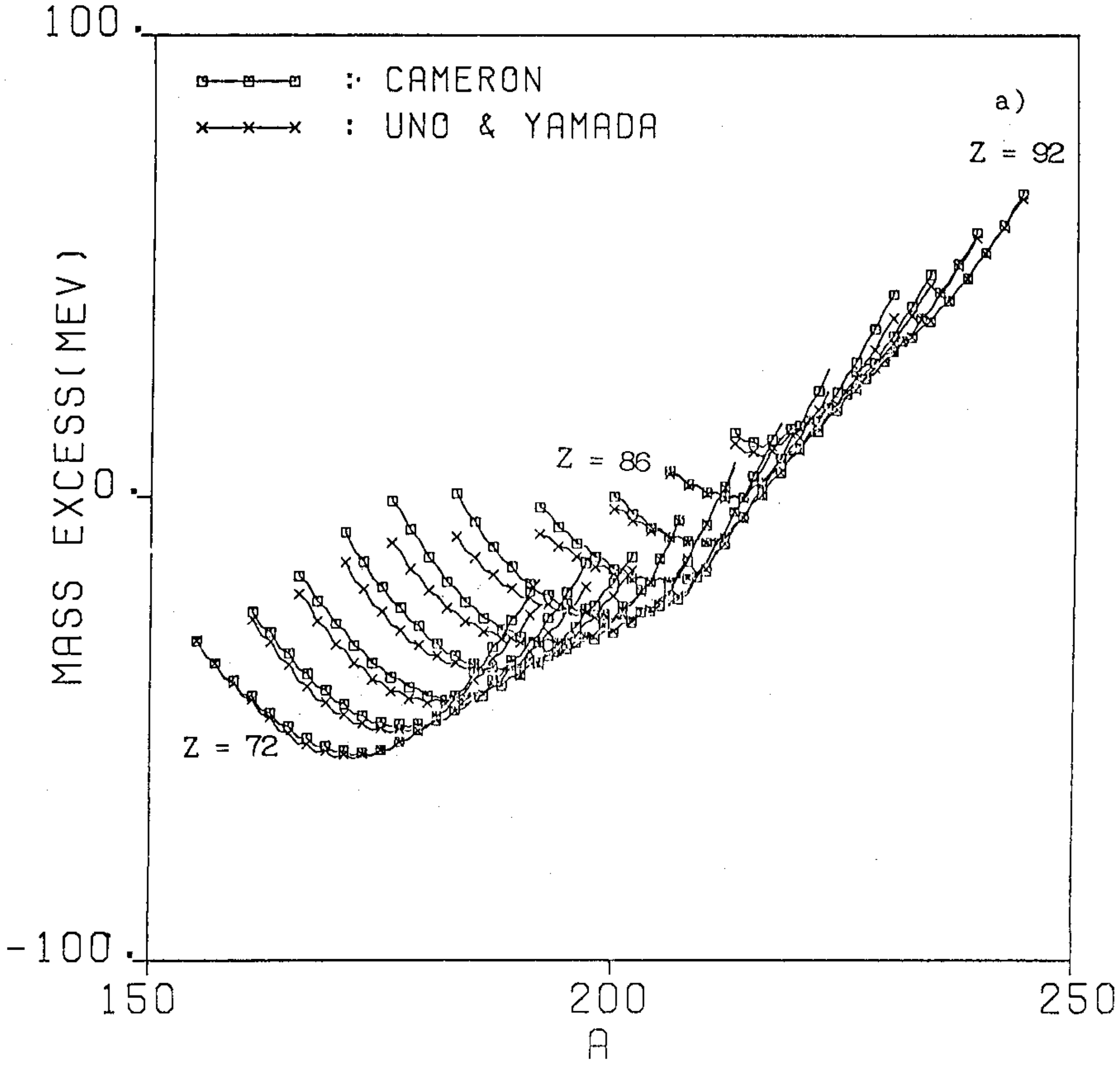

Fig.6 Mass excess distributions calculated by Cameron's and Uno & Yamada's mass formulas for elements with even Z :
a) 92 ~ 72 , b) 70 ~ 52 c) 50 ~ 30

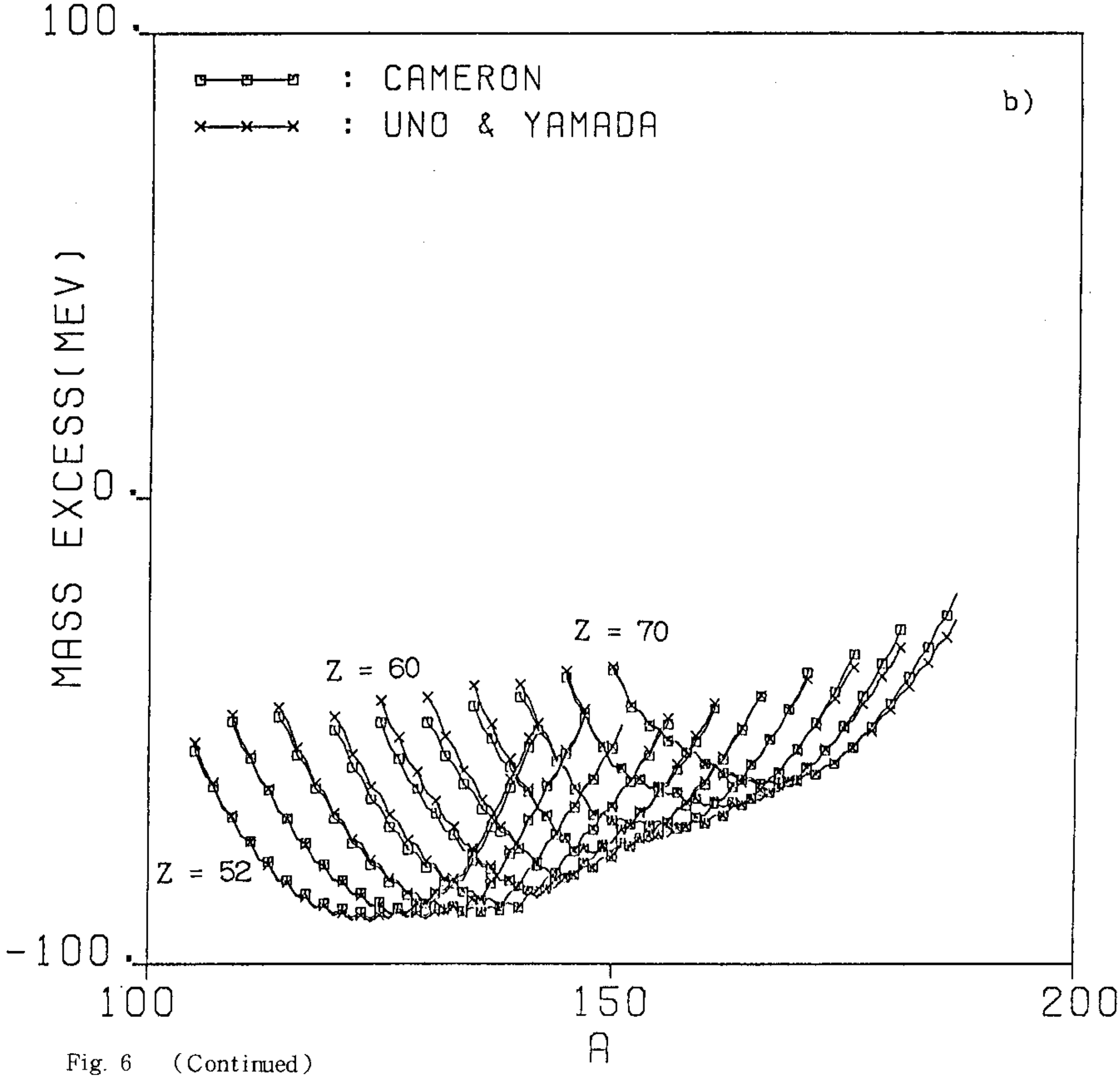

Fig. 6 (Continued)

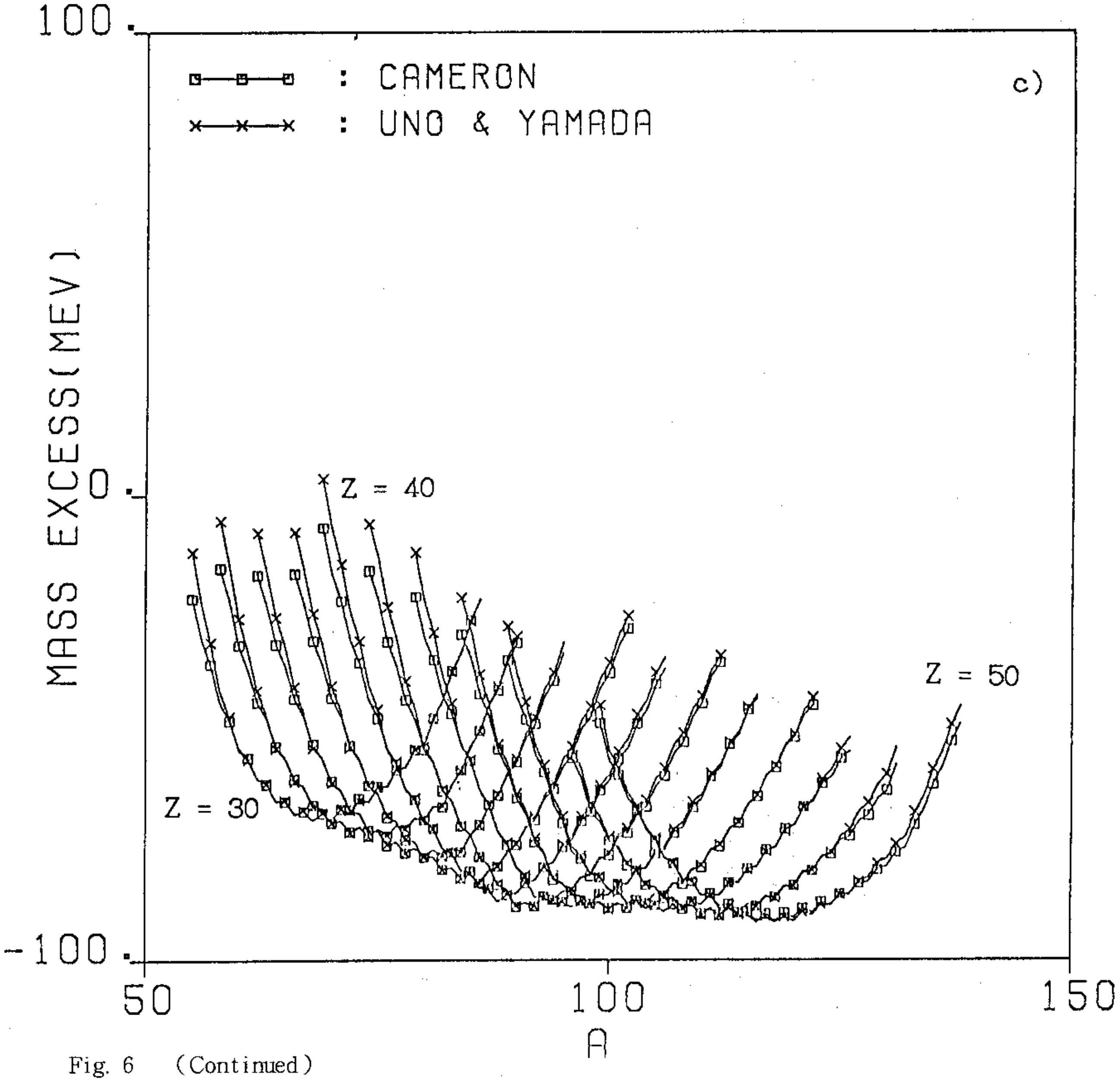

Fig. 6 (Continued)

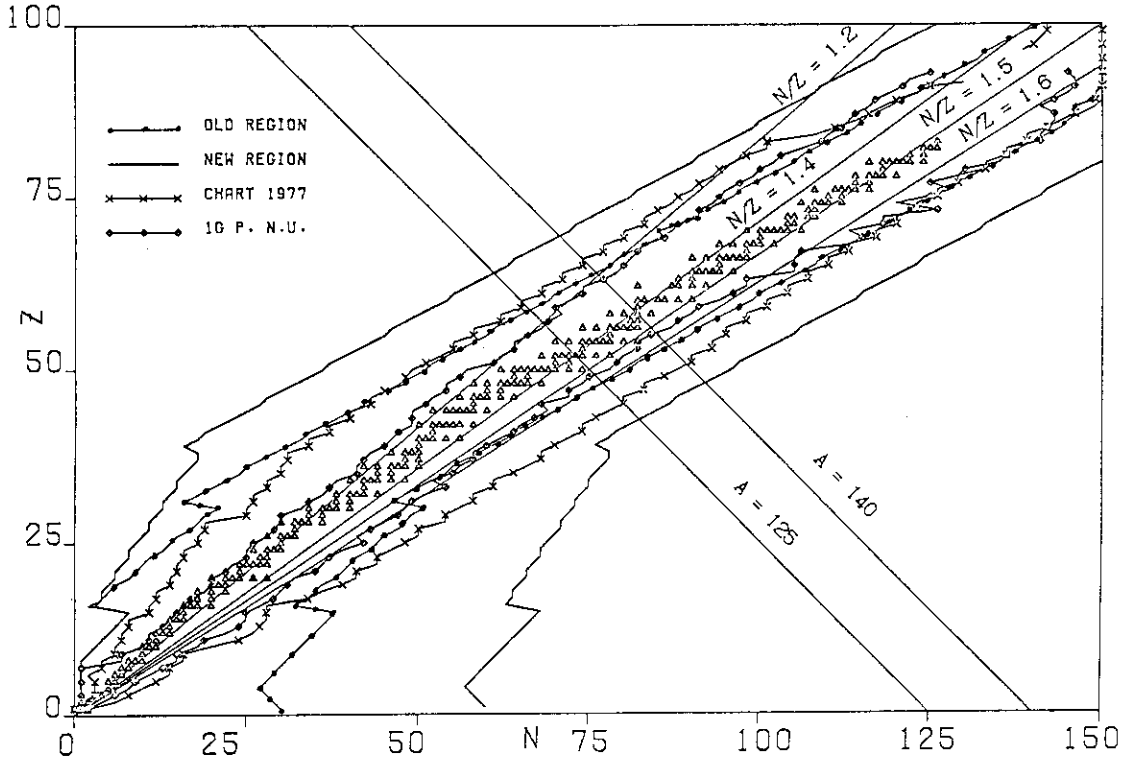

Fig.7 Regions for spallation nuclides to be counted on the neutron number (N) versus the proton number (Z) plane

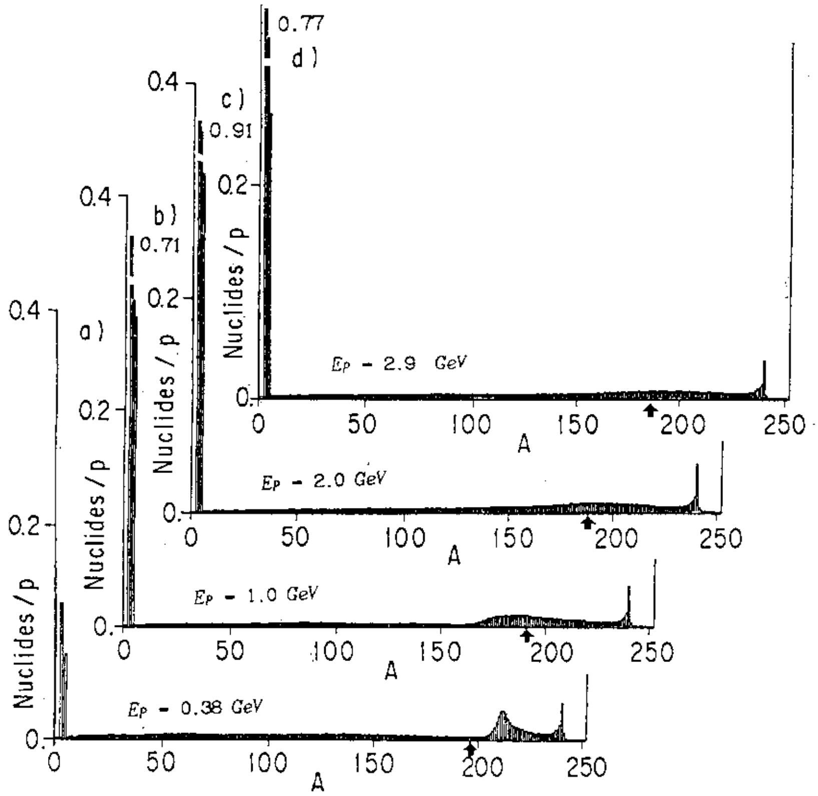

Fig.8 Mass yield distributions (per a target nucleus and an incident proton) versus the mass number A for a uranium nucleus bombarded by protons with energies of

a) 0.38, b) 1, c) 2 and d) 2.9 GeV

The arrow indicates the average mass number of products.

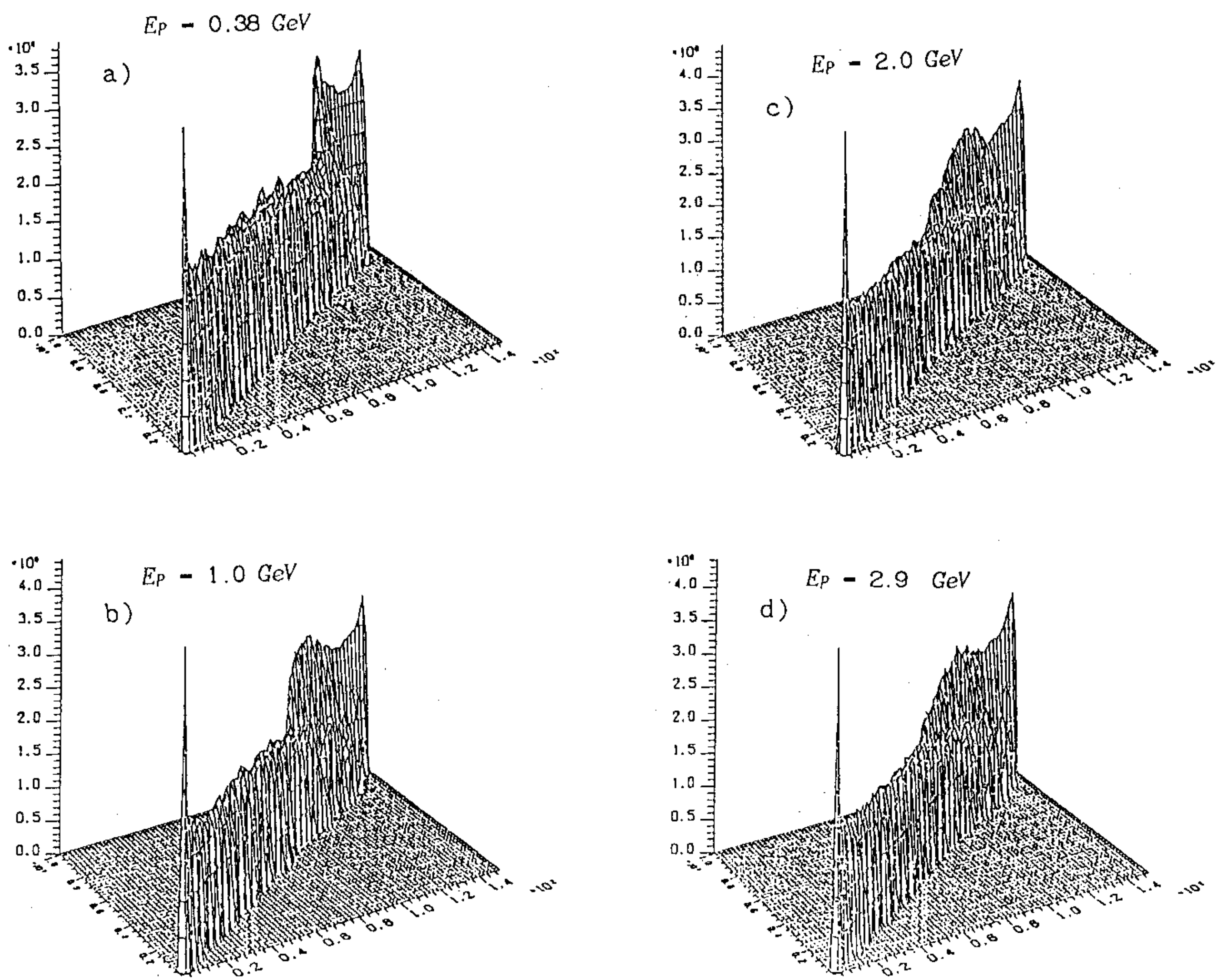

Fig.9 Bird eye's views of product yields for potons impinging on a uranium nucleus
The images viewed from the neutron excess side are for energies of a) 0.38 GeV, b) 1 GeV, c) 2 GeV and d) 2.9 GeV, ones viewed from the neutron deficient side for energies of e) 0.38 GeV, f) 1 GeV, g) 2 GeV and h) 2.9 GeV.

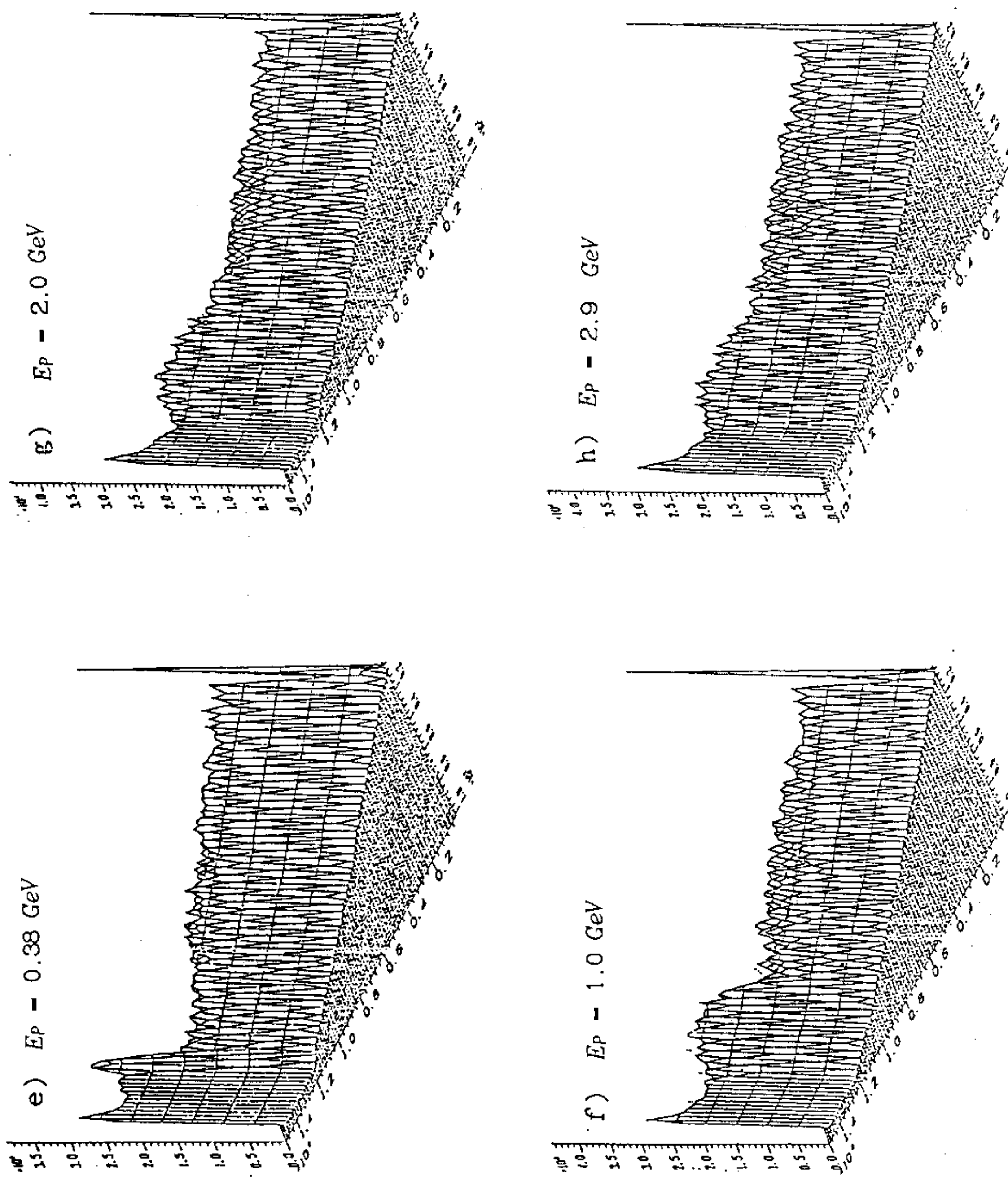

Fig. 9 (Continued)

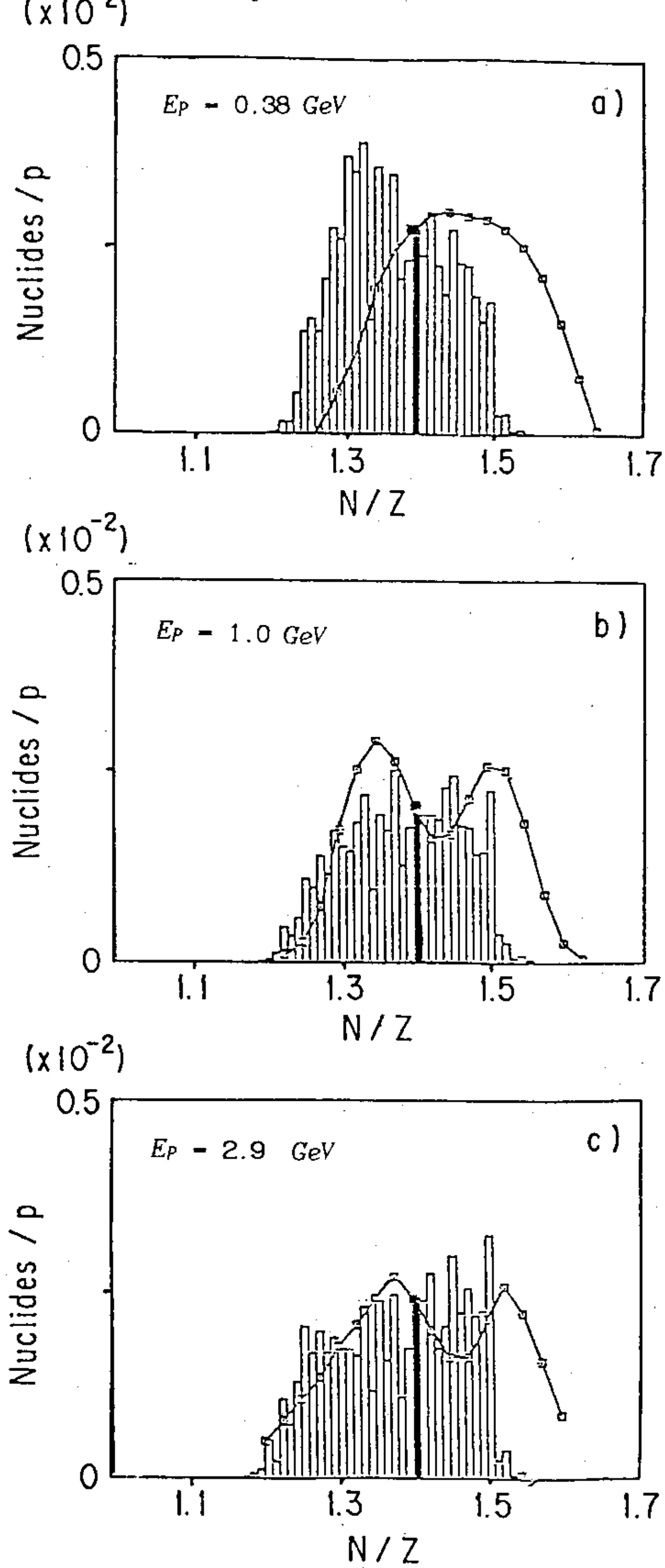

Fig.10 Spallation product yields for A = 125 ~ 140 versus N/Z for a uranium nucleus obtained by using the old version of NUCLEUS The curves show the measured values [2] and the blacked square shows the value of N/Z = 1.4 for the stable nuclides.
Incident proton energy E_p :
a) 0.38 GeV, b) 1 GeV and c) 2.9 GeV

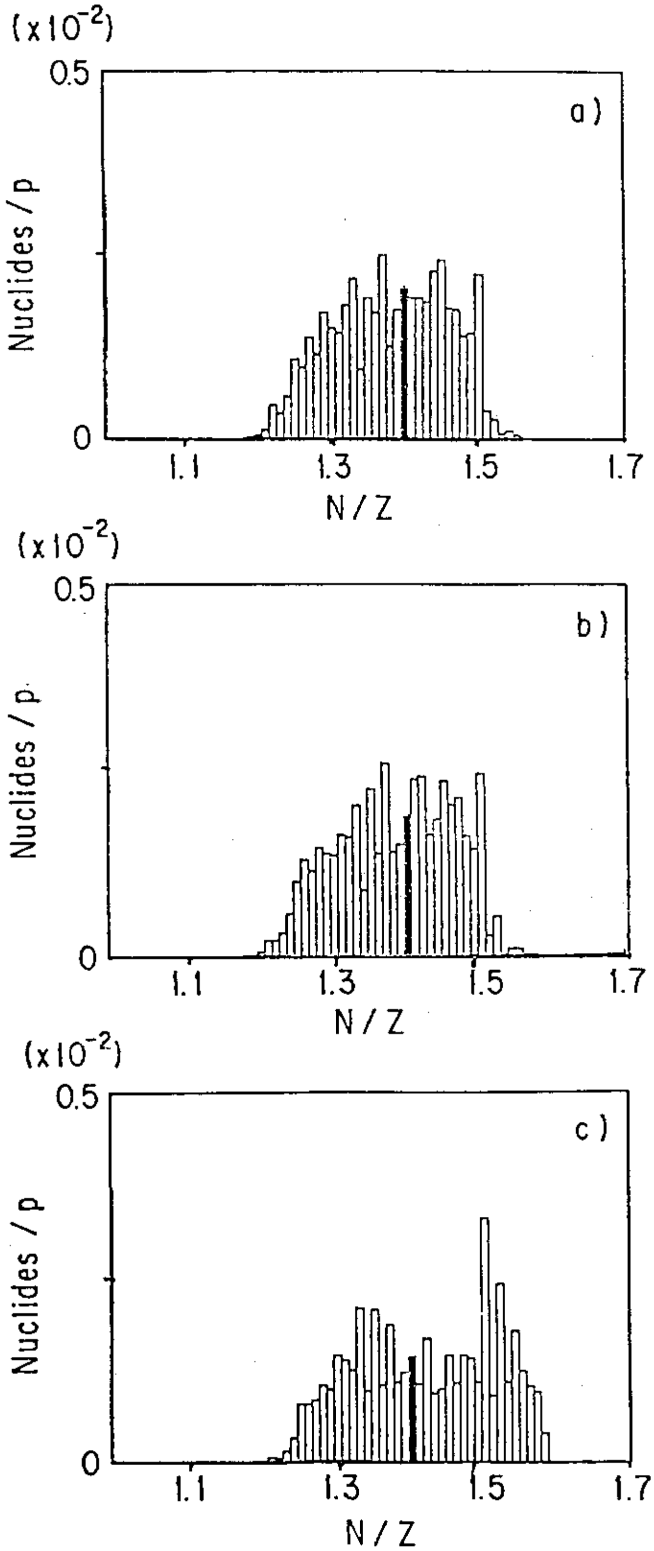

Fig.11 Spallation product yields for A = 125 ~ 140 versus N/Z for a uranium nucleus bombarded by 1 GeV protons
The computation was carried out for three cases of
a) the old mass formula and region,
b) the old mass formula and the extended region,
c) the new mass formula and the extended region.

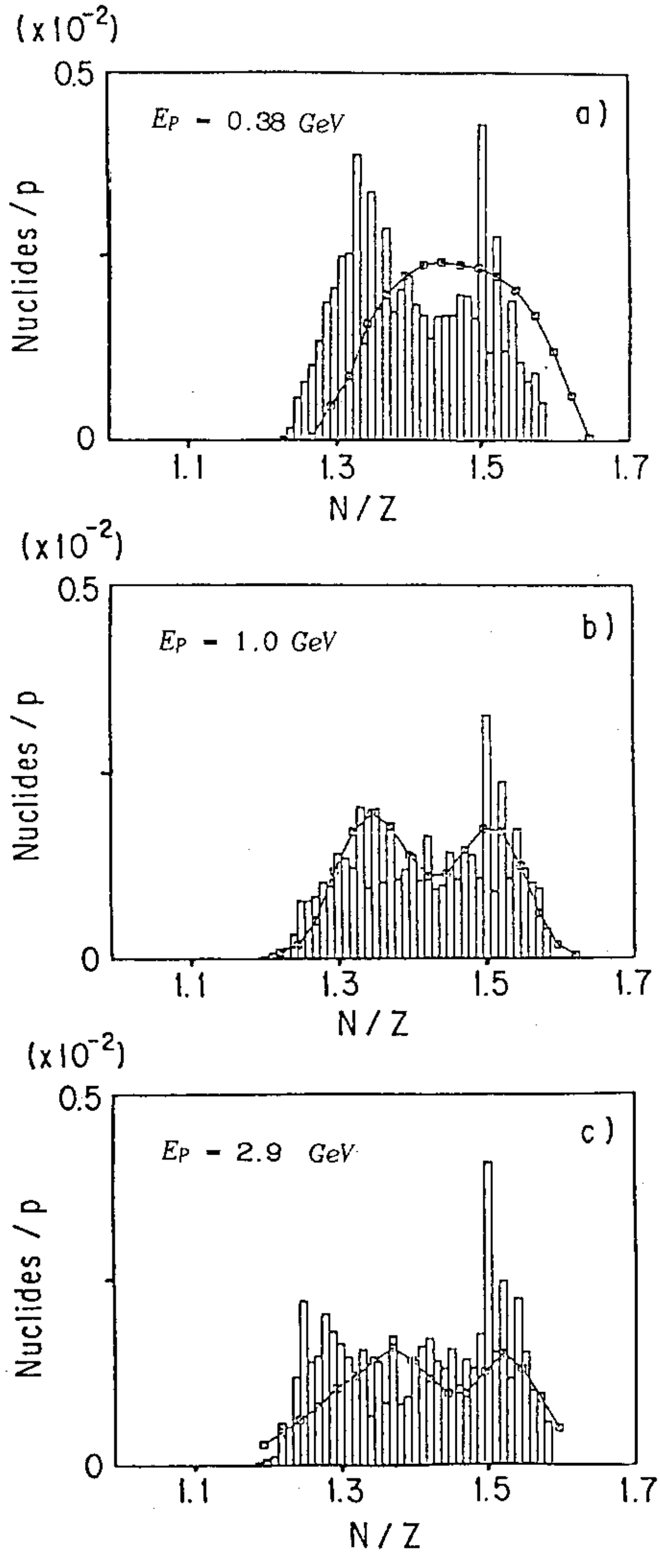

Fig.12 Spallation product yields for $A = 125 \sim 140$ versus N/Z for a uranium nucleus obtained by using the new mass formula and the extended region

The curves show the measured values [(2)] and the blacked square shows the value of N/Z = 1.4 for the stable nuclides.

Incident proton energy E_p :

a) 0.38 GeV, b) 1 GeV and c) 2.9 GeV

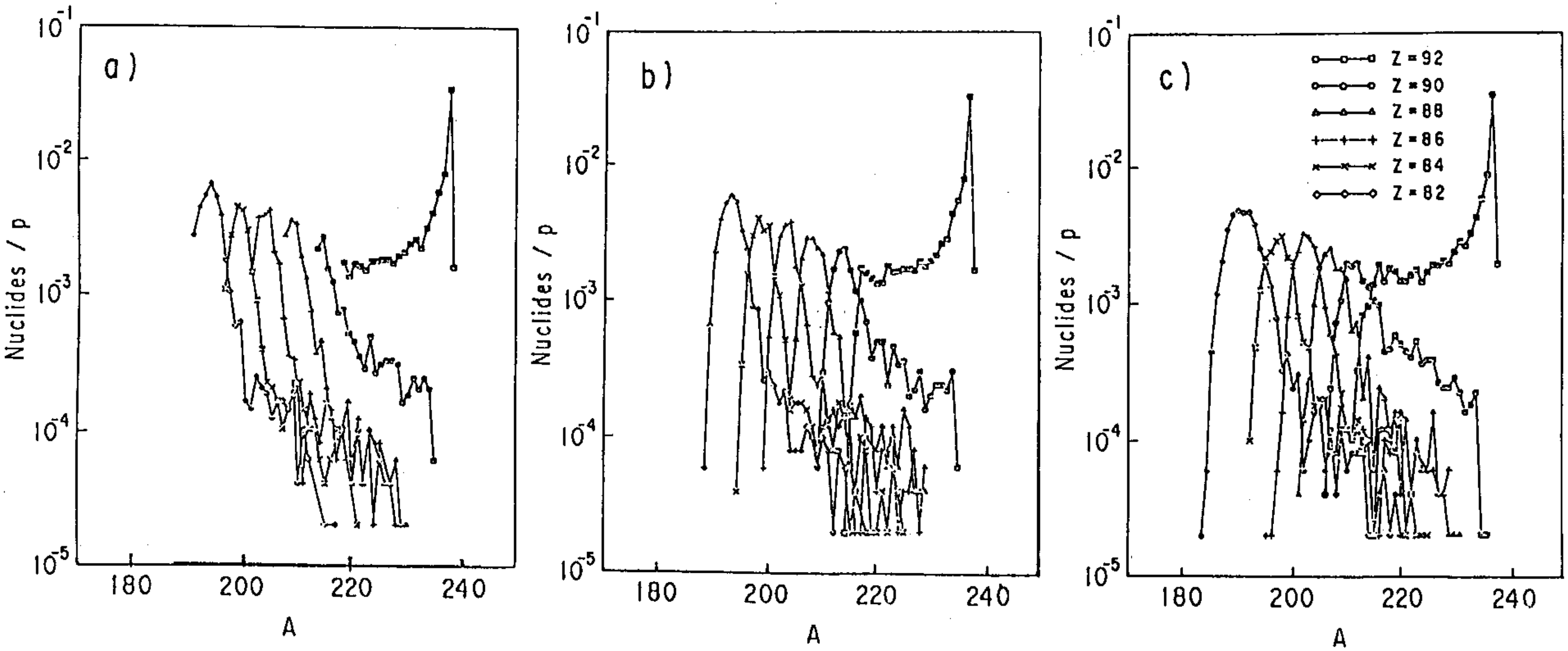

Fig.13 Mass yield distributions of products with even Z from 92 to 82 in the nuclear spallation reaction of a uranium nucleus with a 1 GeV proton for the same cases a), b) and c) as in Fig. 11

Table 1 Particles emitted from a uranium target bombarded by protons in NUCLEUS runs using Uno & Yamada's mass formula for the extended nuclide region
( ) denotes the value calculated by Cameron's mass formula for comparison.

Energy of protons (MeV)	380	1000	2000	2900
Proton	0.994	2.924	3.697	3.276
		(3.126)	(3.750)	
Neutron	12.085	16.050	17.319	15.243
		(16.360)	(17.279)	
Deuteron	0.1249	0.7063	0.9108	0.7729
		(0.7220)	(0.8740)	
Triton	0.0576	0.2719	0.3407	0.2956
		(0.2740)	(0.3226)	
Helium 3	0.0010	0.0258	0.0411	0.0361
		(0.0242)	(0.0374)	
Alpha	0.0732	0.2777	0.3079	0.2588
		(0.2932)	(0.3014)	
Emitted Nucleons per Proton	13.797	22.391	25.215	22.095
		(22.998)	(25.063)	

4. Summary

In order to make evaluations of theoretical models for the nuclear spallation reaction, a simulation code has been modified and a new mass formula has been used to improve the precision in the Monte Carlo calculations. From the analyses of calculated results of distributions of nuclear spallation products we conclude as follows :

(1) The difference between the Cameron's old and Uno & Yamada's new mass formulas is due to those of the methods to fit their shell energy terms to measured data for selected nuclei and data themselves. For nuclides with atomic numbers larger than 70, mass excesses calculated by Cameron's mass formula are greater than those by Uno & Yamada's one, whereas the reverse tendency is seen for ones smaller than 70.

(2) The results show that distributions of produced nuclei have the patterns natural from a physical point of view when the artificial restrictions are removed in counting the nuclide production events.

(3) Th new mass formula can reproduce fairly well the experimental product yield distributions, especially in the neutron excess side.

(4) It is found that the old mass formula gives lower estimation of the number of produced nuclei than the new one, especially in the nuclide region far from the β stable line.

(5) In the integral kind of data, e.g., the number of emitted particles, there are no remarkable discrepancies between the results obtained with the use of the two mass formulas.

In the present research we used only the same type of two mass formulas, Cameron and Uno & Yamada's ones, which had been presented twenty and six years ago respectively. It is desired that these results will be compared with ones which will be calculated by using different types of new mass formulas in the near future.

Acknowledgements

The authors wish to express their hearty thanks to Dr. Y. Ishiguro for his continued interests and encouragements, to Prof. M. Uno (Waseda Univ.) and Prof. H. Sato (Tokyo Univ.) for their helpful suggestions and offering us the use of the program of their new mass formula.

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<APPENDIX> MASS EXCESS TABLE CALCULATED BY BOTH MASS FORMULAS (MEV)

CAME. : VALUES BY CAMERON'S MASS FORMULA
U & Y : VALUES BY UNO & YAMADA'S MASS FORMULA

*** Z = 30

A	CAME.	U & Y	A	CAME.	U & Y	A	CAME.	U & Y	A	CAME.	U & Y
55	-22.23	-12.21	56	-30.88	-23.56	57	-36.30	-31.62	58	-44.57	-41.89
59	-48.51	-47.59	60	-54.17	-54.86	61	-56.47	-56.92	62	-61.07	-61.08
63	-62.17	-62.08	64	-65.88	-65.77	65	-65.90	-65.62	66	-68.74	-68.61
67	-68.00	-67.76	68	-70.02	-69.91	69	-68.48	-68.37	70	-69.75	-69.74
71	-67.48	-67.53	72	-68.05	-68.37	73	-65.17	-65.56	74	-65.59	-65.92
75	-62.66	-62.71	76	-62.67	-62.49	77	-59.17	-59.02	78	-58.52	-58.37
79	-54.72	-54.57	80	-53.76	-53.55	81	-47.91	-48.07	82	-43.99	-44.10
83	-37.77	-37.96	84	-33.43	-33.60	85	-26.74	-27.06	86	-22.39	-22.25

*** Z = 31

A	CAME.	U & Y	A	CAME.	U & Y	A	CAME.	U & Y	A	CAME.	U & Y
57	-22.32	-13.46	58	-28.82	-22.55	59	-37.53	-33.12	60	-42.41	-39.82
61	-48.44	-47.37	62	-51.75	-52.35	63	-56.59	-56.79	64	-58.82	-58.76
65	-62.58	-62.70	66	-63.66	-63.50	67	-66.82	-66.74	68	-67.03	-66.82
69	-69.41	-69.21	70	-68.73	-68.57	71	-70.25	-70.16	72	-68.81	-68.84
73	-69.65	-69.89	74	-67.96	-67.96	75	-68.48	-68.51	76	-66.58	-66.15
77	-66.40	-66.13	78	-63.81	-63.50	79	-63.38	-63.03	80	-60.43	-60.04
81	-59.49	-59.20	82	-54.62	-54.52	83	-50.69	-50.72	84	-45.42	-45.36
85	-41.03	-41.16	86	-35.52	-35.38	87	-31.35	-30.72	88	-25.10	-24.16
89	-20.79	-19.00									

*** Z = 32

A	CAME.	U & Y	A	CAME.	U & Y	A	CAME.	U & Y	A	CAME.	U & Y
58	-15.62	-5.48	59	-22.55	-14.86	60	-32.20	-26.44	61	-37.46	-33.42
62	-44.50	-41.97	63	-48.05	-47.22	64	-54.02	-54.52	65	-56.30	-56.76
66	-61.11	-61.65	67	-62.51	-62.70	68	-66.62	-66.87	69	-67.19	-67.19
70	-70.44	-70.49	71	-70.01	-70.08	72	-72.35	-72.57	73	-71.19	-71.47
74	-73.22	-73.40	75	-71.62	-71.67	76	-73.18	-73.08	77	-71.09	-70.92
78	-71.82	-71.74	79	-69.44	-69.29	80	-69.87	-69.65	81	-66.93	-66.85
82	-66.97	-66.81	83	-62.10	-62.30	84	-59.13	-59.29	85	-53.80	-54.09
86	-50.58	-50.67	87	-45.26	-45.04	88	-41.84	-41.14	89	-35.95	-34.73
90	-31.70	-30.32									

*** Z = 33

A	CAME.	U & Y	A	CAME.	U & Y	A	CAME.	U & Y	A	CAME.	U & Y
61	-23.38	-16.02	62	-29.65	-23.99	63	-36.94	-32.81	64	-41.61	-39.04
65	-47.63	-46.60	66	-50.96	-51.64	67	-56.10	-56.79	68	-58.47	-58.76
69	-62.92	-63.18	70	-64.35	-64.41	71	-67.85	-67.94	72	-68.25	-68.42
73	-70.86	-71.13	74	-70.89	-70.91	75	-73.02	-73.04	76	-72.46	-72.17
77	-73.82	-73.79	78	-72.64	-72.47	79	-73.58	-73.48	80	-72.07	-71.86
81	-72.50	-72.40	82	-70.55	-70.40	83	-70.59	-70.54	84	-66.67	-66.82
85	-63.64	-63.97	86	-59.49	-59.55	87	-56.46	-56.29	88	-51.88	-51.42
89	-48.82	-47.68	90	-42.99	-42.01	91	-39.39	-37.74	92	-33.40	-31.57
93	-29.21	-27.33	94	-22.82	-20.75						

*** Z = 34

A	CAME.	U & Y	A	CAME.	U & Y	A	CAME.	U & Y	A	CAME.	U & Y

62	-17.08	-8.16	63	-23.60	-16.40	64	-32.00	-26.19	65	-36.73	-32.67
66	-43.80	-41.19	67	-47.46	-46.48	68	-53.54	-54.39	69	-56.25	-56.61
70	-61.59	-61.94	71	-63.27	-63.40	72	-67.60	-67.83	73	-68.27	-68.54
74	-72.07	-72.13	75	-72.20	-72.12	76	-75.36	-75.12	77	-74.61	-74.46
78	-76.88	-76.92	79	-75.91	-75.80	80	-77.72	-77.64	81	-76.21	-76.20
82	-77.64	-77.56	83	-75.68	-75.74	84	-76.66	-76.68	85	-72.69	-73.13
86	-70.84	-71.07	87	-66.87	-66.81	88	-64.58	-64.31	89	-60.37	-59.60
90	-57.37	-56.61	91	-52.19	-51.10	92	-49.08	-47.56	93	-43.17	-41.54
94	-39.86	-38.02	95	-33.77	-31.58						

*** Z = 35

A	CAME.	U & Y	A	CAME.	U & Y	A	CAME.	U & Y	A	CAME.	U & Y
65	-23.05	-15.73	66	-28.82	-23.17	67	-36.22	-31.93	68	-40.82	-38.16
69	-47.27	-46.31	70	-50.85	-51.23	71	-56.43	-56.79	72	-58.94	-59.15
73	-63.54	-63.81	74	-65.40	-65.40	75	-69.31	-69.21	76	-70.46	-70.06
77	-73.43	-73.27	78	-73.59	-73.45	79	-76.08	-76.11	80	-75.97	-75.81
81	-77.78	-77.85	82	-77.26	-77.23	83	-78.68	-78.77	84	-77.68	-77.74
85	-78.61	-78.86	86	-75.81	-76.09	87	-74.14	-74.20	88	-70.92	-70.70
89	-69.00	-68.37	90	-64.85	-64.41	91	-62.50	-61.57	92	-57.81	-56.79
93	-54.78	-53.41	94	-49.74	-48.10	95	-46.73	-44.73	96	-41.04	-39.00
97	-37.59	-35.32	98	-31.75	-29.18	99	-27.63	-25.06			

*** Z = 36

A	CAME.	U & Y	A	CAME.	U & Y	A	CAME.	U & Y	A	CAME.	U & Y
66	-16.84	-7.97	67	-22.95	-15.65	68	-31.29	-25.35	69	-36.25	-31.82
70	-43.57	-40.89	71	-47.39	-46.04	72	-53.81	-54.26	73	-56.59	-56.85
74	-62.38	-62.39	75	-64.33	-64.20	76	-69.27	-68.88	77	-70.24	-69.94
78	-74.12	-74.00	79	-74.49	-74.38	80	-77.84	-77.88	81	-77.74	-77.78
82	-80.54	-80.64	83	-80.01	-80.20	84	-82.38	-82.54	85	-81.32	-81.70
86	-83.43	-83.60	87	-80.82	-81.00	88	-79.89	-79.88	89	-77.04	-76.56
90	-75.18	-74.98	91	-71.68	-71.18	92	-69.82	-69.09	93	-65.21	-64.46
94	-63.06	-61.81	95	-58.32	-56.65	96	-55.71	-53.99	97	-50.21	-48.40
98	-47.49	-45.43	99	-41.43	-39.42	100	-38.33	-35.99	101	-32.26	-29.90
102	-28.72	-25.97									

*** Z = 37

A	CAME.	U & Y	A	CAME.	U & Y	A	CAME.	U & Y	A	CAME.	U & Y
68	-14.15	-5.06	69	-22.86	-15.01	70	-28.69	-22.39	71	-36.25	-31.69
72	-40.90	-37.75	73	-47.59	-46.19	74	-51.56	-51.38	75	-57.45	-57.14
76	-60.43	-59.82	77	-65.18	-64.71	78	-67.06	-66.62	79	-71.15	-70.88
80	-72.39	-72.10	81	-75.74	-75.80	82	-76.63	-76.51	83	-79.43	-79.56
84	-79.85	-79.92	85	-82.17	-82.45	86	-82.28	-82.39	87	-84.58	-84.47
88	-82.71	-82.64	89	-82.15	-81.69	90	-79.36	-79.12	91	-78.14	-77.71
92	-75.13	-74.65	93	-73.35	-72.72	94	-69.62	-68.82	95	-67.77	-66.31
96	-63.43	-61.87	97	-61.00	-59.36	98	-56.25	-54.47	99	-53.31	-51.64
100	-48.27	-46.31	101	-45.28	-43.02	102	-40.03	-37.60	103	-36.50	-33.80
104	-30.65	-27.73	105	-26.87	-23.82						

*** Z = 38

A	CAME.	U & Y	A	CAME.	U & Y	A	CAME.	U & Y	A	CAME.	U & Y
69	-7.03	3.67	70	-16.60	-7.19	71	-22.68	-14.81	72	-31.07	-25.01
73	-35.99	-31.29	74	-43.87	-40.63	75	-47.94	-46.04	76	-54.86	-54.36
77	-57.66	-57.24	78	-63.31	-62.99	79	-65.40	-65.11	80	-70.36	-70.21
81	-71.60	-71.63	82	-75.94	-76.15	83	-76.83	-77.05	84	-80.57	-80.91
85	-80.94	-81.46	86	-84.44	-84.78	87	-84.74	-84.90	88	-87.77	-87.75
89	-86.27	-86.10	90	-85.77	-85.92	91	-83.63	-83.51	92	-82.90	-82.85
93	-79.98	-79.95	94	-79.07	-78.75	95	-75.64	-75.01	96	-74.19	-73.22
97	-70.04	-68.93	98	-68.35	-67.13	99	-63.37	-62.38	100	-61.45	-60.24

101	-56.53	-55.06	102	-54.36	-52.45	103	-49.11	-47.16	104	-46.18	-44.03
105	-40.63	-38.09	106	-37.29	-34.83						

*** Z = 39

A	CAME.	U & Y	A	CAME.	U & Y	A	CAME.	U & Y	A	CAME.	U & Y
73	-22.50	-14.61	74	-28.61	-21.78	75	-36.58	-31.33	76	-41.69	-37.61
77	-48.42	-46.14	78	-52.12	-51.54	79	-58.00	-57.49	80	-60.95	-60.44
81	-65.91	-65.75	82	-68.14	-67.99	83	-72.48	-72.70	84	-74.31	-74.41
85	-78.01	-78.46	86	-79.55	-79.80	87	-83.23	-83.30	88	-84.27	-84.19
89	-87.68	-87.22	90	-86.24	-86.33	91	-86.38	-86.32	92	-84.73	-84.66
93	-84.09	-84.16	94	-82.03	-82.00	95	-81.43	-80.95	96	-78.40	-77.93
97	-77.13	-76.30	98	-73.73	-72.71	99	-71.82	-71.06	100	-67.86	-67.00
101	-66.05	-65.01	102	-61.94	-60.51	103	-59.78	-58.03	104	-55.14	-53.41
105	-52.50	-50.42	106	-47.39	-45.13	107	-44.22	-42.01	108	-38.97	-36.80
109	-35.39	-33.31									

*** Z = 40

A	CAME.	U & Y	A	CAME.	U & Y	A	CAME.	U & Y	A	CAME.	U & Y
74	-16.26	-6.21	75	-22.47	-13.60	76	-31.48	-24.02	77	-36.39	-30.51
78	-44.03	-39.90	79	-47.95	-45.51	80	-54.69	-53.93	81	-57.64	-57.09
82	-63.60	-63.22	83	-65.82	-65.65	84	-71.11	-71.18	85	-72.89	-73.08
86	-77.76	-77.92	87	-79.49	-79.44	88	-83.91	-83.73	89	-85.32	-84.80
90	-88.79	-88.60	91	-87.99	-87.88	92	-88.63	-88.62	93	-87.06	-87.13
94	-87.29	-87.37	95	-85.54	-85.37	96	-85.34	-85.05	97	-82.49	-82.18
98	-81.97	-81.26	99	-78.34	-77.83	100	-77.45	-76.87	101	-73.60	-72.97
102	-72.61	-71.66	103	-68.51	-67.30	104	-66.95	-65.50	105	-62.60	-61.02
106	-60.40	-58.68	107	-55.46	-53.53	108	-53.10	-51.05	109	-47.69	-45.98
110	-44.83	-43.12	111	-38.98	-37.59	112	-35.95	-34.44			

*** Z = 41

A	CAME.	U & Y	A	CAME.	U & Y	A	CAME.	U & Y	A	CAME.	U & Y
78	-28.16	-20.47	79	-36.02	-30.07	80	-40.80	-36.51	81	-47.54	-45.14
82	-51.48	-50.72	83	-57.43	-57.05	84	-60.60	-60.29	85	-65.84	-66.01
86	-68.79	-68.70	87	-73.85	-73.73	88	-76.32	-76.03	89	-81.11	-80.49
90	-82.58	-82.33	91	-86.69	-86.31	92	-86.39	-86.34	93	-87.11	-87.25
94	-86.42	-86.50	95	-86.95	-86.90	96	-85.60	-85.62	97	-85.58	-85.46
98	-83.48	-83.30	99	-82.73	-82.54	100	-80.12	-79.80	101	-79.34	-79.00
102	-76.32	-75.78	103	-75.34	-74.61	104	-71.84	-70.92	105	-70.57	-69.26
106	-66.66	-65.44	107	-64.63	-63.25	108	-60.50	-58.74	109	-57.97	-56.40
110	-53.28	-51.96	111	-50.35	-49.24	112	-45.46	-44.33	113	-42.36	-41.30
114	-37.16	-36.15	115	-34.07	-32.79						

*** Z = 42

A	CAME.	U & Y	A	CAME.	U & Y	A	CAME.	U & Y	A	CAME.	U & Y
79	-21.83	-12.37	80	-30.54	-22.82	81	-35.33	-29.46	82	-43.06	-38.91
83	-47.00	-44.69	84	-53.90	-53.41	85	-57.02	-56.85	86	-63.43	-63.36
87	-66.57	-66.25	88	-72.37	-72.06	89	-75.21	-74.54	90	-80.06	-79.77
91	-82.17	-81.79	92	-86.78	-86.52	93	-86.56	-86.73	94	-88.16	-88.38
95	-87.76	-87.79	96	-88.69	-88.92	97	-87.53	-87.81	98	-88.25	-88.37
99	-85.92	-86.37	100	-86.20	-86.31	101	-83.70	-83.72	102	-83.74	-83.61
103	-80.72	-80.53	104	-80.35	-80.05	105	-77.14	-76.51	106	-76.31	-75.51
107	-72.57	-71.83	108	-71.35	-70.29	109	-67.05	-65.92	110	-65.25	-64.22
111	-60.49	-59.92	112	-58.52	-57.82	113	-53.55	-53.04	114	-51.33	-50.64
115	-46.10	-45.61	116	-43.71	-42.86						

*** Z = 43

A	CAME.	U & Y	A	CAME.	U & Y	A	CAME.	U & Y	A	CAME.	U & Y

83	-35.12	-29.36	84	-40.01	-35.95	85	-46.85	-44.86	86	-51.15	-50.64
87	-57.74	-57.34	88	-61.63	-61.01	89	-67.79	-67.00	90	-70.69	-70.26
91	-76.19	-75.67	92	-78.80	-78.44	93	-83.49	-83.34	94	-84.14	-84.29
95	-86.04	-86.11	96	-86.04	-86.25	97	-87.16	-87.54	98	-86.74	-87.15
99	-87.24	-87.86	100	-85.93	-86.56	101	-86.32	-86.66	102	-84.64	-84.77
103	-84.69	-84.80	104	-82.27	-82.40	105	-82.19	-82.07	106	-79.42	-79.19
107	-78.76	-78.34	108	-75.83	-75.31	109	-74.45	-73.91	110	-70.87	-70.18
111	-69.00	-68.62	112	-65.20	-64.94	113	-63.15	-62.98	114	-59.06	-58.82
115	-56.81	-56.54	116	-52.28	-52.12	117	-49.85	-49.49	118	-45.26	-44.77
119	-42.57	-41.86									

*** Z = 44

A	CAME.	U & Y	A	CAME.	U & Y	A	CAME.	U & Y	A	CAME.	U & Y
84	-29.93	-22.00	85	-34.76	-28.78	86	-42.78	-38.49	87	-47.26	-44.46
88	-54.60	-53.48	89	-58.85	-57.33	90	-65.08	-64.10	91	-68.62	-67.53
92	-74.61	-73.70	93	-77.31	-76.65	94	-82.87	-82.30	95	-83.82	-83.42
96	-86.12	-85.97	97	-86.31	-86.28	98	-88.17	-88.29	99	-87.52	-88.05
100	-89.05	-89.48	101	-87.85	-88.34	102	-89.06	-89.13	103	-87.39	-87.39
104	-88.04	-88.11	105	-85.91	-85.86	106	-86.27	-86.19	107	-83.67	-83.46
108	-83.82	-83.27	109	-80.73	-80.38	110	-80.06	-79.63	111	-76.42	-76.04
112	-75.51	-75.11	113	-71.63	-71.57	114	-70.45	-70.23	115	-66.34	-66.20
116	-64.79	-64.54	117	-60.22	-60.25	118	-58.59	-58.23	119	-54.02	-53.62
120	-52.02	-51.32	121	-47.33	-46.31	122	-45.26	-43.50			

*** Z = 45

A	CAME.	U & Y	A	CAME.	U & Y	A	CAME.	U & Y	A	CAME.	U & Y
88	-40.43	-35.50	89	-48.13	-44.70	90	-52.45	-50.83	91	-59.32	-57.77
92	-63.36	-61.96	93	-69.43	-68.31	94	-73.00	-72.00	95	-78.86	-77.82
96	-80.21	-79.67	97	-82.70	-82.39	98	-83.63	-83.42	99	-85.27	-85.59
100	-85.64	-86.06	101	-87.28	-87.65	102	-86.90	-87.20	103	-88.11	-88.15
104	-87.04	-87.09	105	-87.99	-87.95	106	-86.30	-86.38	107	-86.83	-86.86
108	-85.04	-84.78	109	-85.03	-84.74	110	-82.65	-82.50	111	-81.92	-81.88
112	-79.23	-78.93	113	-78.25	-78.14	114	-75.24	-75.22	115	-74.05	-74.02
116	-70.63	-70.60	117	-69.04	-69.07	118	-65.27	-65.38	119	-63.66	-63.48
120	-59.78	-59.47	121	-57.78	-57.29	122	-53.93	-52.87	123	-51.91	-50.18
124	-47.89	-45.52	125	-45.61	-42.55						

*** Z = 46

A	CAME.	U & Y	A	CAME.	U & Y	A	CAME.	U & Y	A	CAME.	U & Y
89	-35.40	-28.13	90	-43.16	-38.11	91	-48.12	-44.42	92	-55.48	-53.61
93	-59.61	-57.98	94	-66.55	-65.07	95	-70.42	-68.93	96	-76.68	-75.49
97	-78.22	-77.51	98	-81.45	-80.95	99	-82.16	-82.15	100	-84.82	-85.04
101	-85.30	-85.66	102	-87.76	-87.95	103	-87.39	-87.66	104	-89.20	-89.29
105	-88.43	-88.38	106	-89.81	-89.93	107	-88.30	-88.50	108	-89.63	-89.65
109	-87.68	-87.72	110	-88.39	-88.32	111	-85.94	-86.23	112	-86.17	-86.25
113	-83.41	-83.44	114	-83.29	-83.28	115	-80.27	-80.49	116	-79.77	-79.91
117	-76.31	-76.63	118	-75.52	-75.70	119	-71.77	-72.15	120	-70.86	-70.85
121	-66.97	-66.96	122	-65.80	-65.37	123	-62.01	-61.07	124	-60.53	-58.96
125	-56.64	-54.42	126	-54.91	-52.02						

*** Z = 47

A	CAME.	U & Y	A	CAME.	U & Y	A	CAME.	U & Y	A	CAME.	U & Y
92	-40.86	-35.12	93	-48.31	-44.49	94	-53.31	-51.06	95	-60.56	-58.33
96	-64.82	-62.93	97	-71.27	-69.66	98	-73.55	-72.40	99	-76.56	-76.00
100	-78.28	-77.91	101	-81.06	-80.96	102	-82.36	-82.28	103	-84.83	-84.73
104	-85.06	-85.12	105	-87.16	-86.91	106	-86.83	-86.68	107	-88.38	-88.37
108	-87.67	-87.60	109	-88.85	-88.90	110	-87.61	-87.62	111	-88.25	-88.37
112	-86.77	-86.91	113	-86.92	-87.08	114	-85.03	-84.89	115	-84.90	-84.87

116	-82.57	-82.71	117	-82.03	-82.26	118	-79.37	-79.58	119	-78.60	-78.79
120	-75.55	-75.83	121	-74.62	-74.66	122	-71.57	-71.36	123	-70.46	-69.89
124	-67.21	-66.18	125	-65.87	-64.19	126	-62.53	-60.22	127	-60.85	-57.94
128	-57.24	-53.90	129	-55.02	-51.18	130	-49.36	-45.07			

*** Z = 48

A	CAME.	U & Y	A	CAME.	U & Y	A	CAME.	U & Y	A	CAME.	U & Y
96	-56.47	-53.93	97	-60.92	-58.69	98	-68.12	-66.15	99	-70.18	-69.05
100	-74.20	-73.37	101	-76.04	-75.44	102	-79.63	-79.19	103	-80.94	-80.68
104	-84.01	-83.81	105	-84.53	-84.36	106	-87.08	-86.83	107	-86.91	-86.75
108	-89.27	-89.11	109	-88.40	-88.49	110	-90.30	-90.44	111	-88.99	-89.31
112	-90.59	-90.71	113	-89.04	-89.39	114	-90.06	-90.19	115	-88.15	-88.15
116	-88.71	-88.75	117	-86.34	-86.72	118	-86.60	-86.89	119	-83.96	-84.34
120	-83.89	-84.16	121	-80.83	-81.33	122	-80.74	-80.75	123	-77.74	-77.58
124	-77.18	-76.70	125	-74.05	-73.10	126	-73.26	-71.69	127	-69.97	-67.84
128	-68.76	-66.13	129	-65.22	-62.21	130	-63.49	-60.04	131	-57.81	-54.06

*** Z = 49

A	CAME.	U & Y	A	CAME.	U & Y	A	CAME.	U & Y	A	CAME.	U & Y
97	-48.99	-44.89	98	-54.19	-51.80	99	-61.16	-59.42	100	-64.23	-63.03
101	-68.37	-67.52	102	-71.03	-70.28	103	-74.63	-74.20	104	-76.54	-76.37
105	-79.90	-79.66	106	-80.87	-80.89	107	-83.58	-83.51	108	-84.22	-84.10
109	-86.43	-86.61	110	-86.27	-86.65	111	-88.09	-88.74	112	-87.75	-88.25
113	-89.28	-89.80	114	-88.59	-89.11	115	-89.59	-90.06	116	-88.38	-88.63
117	-88.90	-89.37	118	-87.33	-87.96	119	-87.61	-88.26	120	-85.67	-86.32
121	-85.59	-86.26	122	-83.36	-84.03	123	-83.33	-83.58	124	-80.88	-80.99
125	-80.44	-80.23	126	-77.87	-77.21	127	-77.13	-75.93	128	-74.30	-72.64
129	-73.16	-71.05	130	-70.12	-67.69	131	-68.37	-65.64	132	-63.34	-60.20
133	-59.64	-56.08	134	-54.15	-50.46	135	-50.23	-46.13			

*** Z = 50

A	CAME.	U & Y	A	CAME.	U & Y	A	CAME.	U & Y	A	CAME.	U & Y
99	-48.99	-45.13	100	-56.98	-54.87	101	-60.17	-58.65	102	-65.13	-63.84
103	-67.79	-66.77	104	-72.00	-71.37	105	-74.20	-73.70	106	-78.00	-77.68
107	-79.13	-79.06	108	-82.65	-82.35	109	-83.14	-83.09	110	-86.06	-86.26
111	-85.84	-86.45	112	-88.62	-89.19	113	-88.20	-88.85	114	-90.60	-91.03
115	-89.89	-90.49	116	-91.59	-92.06	117	-90.34	-90.78	118	-91.66	-92.14
119	-90.11	-90.86	120	-91.09	-91.77	121	-89.14	-89.96	122	-89.89	-90.50
123	-87.72	-88.40	124	-88.23	-88.54	125	-85.91	-86.08	126	-86.02	-85.90
127	-83.50	-83.01	128	-83.22	-82.29	129	-80.47	-79.13	130	-79.81	-78.10
131	-76.76	-74.86	132	-75.66	-73.36	133	-70.78	-68.04	134	-67.30	-64.46
135	-62.25	-58.96	136	-58.50	-55.16	137	-52.91	-49.32	138	-49.06	-45.36

*** Z = 51

A	CAME.	U & Y	A	CAME.	U & Y	A	CAME.	U & Y	A	CAME.	U & Y
102	-51.86	-50.02	103	-56.82	-55.37	104	-60.09	-58.99	105	-64.58	-63.75
106	-67.23	-66.76	107	-71.20	-70.89	108	-73.14	-72.94	109	-76.50	-76.39
110	-77.70	-77.78	111	-80.55	-81.11	112	-81.29	-81.94	113	-84.00	-84.83
114	-84.45	-85.12	115	-86.83	-87.45	116	-86.81	-87.53	117	-88.48	-89.25
118	-88.02	-88.58	119	-89.36	-90.08	120	-88.51	-89.40	121	-89.48	-90.45
122	-88.37	-89.24	123	-89.17	-89.91	124	-87.55	-88.40	125	-88.19	-88.67
126	-86.42	-86.79	127	-86.59	-86.74	128	-84.52	-84.41	129	-84.32	-83.82
130	-82.06	-81.22	131	-81.39	-80.31	132	-78.98	-77.62	133	-78.02	-76.24
134	-73.38	-71.46	135	-70.34	-68.01	136	-65.45	-63.03	137	-62.13	-59.36
138	-56.77	-54.04	139	-52.96	-50.19	140	-47.16	-44.59	141	-43.79	-41.04

*** Z = 52

A	CAME.	U & Y	A	CAME.	U & Y	A	CAME.	U & Y	A	CAME.	U & Y
105	-54.12	-52.46	106	-59.06	-57.92	107	-61.87	-61.08	108	-66.65	-65.88
109	-68.43	-68.09	110	-72.51	-72.20	111	-73.64	-73.74	112	-77.46	-77.72
113	-78.12	-78.70	114	-81.70	-82.23	115	-82.13	-82.67	116	-85.20	-85.62
117	-85.15	-85.86	118	-87.61	-88.19	119	-87.18	-87.66	120	-89.22	-89.77
121	-88.36	-89.24	122	-90.16	-90.88	123	-89.10	-89.81	124	-90.45	-91.07
125	-88.96	-89.69	126	-90.15	-90.54	127	-88.43	-88.79	128	-89.06	-89.31
129	-87.07	-87.12	130	-87.36	-87.09	131	-85.07	-84.61	132	-85.06	-84.26
133	-82.79	-81.69	134	-82.07	-80.86	135	-77.86	-76.20	136	-74.99	-73.29
137	-70.53	-68.43	138	-67.43	-65.28	139	-62.12	-60.08	140	-58.63	-56.76
141	-53.28	-51.27	142	-50.31	-48.24						

*** Z = 53

A	CAME.	U & Y	A	CAME.	U & Y	A	CAME.	U & Y	A	CAME.	U & Y
108	-54.27	-53.08	109	-58.89	-58.04	110	-61.39	-60.90	111	-65.40	-65.16
112	-67.49	-67.35	113	-71.23	-71.48	114	-72.77	-73.10	115	-76.32	-76.78
116	-77.45	-77.85	117	-80.49	-80.95	118	-81.23	-81.80	119	-83.71	-84.27
120	-83.98	-84.35	121	-86.01	-86.60	122	-85.98	-86.67	123	-87.84	-88.45
124	-87.32	-87.96	125	-88.81	-89.36	126	-87.86	-88.56	127	-89.10	-89.54
128	-87.85	-88.37	129	-88.55	-89.02	130	-87.05	-87.38	131	-87.32	-87.48
132	-85.69	-85.56	133	-85.82	-85.33	134	-83.79	-83.31	135	-83.50	-82.60
136	-79.45	-78.48	137	-77.01	-75.68	138	-72.78	-71.36	139	-69.73	-68.33
140	-64.74	-63.65	141	-61.70	-60.44	142	-56.75	-55.46	143	-53.94	-52.55
144	-49.22	-47.73	145	-46.05	-44.67	146	-41.21	-39.72			

*** Z = 54

A	CAME.	U & Y	A	CAME.	U & Y	A	CAME.	U & Y	A	CAME.	U & Y
109	-47.84	-46.41	110	-53.17	-52.03	111	-55.60	-55.04	112	-60.57	-59.96
113	-62.59	-62.30	114	-67.20	-67.07	115	-68.71	-68.84	116	-72.96	-73.15
117	-74.06	-74.37	118	-77.89	-78.09	119	-78.66	-79.08	120	-81.84	-82.17
121	-82.09	-82.39	122	-84.95	-85.24	123	-84.98	-85.45	124	-87.39	-87.82
125	-87.00	-87.47	126	-89.03	-89.46	127	-88.14	-88.79	128	-89.84	-90.35
129	-88.66	-89.31	130	-89.85	-90.53	131	-88.34	-89.02	132	-89.26	-89.68
133	-87.77	-87.88	134	-88.13	-88.20	135	-86.54	-86.31	136	-86.42	-86.14
137	-82.80	-82.14	138	-80.58	-79.88	139	-76.40	-75.67	140	-73.67	-73.17
141	-69.12	-68.61	142	-66.49	-65.91	143	-61.69	-61.05	144	-59.45	-58.65
145	-54.72	-53.95	146	-52.19	-51.38	147	-47.38	-46.55			

*** Z = 55

A	CAME.	U & Y	A	CAME.	U & Y	A	CAME.	U & Y	A	CAME.	U & Y
113	-52.59	-51.52	114	-55.47	-54.50	115	-60.06	-59.42	116	-62.27	-61.82
117	-66.48	-66.28	118	-68.37	-68.11	119	-72.23	-71.98	120	-73.69	-73.58
121	-76.86	-76.81	122	-77.95	-77.64	123	-80.87	-80.63	124	-81.44	-81.43
125	-83.98	-83.94	126	-84.14	-84.17	127	-86.23	-86.30	128	-85.79	-86.20
129	-87.57	-87.89	130	-86.88	-87.41	131	-88.05	-88.76	132	-87.19	-87.81
133	-88.26	-88.60	134	-87.01	-87.35	135	-87.80	-87.80	136	-86.37	-86.45
137	-86.67	-86.40	138	-83.28	-82.93	139	-81.11	-80.79	140	-77.25	-77.11
141	-74.96	-74.73	142	-70.82	-70.68	143	-68.35	-68.11	144	-64.12	-63.76
145	-61.86	-61.46	146	-57.77	-57.27	147	-55.27	-54.82	148	-51.01	-50.47
149	-48.00	-47.48	150	-43.45	-42.73						

*** Z = 56

A	CAME.	U & Y	A	CAME.	U & Y	A	CAME.	U & Y	A	CAME.	U & Y
114	-46.86	-44.80	115	-49.73	-47.93	116	-55.01	-53.48	117	-57.18	-56.03
118	-62.20	-61.12	119	-64.11	-63.10	120	-68.66	-67.58	121	-70.11	-69.33
122	-74.11	-73.16	123	-75.26	-74.13	124	-78.72	-77.72	125	-79.43	-78.65
126	-82.51	-81.75	127	-82.73	-82.13	128	-85.27	-84.83	129	-84.91	-84.86
130	-87.18	-87.13	131	-86.48	-86.78	132	-88.30	-88.69	133	-87.58	-87.87

134	-88.88	-89.21	135	-88.06	-88.09	136	-89.02	-89.09	137	-88.02	-87.86
138	-88.55	-88.35	139	-85.21	-85.01	140	-83.36	-83.39	141	-79.94	-79.83
142	-78.06	-77.97	143	-74.08	-74.05	144	-72.17	-71.99	145	-67.93	-67.75
146	-66.30	-65.96	147	-62.24	-61.88	148	-60.30	-59.93	149	-55.96	-55.70
150	-53.63	-53.19	151	-49.11	-48.56						

*** Z = 57

A	CAME.	U & Y	A	CAME.	U & Y	A	CAME.	U & Y	A	CAME.	U & Y
119	-54.83	-53.01	120	-57.44	-55.60	121	-61.98	-60.23	122	-64.27	-62.58
123	-68.33	-66.56	124	-70.02	-68.12	125	-73.61	-71.85	126	-74.87	-73.37
127	-78.00	-76.61	128	-78.68	-77.55	129	-81.30	-80.39	130	-81.43	-81.00
131	-83.68	-83.40	132	-83.63	-83.61	133	-85.60	-85.65	134	-85.11	-85.38
135	-86.84	-86.85	136	-86.19	-86.27	137	-87.58	-87.40	138	-86.81	-86.70
139	-87.38	-87.32	140	-84.36	-84.50	141	-82.96	-83.02	142	-79.94	-79.97
143	-78.22	-78.23	144	-74.80	-74.82	145	-72.88	-72.88	146	-69.28	-69.15
147	-67.68	-67.48	148	-64.17	-63.89	149	-62.15	-62.06	150	-58.49	-58.32
151	-56.19	-55.93	152	-52.27	-51.77	153	-49.78	-48.98	154	-45.65	-44.55
155	-42.54	-41.46									

*** Z = 58

A	CAME.	U & Y	A	CAME.	U & Y	A	CAME.	U & Y	A	CAME.	U & Y
120	-49.66	-46.83	121	-52.25	-49.57	122	-57.63	-54.80	123	-59.98	-57.30
124	-64.58	-61.88	125	-66.40	-63.58	126	-70.54	-67.90	127	-71.85	-69.56
128	-75.45	-73.38	129	-76.20	-74.46	130	-79.31	-77.87	131	-79.42	-78.61
132	-82.33	-81.57	133	-82.41	-81.92	134	-84.62	-84.52	135	-84.57	-84.38
136	-86.46	-86.40	137	-86.24	-85.95	138	-87.85	-87.61	139	-87.13	-87.04
140	-88.03	-88.19	141	-85.45	-85.50	142	-84.45	-84.54	143	-81.59	-81.62
144	-80.44	-80.39	145	-77.00	-77.10	146	-75.72	-75.67	147	-72.14	-72.06
148	-71.11	-70.89	149	-67.52	-67.42	150	-66.18	-66.08	151	-62.55	-62.46
152	-60.84	-60.55	153	-57.06	-56.51	154	-55.11	-54.20	155	-50.91	-49.88
156	-48.43	-47.27									

*** Z = 59

A	CAME.	U & Y	A	CAME.	U & Y	A	CAME.	U & Y	A	CAME.	U & Y
124	-53.22	-49.56	125	-57.95	-54.28	126	-60.33	-56.57	127	-64.52	-61.03
128	-66.29	-63.27	129	-69.96	-67.23	130	-71.20	-68.88	131	-74.29	-72.43
132	-75.06	-73.73	133	-78.11	-76.83	134	-78.43	-77.73	135	-81.07	-80.46
136	-81.18	-80.87	137	-83.51	-83.01	138	-83.51	-83.10	139	-85.17	-84.89
140	-84.77	-84.86	141	-86.11	-86.13	142	-83.94	-83.96	143	-83.09	-83.12
144	-80.80	-80.72	145	-79.63	-79.62	146	-76.84	-76.83	147	-75.58	-75.52
148	-72.56	-72.41	149	-71.45	-71.36	150	-68.54	-68.38	151	-67.23	-67.16
152	-64.19	-64.02	153	-62.63	-62.23	154	-59.38	-58.67	155	-57.36	-56.48
156	-53.79	-52.63	157	-51.38	-50.13	158	-47.29	-45.98	159	-44.26	-42.97
160	-39.82	-38.52									

*** Z = 60

A	CAME.	U & Y	A	CAME.	U & Y	A	CAME.	U & Y	A	CAME.	U & Y
125	-48.02	-43.41	126	-53.30	-48.72	127	-55.73	-51.15	128	-60.38	-56.19
129	-62.22	-58.57	130	-66.38	-63.11	131	-67.61	-64.90	132	-71.35	-69.01
133	-72.26	-70.45	134	-75.55	-74.10	135	-76.30	-75.13	136	-79.10	-78.42
137	-79.65	-78.96	138	-82.20	-81.64	139	-82.25	-81.86	140	-84.23	-84.19
141	-84.27	-84.28	142	-86.02	-86.08	143	-84.00	-84.04	144	-83.73	-83.72
145	-81.42	-81.43	146	-80.89	-80.84	147	-78.13	-78.18	148	-77.42	-77.37
149	-74.33	-74.38	150	-73.89	-73.83	151	-71.01	-70.98	152	-70.30	-70.24
153	-67.40	-67.22	154	-66.38	-65.91	155	-63.06	-62.47	156	-61.67	-60.75
157	-58.16	-57.02	158	-56.03	-54.98	159	-52.11	-50.94	160	-49.64	-48.40
161	-45.11	-44.06									

*** Z = 61

A	CAME.	U & Y	A	CAME.	U & Y	A	CAME.	U & Y	A	CAME.	U & Y
129	-53.24	-48.44	130	-55.58	-51.39	131	-59.72	-56.06	132	-61.60	-58.42
133	-65.49	-62.67	134	-66.63	-64.66	135	-70.35	-68.45	136	-71.27	-70.03
137	-74.50	-73.44	138	-75.27	-74.52	139	-77.87	-77.34	140	-78.24	-78.09
141	-80.66	-80.54	142	-81.11	-81.16	143	-83.02	-83.09	144	-81.57	-81.56
145	-81.28	-81.37	146	-79.61	-79.60	147	-79.11	-79.13	148	-76.90	-76.97
149	-76.11	-76.29	150	-73.70	-73.79	151	-73.29	-73.36	152	-71.01	-70.99
153	-70.43	-70.38	154	-68.08	-67.84	155	-66.98	-66.65	156	-64.29	-63.68
157	-62.97	-62.07	158	-59.74	-58.81	159	-57.77	-56.89	160	-54.42	-53.31
161	-51.85	-50.88	162	-47.84	-47.00	163	-45.09	-44.18	164	-40.60	-39.98
165	-37.14	-36.75									

*** Z = 62

A	CAME.	U & Y	A	CAME.	U & Y	A	CAME.	U & Y	A	CAME.	U & Y
130	-48.02	-42.64	131	-50.33	-45.73	132	-55.13	-50.97	133	-57.15	-53.46
134	-61.27	-58.27	135	-62.85	-60.40	136	-66.73	-64.74	137	-68.08	-66.45
138	-71.54	-70.41	139	-72.35	-71.62	140	-75.27	-74.98	141	-76.09	-75.86
142	-78.92	-78.84	143	-79.52	-79.58	144	-82.00	-82.03	145	-80.53	-80.64
146	-80.88	-80.95	147	-79.24	-79.31	148	-79.29	-79.35	149	-77.00	-77.31
150	-76.90	-77.13	151	-74.51	-74.75	152	-74.70	-74.81	153	-72.56	-72.57
154	-72.53	-72.44	155	-70.10	-70.02	156	-69.63	-69.31	157	-67.00	-66.45
158	-65.96	-65.32	159	-62.90	-62.17	160	-61.50	-60.72	161	-58.05	-57.25
162	-56.01	-55.28	163	-52.27	-51.51	164	-49.71	-49.14	165	-45.49	-45.06
166	-42.54	-42.28									

*** Z = 63

A	CAME.	U & Y	A	CAME.	U & Y	A	CAME.	U & Y	A	CAME.	U & Y
134	-49.97	-46.07	135	-54.53	-51.02	136	-56.27	-53.69	137	-60.58	-58.17
138	-62.16	-60.43	139	-65.66	-64.52	140	-66.80	-66.26	141	-70.17	-69.75
142	-71.39	-71.16	143	-74.38	-74.27	144	-75.55	-75.53	145	-78.00	-78.11
146	-77.18	-77.22	147	-77.55	-77.67	148	-76.47	-76.53	149	-76.45	-76.69
150	-74.84	-75.15	151	-74.76	-75.09	152	-72.97	-73.21	153	-73.30	-73.39
154	-71.70	-71.63	155	-71.59	-71.62	156	-69.79	-69.68	157	-69.39	-69.08
158	-67.05	-66.70	159	-66.17	-65.69	160	-63.67	-63.00	161	-62.18	-61.66
162	-59.24	-58.66	163	-57.48	-56.80	164	-53.94	-53.48	165	-51.65	-51.23
166	-47.93	-47.59	167	-45.03	-44.92	168	-40.78	-40.90	169	-37.29	-37.93
170	-32.42	-33.66									

*** Z = 64

A	CAME.	U & Y	A	CAME.	U & Y	A	CAME.	U & Y	A	CAME.	U & Y
135	-44.53	-40.07	136	-49.25	-45.57	137	-51.42	-48.38	138	-55.96	-53.40
139	-57.58	-55.79	140	-61.40	-60.42	141	-62.99	-62.30	142	-66.76	-66.32
143	-68.14	-67.86	144	-71.69	-71.49	145	-72.85	-72.88	146	-75.94	-75.98
147	-75.15	-75.22	148	-76.08	-76.17	149	-74.91	-75.16	150	-75.57	-75.83
151	-73.99	-74.41	152	-74.51	-74.84	153	-72.86	-73.08	154	-73.73	-73.75
155	-72.05	-72.11	156	-72.58	-72.58	157	-70.84	-70.76	158	-70.72	-70.64
159	-68.55	-68.38	160	-68.23	-67.83	161	-65.64	-65.26	162	-64.66	-64.39
163	-62.01	-61.50	164	-60.44	-60.10	165	-57.17	-56.89	166	-55.38	-55.08
167	-51.72	-51.56	168	-49.23	-49.33	169	-45.23	-45.43	170	-42.02	-42.89
171	-37.56	-38.74									

*** Z = 65

A	CAME.	U & Y	A	CAME.	U & Y	A	CAME.	U & Y	A	CAME.	U & Y
139	-48.42	-45.75	140	-50.36	-48.68	141	-54.63	-53.44	142	-56.62	-55.85
143	-60.55	-60.00	144	-62.49	-62.06	145	-66.03	-65.82	146	-67.83	-67.73
147	-70.95	-70.95	148	-70.71	-70.70	149	-71.56	-71.78	150	-71.08	-71.27

151	-71.76	-72.06	152	-70.78	-71.14	153	-71.44	-71.69	154	-70.33	-70.42
155	-71.12	-71.22	156	-70.08	-70.05	157	-70.66	-70.65	158	-69.21	-69.30
159	-69.26	-69.30	160	-67.65	-67.50	161	-67.24	-67.07	162	-65.17	-64.96
163	-64.47	-64.21	164	-62.01	-61.77	165	-60.71	-60.49	166	-57.93	-57.73
167	-56.21	-56.03	168	-52.96	-52.95	169	-50.72	-50.84	170	-47.00	-47.37
171	-44.19	-44.94	172	-40.18	-41.22	173	-37.10	-38.59	174	-32.28	-34.48
175	-28.56	-31.33									

*** Z = 66

A	CAME.	U & Y	A	CAME.	U & Y	A	CAME.	U & Y	A	CAME.	U & Y
140	-42.58	-39.91	141	-44.97	-42.97	142	-49.65	-48.26	143	-51.79	-50.80
144	-56.29	-55.47	145	-58.21	-57.67	146	-62.39	-61.95	147	-64.22	-63.98
148	-67.90	-67.72	149	-67.57	-67.59	150	-69.11	-69.18	151	-68.65	-68.79
152	-69.94	-70.08	153	-69.09	-69.28	154	-70.29	-70.33	155	-69.11	-69.18
156	-70.54	-70.46	157	-69.55	-69.42	158	-70.42	-70.49	159	-69.14	-69.26
160	-69.74	-69.73	161	-68.04	-68.05	162	-68.15	-68.09	163	-66.35	-66.10
164	-65.85	-65.80	165	-63.66	-63.48	166	-62.86	-62.65	167	-60.15	-60.01
168	-58.83	-58.76	169	-55.83	-55.79	170	-53.88	-54.11	171	-50.56	-50.76
172	-48.20	-48.77	173	-44.47	-45.16	174	-41.56	-42.95	175	-37.06	-38.95
176	-33.47	-36.23									

*** Z = 67

A	CAME.	U & Y	A	CAME.	U & Y	A	CAME.	U & Y	A	CAME.	U & Y
144	-44.51	-43.33	145	-48.99	-48.14	146	-51.56	-50.85	147	-55.77	-55.26
148	-58.14	-57.81	149	-61.75	-61.67	150	-62.11	-62.05	151	-63.66	-63.76
152	-63.81	-63.87	153	-65.23	-65.28	154	-64.93	-64.97	155	-66.05	-66.15
156	-65.50	-65.48	157	-66.99	-66.88	158	-66.29	-66.32	159	-67.33	-67.51
160	-66.60	-66.75	161	-67.12	-67.34	162	-65.93	-66.13	163	-66.32	-66.28
164	-64.72	-64.75	165	-64.49	-64.56	166	-62.80	-62.70	167	-62.06	-61.98
168	-59.75	-59.78	169	-58.68	-58.65	170	-55.97	-56.12	171	-54.42	-54.56
172	-51.55	-51.64	173	-49.47	-49.76	174	-45.91	-46.57	175	-43.32	-44.48
176	-38.95	-40.91	177	-35.74	-38.29	178	-31.02	-34.40	179	-27.77	-31.73
180	-22.91	-27.72									

*** Z = 68

A	CAME.	U & Y	A	CAME.	U & Y	A	CAME.	U & Y	A	CAME.	U & Y
145	-38.42	-37.07	146	-43.54	-42.40	147	-46.14	-45.24	148	-50.90	-50.16
149	-53.20	-52.84	150	-57.48	-57.20	151	-57.87	-57.71	152	-60.03	-59.92
153	-60.31	-60.16	154	-62.27	-62.07	155	-61.89	-61.88	156	-63.65	-63.54
157	-63.16	-63.00	158	-64.93	-64.88	159	-64.40	-64.44	160	-66.00	-66.10
161	-65.18	-65.46	162	-66.21	-66.52	163	-65.30	-65.43	164	-65.89	-66.04
165	-64.56	-64.63	166	-64.82	-64.90	167	-63.20	-63.15	168	-62.86	-62.88
169	-60.81	-60.80	170	-60.02	-60.11	171	-57.71	-57.70	172	-56.61	-56.57
173	-54.02	-53.76	174	-52.11	-52.31	175	-48.87	-49.24	176	-46.42	-47.58
177	-42.43	-44.11	178	-39.66	-41.92	179	-35.38	-38.13	180	-32.62	-35.88
181	-28.08	-31.98									

*** Z = 69

A	CAME.	U & Y	A	CAME.	U & Y	A	CAME.	U & Y	A	CAME.	U & Y
149	-43.14	-42.47	150	-46.12	-45.65	151	-50.43	-50.15	152	-51.42	-51.15
153	-53.72	-53.49	154	-54.54	-54.21	155	-56.42	-56.25	156	-56.68	-56.55
157	-58.50	-58.33	158	-58.29	-58.27	159	-60.23	-60.27	160	-60.26	-60.30
161	-61.76	-62.09	162	-61.47	-61.92	163	-62.78	-63.10	164	-62.06	-62.46
165	-62.92	-63.20	166	-62.09	-62.24	167	-62.41	-62.63	168	-61.19	-61.33
169	-61.11	-61.17	170	-59.34	-59.53	171	-58.96	-58.96	172	-57.09	-56.98
173	-56.27	-55.97	174	-53.85	-53.59	175	-52.27	-52.26	176	-49.16	-49.61
177	-47.08	-48.06	178	-43.54	-45.01	179	-41.21	-42.93	180	-37.43	-39.56
181	-34.99	-37.42	182	-30.64	-33.92	183	-27.69	-31.84	184	-23.18	-27.96

185	-20.20	-25.82	186	-15.46	-22.03

*** Z = 70

A	CAME.	U & Y	A	CAME.	U & Y	A	CAME.	U & Y	A	CAME.	U & Y
150	-36.93	-36.15	151	-39.93	-39.46	152	-44.84	-44.46	153	-45.97	-45.59
154	-48.81	-48.42	155	-49.55	-49.28	156	-52.08	-51.80	157	-52.39	-52.23
158	-54.50	-54.49	159	-54.45	-54.55	160	-56.95	-57.03	161	-56.89	-57.18
162	-58.91	-59.44	163	-58.89	-59.39	164	-60.40	-61.03	165	-59.95	-60.52
166	-61.31	-61.71	167	-60.54	-60.87	168	-61.27	-61.71	169	-60.30	-60.53
170	-60.51	-60.82	171	-59.14	-59.30	172	-59.20	-59.16	173	-57.62	-57.30
174	-56.97	-56.72	175	-54.87	-54.46	176	-53.42	-53.55	177	-50.69	-51.02
178	-49.06	-49.89	179	-45.95	-46.95	180	-44.12	-45.29	181	-40.66	-42.03
182	-38.41	-40.30	183	-34.30	-36.91	184	-31.88	-35.24	185	-27.50	-31.47
186	-25.11	-29.73	187	-20.44	-26.04						

*** Z = 71

A	CAME.	U & Y	A	CAME.	U & Y	A	CAME.	U & Y	A	CAME.	U & Y
154	-38.37	-37.85	155	-41.14	-40.82	156	-42.52	-42.15	157	-45.10	-44.80
158	-45.70	-45.71	159	-47.97	-48.10	160	-48.49	-48.63	161	-50.90	-51.24
162	-51.35	-51.86	163	-53.65	-54.24	164	-53.83	-54.65	165	-55.60	-56.41
166	-55.66	-56.35	167	-57.08	-57.67	168	-56.72	-57.27	169	-57.70	-58.23
170	-57.01	-57.49	171	-57.62	-57.91	172	-56.70	-56.82	173	-57.04	-56.80
174	-55.62	-55.37	175	-55.30	-54.91	176	-53.34	-53.07	177	-52.26	-52.28
178	-49.97	-50.17	179	-48.79	-49.15	180	-46.17	-46.63	181	-44.66	-45.08
182	-41.39	-42.23	183	-39.38	-40.62	184	-35.80	-37.63	185	-33.51	-36.07
186	-29.73	-32.70	187	-27.40	-31.07	188	-23.08	-27.78	189	-20.53	-25.76
190	-16.06	-22.20	191	-13.24	-19.94						

*** Z = 72

A	CAME.	U & Y	A	CAME.	U & Y	A	CAME.	U & Y	A	CAME.	U & Y
155	-31.27	-31.19	156	-34.67	-34.64	157	-36.11	-36.10	158	-38.98	-39.24
159	-39.74	-40.27	160	-42.58	-43.14	161	-43.00	-43.80	162	-45.93	-46.87
163	-46.66	-47.61	164	-49.16	-50.46	165	-49.60	-50.99	166	-51.88	-53.21
167	-52.00	-53.28	168	-53.82	-55.04	169	-53.71	-54.77	170	-54.98	-56.18
171	-54.69	-55.56	172	-55.74	-56.41	173	-55.10	-55.44	174	-55.62	-55.86
175	-54.53	-54.55	176	-54.33	-54.52	177	-52.74	-52.80	178	-52.11	-52.43
179	-50.27	-50.43	180	-49.57	-49.83	181	-47.28	-47.43	182	-45.96	-46.29
183	-42.93	-43.55	184	-41.46	-42.34	185	-38.01	-39.47	186	-36.31	-38.32
187	-32.58	-35.06	188	-30.61	-33.82	189	-26.74	-30.64	190	-24.61	-29.01
191	-20.54	-25.56	192	-17.93	-23.69						

*** Z = 73

A	CAME.	U & Y	A	CAME.	U & Y	A	CAME.	U & Y	A	CAME.	U & Y
158	-27.74	-28.14	159	-30.77	-31.40	160	-32.10	-32.91	161	-34.84	-35.90
162	-35.78	-37.03	163	-38.99	-40.23	164	-39.91	-41.44	165	-42.68	-44.40
166	-43.62	-45.39	167	-45.96	-47.74	168	-46.49	-48.25	169	-48.56	-50.14
170	-48.73	-50.31	171	-50.40	-51.84	172	-50.57	-51.66	173	-51.90	-52.63
174	-51.43	-52.10	175	-52.27	-52.63	176	-51.31	-51.75	177	-51.49	-51.84
178	-50.35	-50.54	179	-50.16	-50.28	180	-48.81	-48.71	181	-48.44	-48.22
182	-46.33	-46.23	183	-45.25	-45.21	184	-42.75	-42.88	185	-41.41	-41.78
186	-38.55	-39.31	187	-36.92	-38.27	188	-33.54	-35.41	189	-32.02	-34.28
190	-28.57	-31.49	191	-26.84	-29.97	192	-22.98	-26.91	193	-20.59	-25.15
194	-16.59	-21.79	195	-14.01	-19.70	196	-9.74	-15.95			

*** Z = 74

A	CAME.	U & Y	A	CAME.	U & Y	A	CAME.	U & Y	A	CAME.	U & Y
161	-24.90	-26.64	162	-28.16	-30.11	163	-29.39	-31.36	164	-32.79	-35.02

165	-33.98	-36.36	166	-37.25	-39.78	167	-38.26	-40.90	168	-41.00	-43.70
169	-41.77	-44.33	170	-44.13	-46.67	171	-44.71	-46.96	172	-46.83	-48.93
173	-47.27	-48.87	174	-48.77	-50.28	175	-48.63	-49.87	176	-49.60	-50.83
177	-49.01	-50.07	178	-49.64	-50.58	179	-48.94	-49.40	180	-49.24	-49.57
181	-48.22	-48.11	182	-48.03	-48.04	183	-46.17	-46.16	184	-45.62	-45.55
185	-43.25	-43.33	186	-42.50	-42.64	187	-39.71	-40.29	188	-38.42	-39.64
189	-35.50	-36.89	190	-34.40	-36.16	191	-31.35	-33.48	192	-29.83	-32.35
193	-26.20	-29.40	194	-24.30	-28.02	195	-20.63	-24.77	196	-18.22	-23.06
197	-14.30	-19.42									

*** Z = 75

A	CAME.	U & Y	A	CAME.	U & Y	A	CAME.	U & Y	A	CAME.	U & Y
163	-19.25	-21.85	164	-20.67	-23.57	165	-24.33	-27.36	166	-26.03	-29.15
167	-29.36	-32.70	168	-30.77	-34.26	169	-33.77	-37.19	170	-34.83	-38.27
171	-37.59	-40.73	172	-38.61	-41.47	173	-41.01	-43.56	174	-41.62	-43.93
175	-43.45	-45.46	176	-43.44	-45.48	177	-44.78	-46.56	178	-44.64	-46.22
179	-45.71	-46.85	180	-45.50	-46.09	181	-46.13	-46.38	182	-45.29	-45.33
183	-45.35	-45.38	184	-44.02	-43.91	185	-43.60	-43.41	186	-41.82	-41.60
187	-41.13	-41.02	188	-38.69	-39.07	189	-37.86	-38.53	190	-35.35	-36.18
191	-34.66	-35.56	192	-31.81	-33.27	193	-30.52	-32.25	194	-27.38	-29.69
195	-25.83	-28.42	196	-22.32	-25.55	197	-20.25	-23.95	198	-16.85	-20.68
199	-14.78	-18.80	200	-11.28	-15.35	201	-8.35	-12.69			

*** Z = 76

A	CAME.	U & Y	A	CAME.	U & Y	A	CAME.	U & Y	A	CAME.	U & Y
166	-17.11	-21.01	167	-18.87	-22.92	168	-22.60	-26.93	169	-24.27	-28.62
170	-27.55	-31.99	171	-29.01	-33.20	172	-32.21	-36.10	173	-33.52	-36.96
174	-36.09	-39.49	175	-37.03	-39.99	176	-38.99	-41.95	177	-39.35	-42.08
178	-41.14	-43.60	179	-41.44	-43.38	180	-43.00	-44.43	181	-43.12	-43.79
182	-43.93	-44.49	183	-43.34	-43.56	184	-43.92	-44.02	185	-42.72	-42.67
186	-42.90	-42.57	187	-41.19	-40.88	188	-40.85	-40.70	189	-38.86	-38.86
190	-38.44	-38.73	191	-36.34	-36.48	192	-35.85	-36.26	193	-33.23	-34.08
194	-32.43	-33.45	195	-29.64	-31.00	196	-28.24	-30.11	197	-25.08	-27.35
198	-23.53	-26.13	199	-20.38	-22.97	200	-18.62	-21.46	201	-15.23	-18.12
202	-13.01	-15.83									

*** Z = 77

A	CAME.	U & Y	A	CAME.	U & Y	A	CAME.	U & Y	A	CAME.	U & Y
168	-9.27	-14.52	169	-13.26	-18.65	170	-15.20	-20.79	171	-18.89	-24.29
172	-20.79	-25.94	173	-24.28	-28.96	174	-25.75	-30.26	175	-28.65	-32.91
176	-29.72	-33.84	177	-32.05	-35.92	178	-32.86	-36.48	179	-35.10	-38.12
180	-35.89	-38.32	181	-37.78	-39.49	182	-38.08	-39.26	183	-39.13	-40.08
184	-39.07	-39.56	185	-39.79	-40.14	186	-39.18	-39.19	187	-39.42	-39.21
188	-38.05	-37.92	189	-38.17	-37.86	190	-36.59	-36.42	191	-36.58	-36.39
192	-34.69	-34.54	193	-34.42	-34.43	194	-32.31	-32.64	195	-31.84	-32.12
196	-29.21	-30.05	197	-28.16	-29.28	198	-25.52	-26.89	199	-24.22	-25.78
200	-21.38	-23.00	201	-19.72	-21.59	202	-17.04	-18.62	203	-14.85	-16.44
204	-9.89	-11.25	205	-5.98	-7.74	206	-0.94	-2.54			

*** Z = 78

A	CAME.	U & Y	A	CAME.	U & Y	A	CAME.	U & Y	A	CAME.	U & Y
171	-7.73	-14.20	172	-11.86	-18.15	173	-14.04	-19.92	174	-17.70	-23.38
175	-19.50	-24.80	176	-22.53	-27.89	177	-23.97	-28.94	178	-26.75	-31.45
179	-28.00	-32.13	180	-30.73	-34.19	181	-31.85	-34.51	182	-33.92	-36.10
183	-34.46	-35.99	184	-36.05	-37.23	185	-36.12	-36.83	186	-37.43	-37.81
187	-36.88	-36.98	188	-37.47	-37.41	189	-36.56	-36.23	190	-37.09	-36.57
191	-35.92	-35.24	192	-36.12	-35.61	193	-34.45	-33.87	194	-34.68	-34.15
195	-32.90	-32.48	196	-32.60	-32.34	197	-30.31	-30.38	198	-29.78	-29.99

199	-27.39	-27.71	200	-26.41	-26.98	201	-23.67	-24.31	202	-22.72	-23.27
203	-20.07	-20.41	204	-18.21	-18.60	205	-13.35	-13.52	206	-9.97	-10.36
207	-5.08	-5.27									

*** Z = 79

A	CAME.	U & Y	A	CAME.	U & Y	A	CAME.	U & Y	A	CAME.	U & Y
173	-2.54	-10.24	174	-4.90	-12.45	175	-8.88	-16.04	176	-10.81	-17.89
177	-14.21	-21.10	178	-16.10	-22.58	179	-19.32	-25.21	180	-21.07	-26.32
181	-24.12	-28.50	182	-25.42	-29.24	183	-27.74	-30.95	184	-28.81	-31.25
185	-30.53	-32.60	186	-31.19	-32.61	187	-32.56	-33.71	188	-32.37	-33.29
189	-33.41	-33.83	190	-32.91	-33.05	191	-33.85	-33.50	192	-32.88	-32.57
193	-33.31	-33.05	194	-32.14	-31.71	195	-32.71	-32.10	196	-31.09	-30.81
197	-31.14	-30.78	198	-29.36	-29.20	199	-29.09	-28.92	200	-27.01	-27.02
201	-26.12	-26.40	202	-24.10	-24.10	203	-23.18	-23.17	204	-20.86	-20.68
205	-19.10	-18.97	206	-14.78	-14.25	207	-11.54	-11.21	208	-6.72	-6.48
209	-3.25	-3.18	210	1.77	1.67	211	5.65	5.08	212	11.13	9.64

*** Z = 80

A	CAME.	U & Y	A	CAME.	U & Y	A	CAME.	U & Y	A	CAME.	U & Y
176	-0.91	-9.99	177	-3.21	-11.97	178	-7.06	-15.61	179	-9.39	-17.21
180	-13.11	-20.27	181	-15.18	-21.49	182	-18.41	-24.09	183	-19.96	-24.95
184	-22.81	-27.08	185	-24.01	-27.50	186	-26.32	-29.26	187	-27.04	-29.39
188	-28.76	-30.90	189	-29.03	-30.59	190	-30.48	-31.53	191	-30.39	-30.86
192	-31.53	-31.72	193	-30.80	-30.90	194	-31.72	-31.78	195	-30.88	-30.54
196	-31.61	-31.32	197	-30.34	-30.14	198	-30.91	-30.50	199	-29.39	-29.03
200	-29.42	-29.13	201	-27.44	-27.34	202	-27.27	-27.09	203	-25.28	-24.90
204	-24.69	-24.35	205	-22.47	-21.96	206	-21.25	-20.62	207	-17.07	-16.01
208	-13.91	-13.33	209	-9.32	-8.70	210	-6.14	-5.77	211	-1.26	-1.02
212	2.40	2.04	213	7.65	6.50						

*** Z = 81

A	CAME.	U & Y	A	CAME.	U & Y	A	CAME.	U & Y	A	CAME.	U & Y
179	2.29	-7.51	180	-0.53	-9.53	181	-4.57	-12.71	182	-6.82	-14.36
183	-10.30	-17.08	184	-12.38	-18.35	185	-15.36	-20.60	186	-17.16	-21.43
187	-19.53	-23.31	188	-20.60	-23.84	189	-22.78	-25.47	190	-23.45	-25.56
191	-25.31	-26.62	192	-25.43	-26.35	193	-26.80	-27.32	194	-26.56	-26.89
195	-27.82	-27.88	196	-27.14	-27.03	197	-28.22	-27.93	198	-27.47	-27.13
199	-28.28	-27.60	200	-27.08	-26.51	201	-27.21	-26.72	202	-25.94	-25.31
203	-25.80	-25.17	204	-24.14	-23.35	205	-23.65	-22.90	206	-21.97	-20.88
207	-20.89	-19.65	208	-16.78	-15.40	209	-13.86	-12.83	210	-9.57	-8.56
211	-6.53	-5.73	212	-1.87	-1.33	213	1.56	1.62	214	6.41	5.73
215	10.18	8.75	216	15.20	12.84	217	19.17	15.84			

*** Z = 82

A	CAME.	U & Y	A	CAME.	U & Y	A	CAME.	U & Y	A	CAME.	U & Y
183	0.79	-8.65	184	-3.22	-11.79	185	-5.43	-13.18	186	-9.00	-15.84
187	-10.86	-16.79	188	-13.58	-19.08	189	-15.11	-19.73	190	-17.70	-21.76
191	-18.78	-21.97	192	-20.84	-23.43	193	-21.19	-23.27	194	-23.06	-24.64
195	-23.15	-24.32	196	-24.57	-25.70	197	-24.25	-24.97	198	-25.84	-26.25
199	-25.34	-25.57	200	-26.46	-26.42	201	-25.35	-25.44	202	-26.20	-26.03
203	-24.97	-24.72	204	-25.16	-24.95	205	-23.59	-23.25	206	-23.64	-23.17
207	-22.10	-21.26	208	-21.10	-20.39	209	-17.23	-16.25	210	-14.60	-14.03
211	-10.45	-9.88	212	-7.62	-7.40	213	-3.20	-3.11	214	-0.17	-0.51
215	4.55	3.49	216	7.77	6.16	217	12.63	10.16	218	16.10	12.81

*** Z = 83

A	CAME.	U & Y	A	CAME.	U & Y	A	CAME.	U & Y	A	CAME.	U & Y

184	11.52	0.53	185	7.38	-2.73	186	4.57	-4.53	187	0.94	-7.31
188	-1.27	-8.67	189	-4.45	-11.08	190	-6.39	-12.13	191	-9.38	-14.27
192	-10.67	-14.88	193	-12.96	-16.46	194	-13.81	-16.70	195	-16.01	-18.17
196	-16.26	-18.25	197	-18.03	-19.75	198	-18.23	-19.40	199	-20.07	-20.79
200	-19.88	-20.49	201	-21.11	-21.45	202	-20.71	-20.85	203	-21.59	-21.55
204	-20.69	-20.61	205	-20.97	-20.96	206	-19.95	-19.62	207	-20.14	-19.65
208	-18.67	-18.10	209	-17.91	-17.35	210	-14.33	-13.56	211	-11.84	-11.46
212	-7.91	-7.65	213	-5.31	-5.28	214	-1.29	-1.35	215	1.61	1.15
216	5.78	4.80	217	8.83	7.37	218	13.20	11.02	219	16.67	13.57
220	21.33	17.21	221	24.81	19.98	222	29.65	24.05			

*** Z = 84

A	CAME.	U & Y	A	CAME.	U & Y	A	CAME.	U & Y	A	CAME.	U & Y
192	-2.26	-8.07	193	-3.77	-8.79	194	-6.56	-10.76	195	-7.74	-11.12
196	-10.10	-12.99	197	-10.71	-13.18	198	-12.99	-15.06	199	-13.44	-14.83
200	-15.60	-16.60	201	-15.50	-16.42	202	-17.45	-17.76	203	-17.08	-17.27
204	-18.29	-18.34	205	-17.49	-17.52	206	-18.31	-18.23	207	-17.43	-17.00
208	-17.69	-17.40	209	-16.47	-15.97	210	-15.99	-15.57	211	-12.56	-11.90
212	-10.28	-10.15	213	-6.58	-6.45	214	-4.39	-4.44	215	-0.50	-0.61
216	1.86	1.54	217	5.87	5.09	218	8.42	7.31	219	12.78	10.85
220	15.57	13.06	221	20.09	16.60	222	23.09	19.03	223	27.87	23.00

*** Z = 85

A	CAME.	U & Y	A	CAME.	U & Y	A	CAME.	U & Y	A	CAME.	U & Y
196	0.68	-3.57	197	-2.03	-5.55	198	-3.16	-6.13	199	-5.69	-8.13
200	-6.45	-8.28	201	-8.70	-10.17	202	-9.33	-10.35	203	-11.30	-11.81
204	-11.27	-11.69	205	-12.57	-12.88	206	-12.31	-12.43	207	-13.27	-13.25
208	-12.46	-12.39	209	-12.97	-12.90	210	-12.03	-11.82	211	-11.70	-11.54
212	-8.48	-8.22	213	-6.44	-6.58	214	-3.13	-3.23	215	-1.07	-1.33
216	2.27	2.15	217	4.46	4.19	218	7.97	7.39	219	10.52	9.51
220	14.20	12.71	221	16.85	14.81	222	20.89	18.01	223	23.84	20.34
224	28.06	23.97	225	31.12	26.47	226	35.32	30.18	227	38.81	33.03

*** Z = 86

A	CAME.	U & Y	A	CAME.	U & Y	A	CAME.	U & Y	A	CAME.	U & Y
200	0.07	-2.68	201	-0.78	-2.94	202	-3.76	-5.21	203	-4.41	-5.51
204	-6.71	-7.35	205	-6.78	-7.34	206	-8.62	-8.90	207	-8.50	-8.56
208	-9.54	-9.75	209	-8.97	-9.00	210	-9.76	-9.87	211	-8.97	-8.90
212	-8.85	-8.98	213	-5.86	-5.77	214	-4.23	-4.49	215	-1.05	-1.25
216	0.46	0.30	217	3.64	3.67	218	5.33	5.36	219	8.84	8.46
220	10.71	10.23	221	14.25	13.32	222	16.41	15.09	223	20.40	18.18
224	22.79	20.17	225	26.79	23.70	226	29.33	25.86	227	33.52	29.47
228	36.43	32.00	229	40.77	35.96	230	43.89	38.77			

*** Z = 87

A	CAME.	U & Y	A	CAME.	U & Y	A	CAME.	U & Y	A	CAME.	U & Y
203	3.79	2.43	204	2.81	1.76	205	0.41	-0.19	206	-0.19	-0.56
207	-2.18	-2.23	208	-2.13	-2.25	209	-3.41	-3.56	210	-3.13	-3.17
211	-4.07	-4.15	212	-3.49	-3.55	213	-3.60	-3.73	214	-1.02	-0.88
215	0.49	0.30	216	3.12	3.18	217	4.47	4.63	218	7.15	7.65
219	8.83	9.23	220	11.66	11.99	221	13.39	13.65	222	16.45	16.40
223	18.56	18.06	224	21.99	20.82	225	24.16	22.70	226	27.64	25.90
227	30.17	27.96	228	33.78	31.24	229	36.51	33.66	230	40.42	37.30
231	43.52	40.00	232	47.60	43.82	233	50.85	46.93			

*** Z = 88

A	CAME.	U & Y	A	CAME.	U & Y	A	CAME.	U & Y	A	CAME.	U & Y

206	5.69	5.02	207	4.95	4.54	208	2.89	2.51	209	2.70	2.36
210	1.13	0.70	211	1.27	0.98	212	0.11	-0.37	213	0.46	0.12
214	-0.06	-0.42	215	2.40	2.32	216	3.36	3.15	217	5.82	5.92
218	6.67	7.02	219	9.35	9.93	220	10.36	11.17	221	13.05	13.81
222	14.29	15.14	223	17.30	17.78	224	18.85	19.10	225	22.06	21.75
226	23.71	23.30	227	27.18	26.39	228	29.13	28.12	229	32.56	31.30
230	34.86	33.39	231	38.75	36.92	232	41.27	39.30	233	45.21	43.02
234	48.18	45.81									

*** Z = 89

A	CAME.	U & Y	A	CAME.	U & Y	A	CAME.	U & Y	A	CAME.	U & Y
209	10.46	9.49	210	9.98	8.98	211	8.27	7.20	212	8.19	7.12
213	6.80	5.66	214	6.75	5.80	215	6.10	5.15	216	8.01	7.54
217	8.81	8.25	218	10.77	10.67	219	11.62	11.66	220	13.62	14.23
221	14.48	15.36	222	16.69	17.66	223	17.88	18.88	224	20.32	21.19
225	21.66	22.40	226	24.35	24.72	227	25.98	26.16	228	28.88	28.92
229	30.64	30.54	230	33.65	33.39	231	35.93	35.38	232	39.23	38.59
233	41.62	40.86	234	45.28	44.26	235	48.16	46.94	236	52.06	50.65
237	54.91	53.48	238	59.12	57.34						

*** Z = 90

A	CAME.	U & Y	A	CAME.	U & Y	A	CAME.	U & Y	A	CAME.	U & Y
213	14.05	11.68	214	12.26	9.86	215	12.07	9.89	216	10.88	8.89
217	12.62	11.16	218	12.92	11.52	219	14.88	13.84	220	15.05	14.48
221	16.91	16.94	222	17.29	17.72	223	19.44	19.92	224	20.08	20.79
225	22.30	22.99	226	23.12	23.87	227	25.79	26.08	228	26.85	27.19
229	29.56	29.83	230	30.91	31.14	231	33.89	33.88	232	35.58	35.54
233	38.75	38.65	234	40.85	40.60	235	44.42	43.90	236	46.92	46.26
237	50.43	49.86	238	53.21	52.38	239	57.23	56.13			

*** Z = 91

A	CAME.	U & Y	A	CAME.	U & Y	A	CAME.	U & Y	A	CAME.	U & Y
216	19.23	15.61	217	17.87	14.49	218	19.11	16.42	219	19.41	16.67
220	20.69	18.64	221	20.72	19.16	222	22.10	21.28	223	22.43	21.96
224	24.02	23.81	225	24.43	24.58	226	26.14	26.45	227	26.94	27.21
228	29.04	29.09	229	29.91	30.10	230	32.20	32.42	231	33.52	33.61
232	35.92	36.03	233	37.48	37.58	234	40.37	40.36	235	42.38	42.21
236	45.56	45.19	237	47.66	47.45	238	51.11	50.74	239	53.70	53.15
240	57.36	56.59	241	60.05	59.29	242	64.07	63.08	243	67.33	65.97

*** Z = 92

A	CAME.	U & Y	A	CAME.	U & Y	A	CAME.	U & Y	A	CAME.	U & Y
226	27.33	27.01	227	29.02	28.77	228	29.24	29.20	229	31.16	30.97
230	31.61	31.64	231	33.88	33.86	232	34.61	34.72	233	36.88	37.03
234	38.15	38.26	235	40.95	40.94	236	42.58	42.47	237	45.37	45.34
238	47.40	47.28	239	50.65	50.47	240	52.89	52.57	241	56.36	55.90
242	58.86	58.30	243	62.74	61.97	244	65.64	64.57			