The Synthetic Routes to Some 92-173th Elements

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Abstract

In our previous paper, we gave the synthetic routes to the 119-128th elements. In this paper, we give the synthetic routes to some key elements from the 92th to the 173th. The 137th element could be called the Feynman end of the elements, and 173th element could be called the Dirac end of the elements, so the main aim of this work is to explore the frontier of the elements. In addition, we also illustrate a "bridge-correlation effect" in nuclides.

Keywords: synthetic routes, frontier of the elements, bridge-correlation effect.

1. Introduction

R. Feynman deduced that the atomic number of the hydrogen-like atom couldn't be more than 137 according to Bohr model, otherwise the speed of the ground state electron in the atom would exceed the speed of the light in vacuum, so he supposed that the end of the elements would be the 137th element which is called Feymanium (Fy). By more detailed calculation with Dirac equation and considering the volume of the atomic nucleus, the end of the elements should be the 173th element, which should be called the Dirac end of elements. Now there are 118 elements in the periodic table of elements which fill in the whole 7 periods of elements. So to predict the 119-173th elements and design their synthetic routes should be serious theoretical and experimental problems of physics.

In our previous papers [1-14], we predicted the 119-173th elements which we called the ideal extended elements (*ie*), and in a recent paper [13] we designed the synthetic routes to the 119-128th elements. In this paper, we design the synthetic routes to

element 92, 94, 100, 103, 109, 112, 119, 120, 121, 125, 126, 130, 132, 136, 137, 138, 141, 146, 157, 168, 169 and 173. It is worthy to note that the numbers 137, 141, 157 and 173 correspond to the fine-structure constant, the square root of 2, π/2 and the square root of 3 respectively especially in the world of nuclides or the sub-atomic world, and there is formula "141/2 +173/2 = 157" or the three numbers 141, 157 and 173 are in arithmetic progression. The number146 is also special because the most stable isotope of Uranium with 146 neutrons in its atomic nucleus and it is predicted by us that the 146th ideal extended element should have 224 neutrons. 136 and 138 could be called brother numbers of 137, or all of them could be called the numbers of the fine-structure constant, because even numbers 136 and 138 are usually more stable numbers than 137 in nuclides but have the same effect as 137.

2. Bridge-correlation Effect in Nuclides

Another reason to select the above-stated elements to design their synthetic routes is illustrated by a kind of "bridge-correlation effect" as follows.

Bridge-correlation Effect in Nuclides:

$^{56}_{26}Fe_{30}$ $^{82,83,84}_{36}Kr_{46,47,48}$ $^{90,92}_{40}Zr_{50,52}$ $^{100}_{44}Ru_{56}$ $^{103}_{45}Rh_{58}$ $^{107,109}_{47}Ag_{60,62}$ $^{112}_{48}Cd_{64}$ $^{118,119,120}_{50}Sn_{68,69,70}$

$^{120,122-126,128,130}_{52}Te_{68,70-74,76,78}$ $^{136,137,138}_{56}Ba_{80,81,82}$ $^{141}_{56}Ba^{*}_{85}$ $^{140,142}_{58}Ce_{82,84}$ $^{141}_{59}\mathrm{Pr}_{82}$ $^{143,146}_{60}Nd_{83,86}$

$^{146}_{61}Pm^{*}_{85}$ $^{156,157}_{64}Gd_{92,93}$ $^{168}_{68}Er_{100}$ $^{169}_{69}Tm_{100}$ $^{173}_{70}Yb_{103}$ $^{178,179,180}_{72}Hf_{106,107,108}$ $^{180,181}_{73}Ta_{107,108}$

$^{182,183}_{74}W_{108,109}$ $^{185.187}_{75}\mathrm{Re}_{110,112}$ $^{188}_{76}Os_{112}$ $^{199,200,201}_{80}Hg_{119,120,121}$ $^{208}_{82}Pb_{126}$ $^{209}_{83}Bi^{*}_{126}$ $^{209}_{84}Po^{*}_{125}$

$^{210}_{85}At^{*}_{125}$ $^{222}_{86}Rn^{*}_{136}$ $^{223,224}_{87}Fr^{*}_{136,137}$ $^{226}_{88}Ra^{*}_{138}$ $^{227}_{89}Ac^{*}_{138}$ $^{232}_{90}Th^{*}_{142}$ $^{235,238}_{92}U^{*}_{143,146}$ $^{257}_{100}Fm^{*}_{157}$

$^{262}_{103}Lr^{*}_{159}$ $^{278}_{109}Mt^{*}_{169}$ $^{285}_{112}Cn^{*}_{173}$ $^{298,300,302}_{119,120,121}Ch^{ie}_{179,180,181}$ $^{304}_{122}Ch^{ie}_{182}$ $^{306}_{123}Ch^{ie}_{183}$ $^{308}_{124}Ch^{ie}_{184}$ $^{310,312}_{125}Ch^{ie}_{185,187}$

$^{314}_{126}Ch^{ie}_{188}$ $^{317}_{127}Ch^{ie}_{190}$ $^{320}_{128}Ch^{ie}_{192}$ $^{323}_{129}Ch^{ie}_{194}$ $^{326}_{130}Ch^{ie}_{196}$ $^{329}_{131}Ch^{ie}_{198}$ $^{332}_{132}Ch^{ie}_{200}$ $^{335}_{133}Ch^{ie}_{202}$ $^{338}_{134}Ch^{ie}_{204}$

$^{341}_{135}Ch^{ie}_{206}$ $^{344,2\cdot173,348}_{136,137,138}Fy^{ie}_{208,209,210}$ $^{354}_{141}Ch^{ie}_{213}$ $^{370}_{146}Ch^{ie}_{224}$ $^{400}_{157}Ch^{ie}_{243}$ $^{426}_{169}Ch^{ie}_{257}$ $^{435}_{173}Ch^{ie}_{262}$

Note: $112 = 2\cdot56$, $224 = 2\cdot112$; $141 = 3\cdot47$, $188 = 4\cdot47$, $235 = 5\cdot47$;

$136 = 8\cdot17$, $138 = 6\cdot23$, $68 = 4\cdot17$, $69 = 3\cdot23$, $238 = 14\cdot17$;

$141+173 = 314$, $314 = 2\cdot157$, $346 = 2\cdot173$

More simple and typical examples of bridge-correlation effect are as follows:

$^{100}_{44}Ru_{56}$ $^{103}_{45}Rh_{58}$ $^{112}_{48}Cd_{64}$ $^{119}_{50}Sn_{69}$ $^{137}_{56}Ba_{81}$ $^{140,142}_{58}Ce_{82,84}$ $^{157}_{64}Gd_{93}$ $^{169}_{69}Tm_{100}$ $^{173}_{70}Yb_{103}$ $^{188}_{76}Os_{112}$

$^{209}_{83}Bi^{*}_{126}$ $^{224}_{87}Fr^{*}_{137}$ $^{257}_{100}Fm^{*}_{157}$ $^{262}_{103}Lr^{*}_{159}$ $^{285}_{112}Cn^{*}_{173}$ $^{2\cdot173}_{137}Fy^{ie}_{209}$ $^{2\cdot157}_{126}Ch^{ie}_{188}$ $^{426}_{169}Ch^{ie}_{257}$ $^{435}_{173}Ch^{ie}_{262}$

Or: $^{100}_{44}Ru_{56}$ $^{112}_{48}Cd_{64}$ $^{119}_{50}Sn_{69}$ $^{157}_{64}Gd_{93}$ $^{169}_{69}Tm_{100}$ $^{257}_{100}Fm^{*}_{157}$ $^{188}_{76}Os_{112}$ $^{2\cdot157}_{126}Ch^{ie}_{188}$ $^{426}_{169}Ch^{ie}_{257}$;

$^{103}_{45}Rh_{58}$ $^{137}_{56}Ba_{81}$ $^{140,142}_{58}Ce_{82,84}$ $^{173}_{70}Yb_{103}$ $^{209}_{83}Bi^{*}_{126}$ $^{224}_{87}Fr^{*}_{137}$ $^{262}_{103}Lr^{*}_{159}$ $^{285}_{112}Cn^{*}_{173}$ $^{2\cdot173}_{137}Fy^{ie}_{209}$ $^{435}_{173}Ch^{ie}_{262}$

It seems that there is a "bridge-correlation effect" in nuclides with which some key numbers of nucleon of a former nuclide will act as a "bridge" for a later corresponding nuclide. And in the above elements, i.e., element 92, 94, 100, 103, 109, 112, 120, 125, 126, 128, 130, 132, 136, 137, 138, 141, 146, 157, 168, 169 and 173, have more critical "bridge-correlation effect" and act as "skeleton" of the all elements.

3. The Synthetic Routes to Element 92, 94, 100, 103, 109, 119, 120, 121, 125, 126, 128, 130, 132, 136, 137, 138, 141, 146, 157, 168, 169 and 173

Preparation of the key starting nuclide ${}^{141}_{56}Ba^{*}_{85}$ (half life 18.27min):

$${}^{235}_{92}U^{*}_{146} + n \rightarrow {}^{92}_{36}Kr^{*}_{56} + {}^{141}_{56}Ba^{*}_{85} + 3n$$

$${}^{141}_{56}Ba \rightarrow {}^{141}_{57}La^{*}_{85} + \beta \rightarrow {}^{141}_{58}Ce^{*}_{85} + 2\beta \rightarrow {}^{141}_{59}\mathrm{Pr}_{82} + 3\beta$$

The Synthetic Routes to the 92th Element:

$${}^{141}_{56}Ba^{*}_{85} + {}^{94}_{40}Zr_{54} \rightarrow {}^{235}_{96}Cm^{*}_{139} \rightarrow {}^{235}_{92}U^{*}_{143} + 4\beta^{+}$$

$${}^{141}_{56}Ba^{*}_{85} + {}^{98}_{42}Mo_{56} \rightarrow {}^{239}_{98}Cf^{*}_{141} \rightarrow {}^{235}_{96}Cm^{*}_{139} + \alpha \rightarrow {}^{235}_{96}Cm^{*}_{139} + \alpha + 4\beta^{+}$$

$${}^{204}_{80}Hg_{124} + {}^{31}_{15}P_{16} \rightarrow {}^{235}_{95}Am^{*}_{140} \rightarrow {}^{235}_{92}U^{*}_{143} + 3\beta^{+}$$

$${}^{204}_{80}Hg_{124} + {}^{35}_{17}Cl_{18} \rightarrow {}^{239}_{97}Bk^{*}_{142} \rightarrow {}^{235}_{95}Am^{*}_{140} + \alpha \rightarrow {}^{235}_{92}U^{*}_{143} + \alpha + 3\beta^{+}$$

$${}^{205}_{81}Tl_{124} + {}^{30}_{14}Si_{16} \rightarrow {}^{235}_{95}Am^{*}_{140} \rightarrow {}^{235}_{92}U^{*}_{143} + 3\beta^{+}$$

$${}^{205}_{81}Tl_{124} + {}^{34}_{16}S_{18} \rightarrow {}^{239}_{97}Bk^{*}_{142} \rightarrow {}^{235}_{95}Am^{*}_{140} + \alpha \rightarrow {}^{235}_{92}U^{*}_{143} + \alpha + 3\beta^{+}$$

$${}^{208}_{82}Pb_{126} + {}^{27}_{13}Al_{14} \rightarrow {}^{235}_{95}Am^{*}_{140} \rightarrow {}^{235}_{92}U^{*}_{143} + 3\beta^{+}$$

$${}^{208}_{82}Pb_{126} + {}^{31}_{15}P_{16} \rightarrow {}^{239}_{97}Bk^{*}_{142} \rightarrow {}^{235}_{95}Am^{*}_{140} + \alpha \rightarrow {}^{235}_{92}U^{*}_{143} + \alpha + 3\beta^{+}$$

$${}^{209}_{83}Bi^{*}_{126} + {}^{26}_{12}Mg_{14} \rightarrow {}^{235}_{95}Am^{*}_{140} \rightarrow {}^{235}_{92}U^{*}_{143} + 3\beta^{+}$$

$${}^{209}_{83}Bi^{*}_{126} + {}^{30}_{14}Si_{16} \rightarrow {}^{239}_{97}Bk^{*}_{142} \rightarrow {}^{235}_{95}Am^{*}_{140} + \alpha \rightarrow {}^{235}_{92}U^{*}_{143} + \alpha + 3\beta^{+}$$

$${}^{204}_{80}Hg_{124} + {}^{34}_{16}S_{18} \rightarrow {}^{238}_{96}Cm^{*}_{142} \rightarrow {}^{238}_{92}U^{*}_{146} + 4\beta^{+}$$

$${}^{204}_{80}Hg_{124} + {}^{38}_{18}Ar_{20} \rightarrow {}^{242}_{98}Cf^{*}_{144} \rightarrow {}^{238}_{96}Cm^{*}_{142} + \alpha \rightarrow {}^{238}_{92}U^{*}_{146} + \alpha + 4\beta^{+}$$

$${}^{205}_{81}Tl_{124} + {}^{33}_{16}S_{17} \rightarrow {}^{238}_{97}Bk^{*}_{141} \rightarrow {}^{238}_{92}U^{*}_{146} + 5\beta^{+}$$

$${}^{205}_{81}Tl_{124} + {}^{37}_{17}Cl_{20} \rightarrow {}^{242}_{98}Cf^{*}_{144} \rightarrow {}^{238}_{96}Cm^{*}_{142} + \alpha \rightarrow {}^{238}_{92}U^{*}_{146} + \alpha + 4\beta^{+}$$

$${}^{208}_{82}Pb_{126} + {}^{30}_{14}Si_{16} \rightarrow {}^{238}_{96}Cm^{*}_{142} \rightarrow {}^{238}_{92}U^{*}_{146} + 4\beta^{+}$$

$${}^{208}_{82}Pb_{126} + {}^{34}_{16}S_{18} \rightarrow {}^{242}_{98}Cf^{*}_{144} \rightarrow {}^{238}_{96}Cm^{*}_{142} + \alpha \rightarrow {}^{238}_{92}U^{*}_{146} + \alpha + 4\beta^{+}$$

$${}^{209}_{83}Bi^{*}_{126} + {}^{29}_{14}Si_{15} \rightarrow {}^{238}_{97}Bk^{*}_{141} \rightarrow {}^{238}_{92}U^{*}_{146} + 5\beta^{+}$$

$${}^{209}_{83}Bi^{*}_{126} + {}^{33}_{16}S_{17} \rightarrow {}^{242}_{99}Es^{*}_{143} \rightarrow {}^{238}_{97}Bk^{*}_{141} + \alpha \rightarrow {}^{238}_{92}U^{*}_{146} + \alpha + 5\beta^{+}$$

The Synthetic Routes to the 94th Element Pu239:

${}^{239}_{94}Pu^{*}_{145}$ is fissible, so it is worthy to synthesized it.

$$^{141}_{56}Ba^{*}_{85} + {}^{98}_{42}Mo_{56} \rightarrow {}^{239}_{98}Cf^{*}_{141} \rightarrow {}^{239}_{94}Pu^{*}_{145} + 4\beta^{+}$$

$$^{141}_{56}Ba^{*}_{85} + {}^{102}_{44}Ru_{58} \rightarrow {}^{243}_{100}Es^{*}_{143} \rightarrow {}^{239}_{98}Cf^{*}_{141} + \alpha \rightarrow {}^{239}_{94}Pu^{*}_{145} + \alpha + 4\beta^{+}$$

$$^{204}_{80}Hg_{124} + {}^{35}_{17}Cl_{18} \rightarrow {}^{239}_{97}Bk^{*}_{142} \rightarrow {}^{239}_{94}Pu^{*}_{145} + 3\beta^{+}$$

$$^{204}_{80}Hg_{124} + {}^{39}_{19}K_{20} \rightarrow {}^{243}_{99}Es^{*}_{144} \rightarrow {}^{239}_{97}Bk^{*}_{142} + \alpha \rightarrow {}^{239}_{94}Pu^{*}_{145} + \alpha + 3\beta^{+}$$

$$^{205}_{81}Tl_{124} + {}^{34}_{16}S_{18} \rightarrow {}^{239}_{97}Bk^{*}_{142} \rightarrow {}^{239}_{94}Pu^{*}_{145} + 3\beta^{+}$$

$$^{205}_{81}Tl_{124} + {}^{38}_{18}Sr_{20} \rightarrow {}^{243}_{99}Es^{*}_{144} \rightarrow {}^{239}_{97}Bk^{*}_{142} + \alpha \rightarrow {}^{239}_{94}Pu^{*}_{145} + \alpha + 3\beta^{+}$$

$$^{208}_{82}Pb_{126} + {}^{31}_{15}P_{16} \rightarrow {}^{239}_{97}Bk^{*}_{142} \rightarrow {}^{239}_{94}Pu^{*}_{145} + 3\beta^{+}$$

$$^{208}_{82}Pb_{126} + {}^{35}_{17}Cl_{18} \rightarrow {}^{243}_{99}Es^{*}_{144} \rightarrow {}^{239}_{97}Bk^{*}_{142} + \alpha \rightarrow {}^{239}_{94}Pu^{*}_{145} + \alpha + 3\beta^{+}$$

$$^{209}_{83}Bi^{*}_{126} + {}^{30}_{14}Si_{16} \rightarrow {}^{239}_{97}Bk^{*}_{142} \rightarrow {}^{239}_{94}Pu^{*}_{145} + 3\beta^{+}$$

$$^{209}_{83}Bi^{*}_{126} + {}^{34}_{16}S_{18} \rightarrow {}^{243}_{99}Es^{*}_{144} \rightarrow {}^{239}_{97}Bk^{*}_{142} + \alpha \rightarrow {}^{239}_{94}Pu^{*}_{145} + \alpha + 3\beta^{+}$$

$$^{235}_{92}U^{*}_{143} + {}^{4}_{2}He_{2} \rightarrow {}^{239}_{94}Pu^{*}_{145}$$

$$^{238}_{92}U^{*}_{146} + n \rightarrow {}^{239}_{92}U^{*}_{147} \rightarrow {}^{239}_{93}Np^{*}_{146} + \beta \rightarrow {}^{239}_{94}Pu^{*}_{145} + 2\beta$$

The Synthetic Routes to the 100th Element:

$$^{141}_{56}Ba^{*}_{85} + {}^{116}_{48}Cd_{68} \rightarrow {}^{257}_{104}Rf^{*}_{153} \rightarrow {}^{257}_{100}Fm^{*}_{157} + 4\beta^{+}$$

$$^{141}_{56}Ba^{*}_{85} + {}^{120}_{50}Sn_{70} \rightarrow {}^{261}_{106}Sg^{*}_{155} \rightarrow {}^{257}_{104}Rf^{*}_{153} + \alpha \rightarrow {}^{257}_{100}Fm^{*}_{157} + \alpha + 4\beta$$

$$^{209}_{83}Bi^{*}_{126} + {}^{48}_{20}Ca_{28} \rightarrow {}^{257}_{103}Lr^{*}_{154} \rightarrow {}^{257}_{100}Fm^{*}_{157} + 2\beta^{+}$$

$$^{232}_{90}Th^{*}_{142} + {}^{25}_{12}Mg_{13} \rightarrow {}^{257}_{102}No^{*}_{155} \rightarrow {}^{257}_{100}Fm^{*}_{157} + 2\beta^{+}$$

$$^{232}_{90}Th^{*}_{142} + {}^{29}_{14}Si_{15} \rightarrow {}^{261}_{104}Rf^{*}_{157} \rightarrow {}^{257}_{102}No^{*}_{155} + \alpha \rightarrow {}^{257}_{100}Fm^{*}_{157} + \alpha + 2\beta^{+}$$

$$^{235}_{92}U^{*}_{143} + {}^{22}_{10}Ne_{12} \rightarrow {}^{257}_{102}No^{*}_{155} \rightarrow {}^{257}_{100}Fm^{*}_{157} + 2\beta^{+}$$

$$^{235}_{92}U^{*}_{143} + {}^{26}_{12}Mg_{14} \rightarrow {}^{261}_{104}Rf^{*}_{157} \rightarrow {}^{257}_{102}No^{*}_{155} + \alpha \rightarrow {}^{257}_{100}Fm^{*}_{157} + \alpha + 2\beta^{+}$$

$$^{238}_{92}U^{*}_{146} + {}^{19}_{9}F_{10} \rightarrow {}^{257}_{101}Md^{*}_{156} \rightarrow {}^{257}_{100}Fm^{*}_{157} + \beta^{+}$$

$$^{238}_{92}U^{*}_{146} + {}^{23}_{11}Na_{12} \rightarrow {}^{261}_{103}Lr^{*}_{158} \rightarrow {}^{257}_{101}Md^{*}_{156} + \alpha \rightarrow {}^{257}_{100}Fm^{*}_{157} + \alpha + \beta^{+}$$

The Synthetic Routes to the 103th Element:

$$^{141}_{56}Ba^{*}_{85} + {}^{121}_{51}Sb_{70} \rightarrow {}^{262}_{107}Bh^{*}_{155} \rightarrow {}^{262}_{103}Lr^{*}_{159} + 4\beta^{+}$$

$$^{141}_{56}Ba^{*}_{85} + {}^{125}_{52}Te_{73} \rightarrow {}^{266}_{108}Hs^{*}_{158} \rightarrow {}^{262}_{106}Sg^{*}_{156} + \alpha \rightarrow {}^{262}_{103}Lr^{*}_{159} + \alpha + 4\beta^{+}$$

$$^{209}_{83}Bi^{*}_{126} + {}^{53}_{24}Cr_{29} \rightarrow {}^{262}_{107}Bh^{*}_{155} \rightarrow {}^{262}_{103}Lr^{*}_{159} + 4\beta^{+}$$

$$^{209}_{83}Bi^{*}_{126} + {}^{57}_{26}Fe_{31} \rightarrow {}^{266}_{109}Mt^{*}_{157} \rightarrow {}^{262}_{107}Bh^{*}_{155} + \alpha \rightarrow {}^{262}_{103}Lr^{*}_{159} + 4\beta^{+}$$

$$^{232}_{90}Th^{*}_{142} + {}^{30}_{14}Mg_{16} \rightarrow {}^{262}_{104}Rf^{*}_{158} \rightarrow {}^{262}_{103}Lr^{*}_{159} + \beta^{+}$$

$$^{232}_{90}Th^{*}_{142} + {}^{34}_{16}S_{18} \rightarrow {}^{266}_{106}Sg^{*}_{160} \rightarrow {}^{262}_{104}Rf^{*}_{158} + \alpha \rightarrow {}^{262}_{103}Lr^{*}_{159} + \alpha + \beta^{+}$$

$$^{235}_{92}U^{*}_{143} + {}^{27}_{13}Al_{14} \rightarrow {}^{262}_{105}Db^{*}_{157} \rightarrow {}^{262}_{103}Lr^{*}_{159} + 2\beta^{+}$$

$$^{235}_{92}U^{*}_{143} + {}^{31}_{15}P_{16} \rightarrow {}^{266}_{107}Bh^{*}_{155} \rightarrow {}^{262}_{105}Db^{*}_{157} + \alpha \rightarrow {}^{262}_{103}Lr^{*}_{159} + \alpha + 2\beta^{+}$$

$$^{238}_{92}U^{*}_{146} + {}^{24}_{12}Mg_{12} \rightarrow {}^{262}_{104}Rf^{*}_{158} \rightarrow {}^{262}_{103}Lr^{*}_{159} + \beta^{+}$$

$$^{238}_{92}U^{*}_{146} + {}^{28}_{14}Si_{14} \rightarrow {}^{266}_{106}Sg^{*}_{160} \rightarrow {}^{262}_{104}Rf^{*}_{158} + \alpha \rightarrow {}^{262}_{103}Lr^{*}_{159} + \alpha + \beta^{+}$$

The Synthetic Routes to the 109th Element:

$$^{141}_{56}Ba^{*}_{85} + {}^{137}_{56}Ba_{81} \rightarrow {}^{278}_{112}Cn^{*}_{166} \rightarrow {}^{278}_{109}Mt^{*}_{169} + 3\beta^{+}$$

$$^{141}_{56}Ba^{*}_{85} + {}^{141}_{56}Ba^{*}_{85} \rightarrow {}^{282}_{112}Cn^{*}_{170} \rightarrow {}^{278}_{110}Ds^{*}_{168} + \alpha \rightarrow {}^{278}_{109}Mt^{*}_{169} + \alpha + \beta^{+}$$

$$^{209}_{83}Bi^{*}_{126} + {}^{69}_{31}Ga_{38} \rightarrow {}^{278}_{114}Fl^{ie}_{164} \rightarrow {}^{278}_{109}Mt^{*}_{169} + 5\beta^{+}$$

$$^{209}_{83}Bi^{*}_{126} + {}^{73}_{32}Ge_{41} \rightarrow {}^{282}_{115}Mc^{ie}_{167} \rightarrow {}^{278}_{113}Nh^{*}_{165} + \alpha \rightarrow {}^{278}_{109}Mt^{*}_{169} + \alpha + 4\beta^{+}$$

$$^{232}_{90}Th^{*}_{142} + {}^{46}_{22}Ti_{24} \rightarrow {}^{278}_{112}Cn^{*}_{166} \rightarrow {}^{278}_{109}Mt^{*}_{169} + 3\beta^{+}$$

$$^{232}_{90}Th^{*}_{142} + {}^{50}_{22}Ti_{28} \rightarrow {}^{282}_{112}Cn^{*}_{170} \rightarrow {}^{278}_{110}Ds^{*}_{168} + \alpha \rightarrow {}^{278}_{109}Mt^{*}_{169} + \alpha + \beta^{+}$$

$$^{235}_{92}U^{*}_{143} + {}^{43}_{20}Ca_{23} \rightarrow {}^{278}_{112}Cn^{*}_{166} \rightarrow {}^{278}_{109}Mt^{*}_{169} + 3\beta^{+}$$

$$^{235}_{92}U^{*}_{143} + {}^{47}_{22}Ti_{25} \rightarrow {}^{282}_{114}Fl^{ie}_{168} \rightarrow {}^{278}_{112}Cn^{*}_{166} + \alpha \rightarrow {}^{278}_{109}Mt^{*}_{169} + \alpha + 3\beta^{+}$$

$$^{238}_{92}U^{*}_{146} + {}^{40}_{18}Ar_{22} \rightarrow {}^{278}_{110}Ds^{*}_{168} \rightarrow {}^{278}_{109}Mt^{*}_{169} + \beta^{+}$$

$$^{238}_{92}U^{*}_{146} + {}^{40}_{19}K_{21} \rightarrow {}^{278}_{111}Rg^{*}_{167} \rightarrow {}^{278}_{109}Mt^{*}_{169} + 2\beta^{+}$$

$$^{238}_{92}U^{*}_{146} + {}^{40}_{20}Ca_{20} \rightarrow {}^{278}_{112}Cn^{*}_{166} \rightarrow {}^{278}_{109}Mt^{*}_{169} + 3\beta^{+}$$

$$^{238}_{92}U^{*}_{146} + {}^{44}_{20}Ca_{24} \rightarrow {}^{282}_{112}Cn^{*}_{170} \rightarrow {}^{278}_{110}Ds^{*}_{168} + \alpha \rightarrow {}^{278}_{109}Mt^{*}_{169} + \alpha + \beta^{+}$$

The Synthetic Routes to the 112th Element:

$$^{141}_{56}Ba^{*}_{85} + {}^{144}_{60}Nd_{84} \rightarrow {}^{285}_{116}Lv^{ie}_{169} \rightarrow {}^{285}_{112}Cn^{*}_{173} + 4\beta^{+}$$

$$^{141}_{56}Ba^{*}_{85} + {}^{148}_{60}Nd_{88} \rightarrow {}^{289}_{116}Lv^{ie}_{173} \rightarrow {}^{285}_{114}Fl^{ie}_{171} + \alpha \rightarrow {}^{285}_{112}Cn^{*}_{173} + \alpha + 2\beta^{+}$$

$$^{209}_{83}Bi^{*}_{126} + {}^{76}_{34}Se_{42} \rightarrow {}^{285}_{117}Ts^{ie}_{168} \rightarrow {}^{285}_{112}Cn^{*}_{173} + 5\beta^{+}$$

$$^{209}_{83}Bi^{*}_{126} + {}^{80}_{34}Se_{46} \rightarrow {}^{289}_{117}Ts^{ie}_{172} \rightarrow {}^{285}_{115}Mc^{ie}_{170} + \alpha \rightarrow {}^{285}_{112}Cn^{*}_{173} + \alpha + 3\beta^{+}$$

$$^{232}_{90}Th^{*}_{142} + {}^{53}_{24}Cr_{29} \rightarrow {}^{285}_{114}Fl^{ie}_{171} \rightarrow {}^{285}_{112}Cn^{*}_{173} + 2\beta^{+}$$

$$^{232}_{90}Th^{*}_{142} + {}^{57}_{26}Fe_{31} \rightarrow {}^{289}_{116}Lv^{ie}_{173} \rightarrow {}^{285}_{114}Fl^{ie}_{171} + \alpha \rightarrow {}^{285}_{112}Cn^{*}_{173} + \alpha + 2\beta^{+}$$

$$^{235}_{92}U^{*}_{143} + {}^{50}_{22}Ti_{28} \rightarrow {}^{285}_{114}Fl^{ie}_{171} \rightarrow {}^{285}_{112}Cn^{*}_{173} + 2\beta^{+}$$

$$^{235}_{92}U^{*}_{143} + {}^{54}_{24}Cr_{30} \rightarrow {}^{289}_{116}Lv^{ie}_{173} \rightarrow {}^{285}_{114}Fl^{ie}_{171} + \alpha \rightarrow {}^{285}_{112}Cn^{*}_{173} + \alpha + 2\beta^{+}$$

$$^{238}_{92}U^{*}_{146} + {}^{47}_{22}Ti_{25} \rightarrow {}^{285}_{114}Fl^{ie}_{171} \rightarrow {}^{285}_{112}Cn^{*}_{173} + 2\beta^{+}$$

$$^{238}_{92}U^{*}_{146} + {}^{51}_{23}V_{28} \rightarrow {}^{289}_{115}Mc^{ie}_{174} \rightarrow {}^{285}_{113}Nh^{ie}_{172} + \alpha \rightarrow {}^{285}_{112}Cn^{*}_{173} + \alpha + \beta^{+}$$

The Synthetic Routes to the 119th Element:

$$^{141}_{56}Ba^{*}_{85} + {}^{157}_{64}Gd_{93} \rightarrow {}^{298}_{120}Ch^{ie}_{178} \rightarrow {}^{298}_{119}Ch^{ie}_{179} + \beta^{+}$$

$$^{141}_{56}Ba^{*}_{85} + {}^{161}_{66}Dy_{95} \rightarrow {}^{302}_{122}Ch^{ie}_{180} \rightarrow {}^{298}_{120}Ch^{ie}_{178} + \alpha \rightarrow {}^{298}_{119}Ch^{ie}_{179} + \alpha + \beta^{+}$$

$$^{209}_{83}Bi^{*}_{126} + {}^{89}_{39}Sr_{50} \rightarrow {}^{298}_{122}Ch^{ie}_{176} \rightarrow {}^{298}_{119}Ch^{ie}_{179} + 3\beta^{+}$$

$$^{209}_{83}Bi^{*}_{126} + {}^{93}_{41}Nb_{52} \rightarrow {}^{302}_{124}Ch^{ie}_{178} \rightarrow {}^{298}_{122}Ch^{ie}_{178} + \alpha \rightarrow {}^{298}_{119}Ch^{ie}_{179} + \alpha + 3\beta^{+}$$

$$^{232}_{90}Th^{*}_{142} + {}^{66}_{30}Zn_{36} \rightarrow {}^{298}_{120}Ch^{ie}_{178} \rightarrow {}^{298}_{119}Ch^{ie}_{179} + \beta^{+}$$

$$^{232}_{90}Th^{*}_{142} + {}^{70}_{32}Ge_{38} \rightarrow {}^{302}_{122}Ch^{ie}_{180} \rightarrow {}^{198}_{119}Ch^{ie}_{179} + \alpha + \beta^{+}$$

$$^{235}_{92}U^{*}_{143} + {}^{63}_{29}Cu_{34} \rightarrow {}^{298}_{121}Ch^{ie}_{177} \rightarrow {}^{298}_{119}Ch^{ie}_{179} + 2\beta^{+}$$

$$^{235}_{92}U^{*}_{143} + {}^{67}_{30}Zn_{37} \rightarrow {}^{302}_{122}Ch^{ie}_{180} \rightarrow {}^{298}_{120}Ch^{ie}_{178} + \alpha \rightarrow {}^{298}_{119}Ch^{ie}_{179} + \alpha + \beta^{+}$$

$$^{238}_{92}U^{*}_{146} + {}^{60}_{27}Co^{*}_{33} \rightarrow {}^{298}_{119}Ch^{ie}_{179}$$

$$^{238}_{92}U^{*}_{146} + {}^{60}_{28}Si_{32} \rightarrow {}^{298}_{120}Ch^{ie}_{178} \rightarrow {}^{298}_{119}Ch^{ie}_{179} + \beta^{+}$$

$$^{238}_{92}U^{*}_{146} + {}^{64}_{28}Si_{36} \rightarrow {}^{302}_{120}Ch^{ie}_{182} \rightarrow {}^{298}_{118}Og^{ie}_{180} + \alpha \rightarrow {}^{198}_{119}Ch^{ie}_{179} + \alpha + \beta$$

The Synthetic Routes to the 120th Element:

$$^{141}_{56}Ba^{*}_{85} + {}^{159}_{65}Tb_{94} \rightarrow {}^{300}_{121}Ch^{ie}_{179} \rightarrow {}^{300}_{120}Ch^{ie}_{180} + \beta^{+}$$

$$^{141}_{56}Ba^{*}_{85} + {}^{163}_{66}Dy_{97} \rightarrow {}^{304}_{122}Ch^{ie}_{182} \rightarrow {}^{300}_{120}Ch^{ie}_{180} + \alpha$$

$$^{209}_{83}Bi^{*}_{126} + {}^{91}_{40}Zr_{51} \rightarrow {}^{300}_{123}Ch^{ie}_{177} \rightarrow {}^{300}_{120}Ch^{ie}_{180} + 3\beta^{+}$$

$$^{209}_{83}Bi^{*}_{126} + {}^{95}_{42}Mo_{53} \rightarrow {}^{304}_{125}Ch^{ie}_{179} \rightarrow {}^{300}_{123}Ch^{ie}_{177} + \alpha \rightarrow {}^{300}_{120}Ch^{ie}_{180} + \alpha + 3\beta^{+}$$

$$^{232}_{90}Th^{*}_{142} + {}^{68}_{30}Zn_{38} \rightarrow {}^{300}_{120}Ch^{ie}_{180}$$

$$^{232}_{90}Th^{*}_{142} + {}^{72}_{32}Ge_{40} \rightarrow {}^{304}_{122}Ch^{ie}_{182} \rightarrow {}^{300}_{120}Ch^{ie}_{180} + \alpha$$

$$^{235}_{92}U^{*}_{143} + {}^{65}_{29}Cu_{36} \rightarrow {}^{300}_{121}Ch^{ie}_{179} \rightarrow {}^{300}_{120}Ch^{ie}_{180} + \beta^{+}$$

$$^{235}_{92}U^{*}_{143} + {}^{69}_{31}Ga_{38} \rightarrow {}^{304}_{123}Ch^{ie}_{181} \rightarrow {}^{300}_{121}Ch^{ie}_{179} + \alpha \rightarrow {}^{300}_{120}Ch^{ie}_{180} + \alpha + \beta^{+}$$

$$^{238}_{92}U^{*}_{146} + {}^{62}_{28}Ni_{34} \rightarrow {}^{300}_{120}Ch^{ie}_{180}$$

$$^{238}_{92}U^{*}_{146} + {}^{66}_{30}Zn_{36} \rightarrow {}^{304}_{122}Ch^{ie}_{182} \rightarrow {}^{300}_{120}Ch^{ie}_{180} + \alpha$$

The Synthetic Routes to the 121th Element:

$$^{141}_{56}Ba^{*}_{85} + {}^{161}_{66}Dy_{95} \rightarrow {}^{302}_{122}Ch^{ie}_{180} \rightarrow {}^{302}_{121}Ch^{ie}_{181} + \beta^{+}$$

$$^{141}_{56}Ba^{*}_{85} + {}^{165}_{67}Ho_{98} \rightarrow {}^{306}_{123}Ch^{ie}_{183} \rightarrow {}^{302}_{121}Ch^{ie}_{181} + \alpha$$

$$^{209}_{83}Bi^{*}_{126} + {}^{93}_{41}Nb_{52} \rightarrow {}^{302}_{124}Ch^{ie}_{178} \rightarrow {}^{302}_{121}Ch^{ie}_{181} + 3\beta^{+}$$

$$^{209}_{83}Bi^{*}_{126} + {}^{97}_{42}Mo_{55} \rightarrow {}^{306}_{125}Ch^{ie}_{181} \rightarrow {}^{302}_{123}Ch^{ie}_{179} + \alpha \rightarrow {}^{302}_{121}Ch^{ie}_{181} + \alpha + 2\beta^{+}$$

$$^{232}_{90}Th^{*}_{142} + {}^{70}_{32}Ge_{38} \rightarrow {}^{302}_{122}Ch^{ie}_{180} \rightarrow {}^{302}_{121}Ch^{ie}_{181} + \beta^{+}$$

$$^{232}_{90}Th^{*}_{142} + {}^{74}_{32}Ge_{42} \rightarrow {}^{306}_{122}Ch^{ie}_{184} \rightarrow {}^{302}_{120}Ch^{ie}_{182} + \alpha \rightarrow {}^{302}_{121}Ch^{ie}_{181} + \alpha + \beta$$

$$^{235}_{92}U^{*}_{143} + {}^{67}_{30}Zn_{37} \rightarrow {}^{302}_{122}Ch^{ie}_{180} \rightarrow {}^{302}_{121}Ch^{ie}_{181} + \beta^{+}$$

$$^{235}_{92}U^{*}_{143} + {}^{71}_{31}Ga_{40} \rightarrow {}^{306}_{123}Ch^{ie}_{183} \rightarrow {}^{302}_{121}Ch^{ie}_{181} + \alpha$$

$$^{238}_{92}U^{*}_{146} + {}^{64}_{30}Zn_{34} \rightarrow {}^{302}_{122}Ch^{ie}_{180} \rightarrow {}^{302}_{121}Ch^{ie}_{181} + \beta^{+}$$

$$^{238}_{92}U^{*}_{146} + {}^{68}_{30}Zn_{38} \rightarrow {}^{306}_{122}Ch^{ie}_{184} \rightarrow {}^{302}_{120}Ch^{ie}_{182} + \alpha \rightarrow {}^{302}_{121}Ch^{ie}_{181} + \alpha + \beta$$

The Synthetic Routes to the 125th Element 125Ch310:

$$^{141}_{56}Ba^{*}_{85} + {}^{169}_{69}Tm_{100} \rightarrow {}^{310}_{125}Ch^{ie}_{185}$$

$$^{141}_{56}Ba^{*}_{85} + {}^{173}_{70}Yb_{103} \rightarrow {}^{314}_{126}Ch^{ie}_{188} \rightarrow {}^{310}_{124}Ch^{ie}_{186} + \alpha \rightarrow {}^{310}_{124}Ch^{ie}_{186} + \alpha + \beta$$

$$^{141}_{59}\mathrm{Pr}_{82} + {}^{169}_{69}Tm_{100} \rightarrow {}^{310}_{128}Ch^{ie}_{182} \rightarrow {}^{310}_{125}Ch^{ie}_{185} + 3\beta^{+}$$

$$^{141}_{59}\mathrm{Pr}_{82} + {}^{173}_{70}Yb_{103} \rightarrow {}^{314}_{129}Ch^{ie}_{185} \rightarrow {}^{310}_{127}Ch^{ie}_{183} + \alpha \rightarrow {}^{310}_{125}Ch^{ie}_{185} + \alpha + 2\beta^{+}$$

$$^{209}_{83}Bi^{*}_{126} + {}^{101}_{44}Ru_{57} \rightarrow {}^{310}_{127}Ch^{ie}_{183} \rightarrow {}^{310}_{125}Ch^{ie}_{185} + 2\beta^{+}$$

$$^{209}_{83}Bi^{*}_{126} + {}^{105}_{46}Pd_{59} \rightarrow {}^{314}_{129}Ch^{ie}_{185} \rightarrow {}^{310}_{127}Ch^{ie}_{183} + \alpha \rightarrow {}^{310}_{125}Ch^{ie}_{185} + \alpha + 2\beta^{+}$$

$$^{232}_{90}Th^{*}_{142} + {}^{78}_{34}Se_{44} \rightarrow {}^{310}_{124}Ch^{ie}_{186} \rightarrow {}^{310}_{125}Ch^{ie}_{185} + \beta$$

$$^{232}_{90}Th^{*}_{142} + {}^{72}_{34}Se_{48} \rightarrow {}^{314}_{124}Ch^{ie}_{190} \rightarrow {}^{310}_{122}Ch^{ie}_{188} + \alpha \rightarrow {}^{310}_{122}Ch^{ie}_{188} + \alpha + 3\beta$$

$$^{232}_{90}Th^{*}_{142} + {}^{78}_{36}Kr_{42} \rightarrow {}^{310}_{126}Ch^{ie}_{148} \rightarrow {}^{310}_{125}Ch^{ie}_{185} + \beta^{+}$$

$$^{232}_{90}Th^{*}_{142} + {}^{82}_{36}Kr_{46} \rightarrow {}^{314}_{126}Ch^{ie}_{188} \rightarrow {}^{310}_{124}Ch^{ie}_{186} + \alpha \rightarrow {}^{310}_{125}Ch^{ie}_{185} + \alpha + \beta$$

$$^{235}_{92}U^{*}_{143} + {}^{75}_{33}As_{42} \rightarrow {}^{310}_{125}Ch^{ie}_{185}$$

$$^{235}_{92}U^{*}_{143} + {}^{79}_{35}Br_{44} \rightarrow {}^{314}_{127}Ch^{ie}_{187} \rightarrow {}^{310}_{125}Ch^{ie}_{185} + \alpha$$

$$^{238}_{92}U^{*}_{146} + {}^{72}_{32}Ge_{40} \rightarrow {}^{310}_{124}Ch^{ie}_{186} \rightarrow {}^{310}_{125}Ch^{ie}_{185} + \beta$$

$$^{238}_{92}U^{*}_{146} + {}^{76}_{32}Ge_{44} \rightarrow {}^{314}_{124}Ch^{ie}_{190} \rightarrow {}^{310}_{122}Ch^{ie}_{188} + \alpha \rightarrow {}^{310}_{125}Ch^{ie}_{185} + \alpha + 3\beta$$

The Synthetic Routes to the 125th Element 125Ch312:

$$^{141}_{56}Ba^{*}_{85} + {}^{171}_{70}Yb_{101} \rightarrow {}^{312}_{126}Ch^{ie}_{186} \rightarrow {}^{312}_{125}Ch^{ie}_{187} + \beta^{+}$$

$$^{141}_{56}Ba^{*}_{85} + {}^{175}_{71}Lu_{104} \rightarrow {}^{316}_{127}Ch^{ie}_{189} \rightarrow {}^{312}_{125}Ch^{ie}_{187} + \alpha$$

$$^{209}_{83}Bi^{*}_{126} + {}^{103}_{45}Rh_{58} \rightarrow {}^{312}_{128}Ch^{ie}_{184} \rightarrow {}^{310}_{125}Ch^{ie}_{187} + 3\beta^{+}$$

$$^{209}_{83}Bi^{*}_{126} + {}^{107}_{47}Ag_{60} \rightarrow {}^{316}_{130}Ch^{ie}_{186} \rightarrow {}^{312}_{128}Ch^{ie}_{184} + \alpha \rightarrow {}^{312}_{125}Ch^{ie}_{187} + \alpha + 3\beta^{+}$$

$$^{232}_{90}Th^{*}_{142} + {}^{80}_{34}Se_{46} \rightarrow {}^{312}_{124}Ch^{ie}_{188} \rightarrow {}^{312}_{125}Ch^{ie}_{187} + \beta$$

$$^{232}_{90}Th^{*}_{142} + {}^{80}_{36}Kr_{44} \rightarrow {}^{312}_{126}Ch^{ie}_{186} \rightarrow {}^{312}_{125}Ch^{ie}_{187} + \beta^{+}$$

$$^{232}_{90}Th^{*}_{142} + {}^{84}_{36}Kr_{48} \rightarrow {}^{316}_{126}Ch^{ie}_{190} \rightarrow {}^{312}_{124}Ch^{ie}_{188} + \alpha \rightarrow {}^{312}_{125}Ch^{ie}_{187} + \alpha + \beta$$

$$^{235}_{92}U^{*}_{143} + {}^{77}_{34}Se_{43} \rightarrow {}^{312}_{126}Ch^{ie}_{186} \rightarrow {}^{312}_{125}Ch^{ie}_{187} + \beta^{+}$$

$$^{235}_{92}U^{*}_{143} + {}^{81}_{35}Br_{46} \rightarrow {}^{316}_{127}Ch^{ie}_{189} \rightarrow {}^{312}_{125}Ch^{ie}_{187} + \alpha$$

$$^{238}_{92}U^{*}_{146} + {}^{74}_{32}Ge_{42} \rightarrow {}^{312}_{124}Ch^{ie}_{188} \rightarrow {}^{312}_{125}Ch^{ie}_{187} + \beta$$

$$^{238}_{92}U^{*}_{146} + {}^{78}_{34}Se_{44} \rightarrow {}^{316}_{126}Ch^{ie}_{190} \rightarrow {}^{312}_{124}Ch^{ie}_{188} + \alpha \rightarrow {}^{312}_{125}Ch^{ie}_{187} + \alpha + \beta$$

The Synthetic Routes to the 126th Element:

$$^{130}_{56}Ba_{74} + {}^{184}_{74}W_{110} \rightarrow {}^{314}_{130}Ch^{ie}_{184} \rightarrow {}^{314}_{126}Ch^{ie}_{188} + 4\beta^{+}$$

$$^{132}_{56}Ba_{76} + {}^{182}_{74}W_{108} \rightarrow {}^{314}_{130}Ch^{ie}_{184} \rightarrow {}^{314}_{126}Ch^{ie}_{188} + 4\beta^{+}$$

$$^{132}_{56}Ba_{76} + {}^{186}_{74}W_{112} \rightarrow {}^{318}_{130}Ch^{ie}_{188} \rightarrow {}^{314}_{128}Ch^{ie}_{186} + \alpha \rightarrow {}^{314}_{126}Ch^{ie}_{188} + 2\beta^{+}$$

$$^{134}_{56}Ba_{78} + {}^{180}_{72}Hf_{108} \rightarrow {}^{314}_{128}Ch^{ie}_{186} \rightarrow {}^{314}_{126}Ch^{ie}_{188} + 2\beta^{+}$$

$$^{134}_{56}Ba_{78} + {}^{180}_{73}Ta_{107} \rightarrow {}^{314}_{129}Ch^{ie}_{185} \rightarrow {}^{314}_{126}Ch^{ie}_{188} + 3\beta^{+}$$

$$^{134}_{56}Ba_{78} + {}^{184}_{74}W_{110} \rightarrow {}^{318}_{130}Ch^{ie}_{188} \rightarrow {}^{314}_{128}Ch^{ie}_{186} + \alpha \rightarrow {}^{314}_{126}Ch^{ie}_{188} + 2\beta^{+}$$

$$^{135}_{56}Ba_{79} + {}^{179}_{72}Hf_{107} \rightarrow {}^{314}_{128}Ch^{ie}_{186} \rightarrow {}^{314}_{126}Ch^{ie}_{188} + 2\beta^{+}$$

$$^{135}_{56}Ba_{79} + {}^{183}_{74}W_{109} \rightarrow {}^{318}_{130}Ch^{ie}_{188} \rightarrow {}^{314}_{128}Ch^{ie}_{186} + \alpha \rightarrow {}^{314}_{126}Ch^{ie}_{188} + 2\beta^{+}$$

$$^{136}_{56}Ba_{80} + {}^{178}_{72}Hf_{106} \rightarrow {}^{314}_{128}Ch^{ie}_{186} \rightarrow {}^{314}_{126}Ch^{ie}_{188} + 2\beta^{+}$$

$$^{136}_{56}Ba_{80} + {}^{182}_{74}W_{108} \rightarrow {}^{318}_{130}Ch^{ie}_{188} \rightarrow {}^{314}_{128}Ch^{ie}_{186} + \alpha \rightarrow {}^{314}_{126}Ch^{ie}_{188} + 2\beta^{+}$$

$$^{137}_{56}Ba_{81} + {}^{177}_{72}Hf_{105} \rightarrow {}^{314}_{128}Ch^{ie}_{186} \rightarrow {}^{314}_{126}Ch^{ie}_{188} + 2\beta^{+}$$

$$^{137}_{56}Ba_{81} + {}^{181}_{73}Ta_{108} \rightarrow {}^{318}_{129}Ch^{ie}_{189} \rightarrow {}^{314}_{127}Ch^{ie}_{187} + \alpha \rightarrow {}^{314}_{126}Ch^{ie}_{188} + \beta^{+}$$

$$^{138}_{56}Ba_{82} + {}^{176}_{72}Hf_{104} \rightarrow {}^{314}_{128}Ch^{ie}_{186} \rightarrow {}^{314}_{126}Ch^{ie}_{188} + 2\beta^+$$

$$^{138}_{56}Ba_{82} + {}^{180}_{72}Hf_{108} \rightarrow {}^{318}_{128}Ch^{ie}_{190} \rightarrow {}^{314}_{126}Ch^{ie}_{188} + \alpha$$

$$^{138}_{56}Ba_{82} + {}^{180}_{73}Ta_{107} \rightarrow {}^{318}_{129}Ch^{ie}_{189} \rightarrow {}^{314}_{127}Ch^{ie}_{187} + \alpha \rightarrow {}^{314}_{126}Ch^{ie}_{188} + \beta^+$$

$$^{141}_{56}Ba^{*}_{85} + {}^{173}_{70}Yb_{103} \rightarrow {}^{314}_{126}Ch^{ie}_{188}$$

$$^{141}_{56}Ba^{*}_{85} + {}^{177}_{72}Hf_{105} \rightarrow {}^{318}_{128}Ch^{ie}_{190} \rightarrow {}^{314}_{126}Ch^{ie}_{188} + \alpha$$

$$^{138}_{57}La_{81} + {}^{176}_{70}Yb_{106} \rightarrow {}^{314}_{127}Ch^{ie}_{187} \rightarrow {}^{314}_{126}Ch^{ie}_{188} + \beta^+$$

$$^{138}_{57}La_{81} + {}^{176}_{71}Lu_{105} \rightarrow {}^{314}_{128}Ch^{ie}_{186} \rightarrow {}^{314}_{126}Ch^{ie}_{188} + 2\beta^+$$

$$^{138}_{57}La_{81} + {}^{176}_{72}Hf_{104} \rightarrow {}^{314}_{129}Ch^{ie}_{185} \rightarrow {}^{314}_{126}Ch^{ie}_{188} + 3\beta^+$$

$$^{138}_{57}La_{81} + {}^{180}_{72}Hf_{108} \rightarrow {}^{318}_{129}Ch^{ie}_{189} \rightarrow {}^{314}_{127}Ch^{ie}_{187} + \alpha \rightarrow {}^{314}_{126}Ch^{ie}_{188} + \beta^+$$

$$^{138}_{57}La_{81} + {}^{180}_{73}Ta_{107} \rightarrow {}^{318}_{130}Ch^{ie}_{188} \rightarrow {}^{314}_{128}Ch^{ie}_{186} + \alpha \rightarrow {}^{314}_{126}Ch^{ie}_{188} + 2\beta^+$$

$$^{139}_{57}La_{82} + {}^{175}_{71}Lu_{104} \rightarrow {}^{314}_{128}Ch^{ie}_{186} \rightarrow {}^{314}_{126}Ch^{ie}_{188} + 2\beta^+$$

$$^{139}_{57}La_{82} + {}^{179}_{72}Hf_{107} \rightarrow {}^{318}_{129}Ch^{ie}_{189} \rightarrow {}^{314}_{127}Ch^{ie}_{187} + \alpha \rightarrow {}^{314}_{126}Ch^{ie}_{188} + \beta^+$$

$$^{141}_{57}La^{*}_{84} + {}^{173}_{70}Yb_{103} \rightarrow {}^{314}_{127}Ch^{ie}_{187} \rightarrow {}^{314}_{126}Ch^{ie}_{188} + \beta^+$$

$$^{141}_{57}La^{*}_{84} + {}^{177}_{72}Hf_{105} \rightarrow {}^{318}_{129}Ch^{ie}_{189} \rightarrow {}^{314}_{127}Ch^{ie}_{187} + \alpha \rightarrow {}^{314}_{126}Ch^{ie}_{188} + \beta^+$$

$$^{138}_{58}Ce_{80} + {}^{176}_{70}Yb_{106} \rightarrow {}^{314}_{128}Ch^{ie}_{186} \rightarrow {}^{314}_{126}Ch^{ie}_{188} + 2\beta^+$$

$$^{138}_{58}Ce_{80} + {}^{180}_{72}Hf_{108} \rightarrow {}^{318}_{130}Ch^{ie}_{188} \rightarrow {}^{314}_{128}Ch^{ie}_{186} + \alpha \rightarrow {}^{314}_{126}Ch^{ie}_{188} + 2\beta^+$$

$$^{138}_{58}Ce_{80} + {}^{180}_{73}Ta_{107} \rightarrow {}^{318}_{131}Ch^{ie}_{187} \rightarrow {}^{314}_{129}Ch^{ie}_{185} + \alpha \rightarrow {}^{314}_{126}Ch^{ie}_{188} + 3\beta^+$$

$$^{140}_{58}Ce_{82} + {}^{174}_{70}Yb_{104} \rightarrow {}^{314}_{128}Ch^{ie}_{186} \rightarrow {}^{314}_{126}Ch^{ie}_{188} + 2\beta^+$$

$$^{140}_{58}Ce_{82} + {}^{178}_{72}Hf_{106} \rightarrow {}^{318}_{130}Ch^{ie}_{188} \rightarrow {}^{314}_{128}Ch^{ie}_{186} + \alpha \rightarrow {}^{314}_{126}Ch^{ie}_{188} + 2\beta^+$$

$$^{141}_{58}Ce^{*}_{83} + {}^{173}_{70}Yb_{103} \rightarrow {}^{314}_{128}Ch^{ie}_{186} \rightarrow {}^{314}_{126}Ch^{ie}_{188} + 2\beta^+$$

$$^{141}_{58}Ce^{*}_{83} + {}^{177}_{72}Hf_{105} \rightarrow {}^{318}_{130}Ch^{ie}_{188} \rightarrow {}^{314}_{128}Ch^{ie}_{186} + \alpha \rightarrow {}^{314}_{126}Ch^{ie}_{188} + 2\beta^+$$

$$^{142}_{58}Ce_{84} + {}^{172}_{70}Yb_{102} \rightarrow {}^{314}_{128}Ch^{ie}_{186} \rightarrow {}^{314}_{126}Ch^{ie}_{188} + 2\beta^+$$

$$^{142}_{58}Ce_{84} + {}^{176}_{72}Hf_{104} \rightarrow {}^{318}_{130}Ch^{ie}_{188} \rightarrow {}^{314}_{128}Ch^{ie}_{186} + \alpha \rightarrow {}^{314}_{126}Ch^{ie}_{188} + 2\beta^+$$

$$^{141}_{59}\mathrm{Pr}_{82} + {}^{173}_{70}Yb_{103} \rightarrow {}^{314}_{129}Ch^{ie}_{185} \rightarrow {}^{314}_{126}Ch^{ie}_{188} + 3\beta^+$$

$$^{141}_{59}\mathrm{Pr}_{82} + {}^{177}_{72}Hf_{105} \rightarrow {}^{318}_{131}Ch^{ie}_{187} \rightarrow {}^{314}_{129}Ch^{ie}_{185} + \alpha \rightarrow {}^{314}_{126}Ch^{ie}_{188} + 3\beta^+$$

$$^{209}_{83}Bi^{*}_{126} + {}^{105}_{46}Pd_{59} \rightarrow {}^{314}_{129}Ch^{ie}_{184} \rightarrow {}^{314}_{126}Ch^{ie}_{188} + 3\beta^+$$

$$^{209}_{83}Bi^{*}_{126} + {}^{109}_{47}Ag_{62} \rightarrow {}^{318}_{130}Ch^{ie}_{188} \rightarrow {}^{314}_{128}Ch^{ie}_{186} + \alpha \rightarrow {}^{314}_{126}Ch^{ie}_{188} + \alpha + 2\beta^+$$

$$^{232}_{90}Th^{*}_{142} + {}^{82}_{36}Kr_{46} \rightarrow {}^{314}_{126}Ch^{ie}_{188}$$

$$^{232}_{90}Th^{*}_{142} + {}^{86}_{38}Sr_{48} \rightarrow {}^{318}_{128}Ch^{ie}_{190} \rightarrow {}^{314}_{126}Ch^{ie}_{188} + \alpha$$

$$^{235}_{92}U^{*}_{143} + {}^{79}_{35}Br_{44} \rightarrow {}^{314}_{127}Ch^{ie}_{187} \rightarrow {}^{314}_{126}Ch^{ie}_{188} + \beta^+$$

$$^{235}_{92}U^{*}_{143} + {}^{83}_{36}Kr_{47} \rightarrow {}^{318}_{128}Ch^{ie}_{190} \rightarrow {}^{314}_{126}Ch^{ie}_{188} + \alpha$$

$$^{238}_{92}U^{*}_{146} + {}^{76}_{34}Se_{42} \rightarrow {}^{314}_{126}Ch^{ie}_{188}$$

$$^{238}_{92}U^{*}_{146} + {}^{80}_{36}Kr_{44} \rightarrow {}^{318}_{128}Ch^{ie}_{190} \rightarrow {}^{314}_{126}Ch^{ie}_{188} + \alpha$$

The Synthetic Routes to the 128th Element:

$$^{141}_{56}Ba^{*}_{85} + {}^{179}_{72}Hf_{107} \rightarrow {}^{320}_{128}Ch^{ie}_{192}$$

$$^{141}_{56}Ba^{*}_{85} + {}^{183}_{74}W_{109} \rightarrow {}^{324}_{130}Ch^{ie}_{194} \rightarrow {}^{320}_{128}Ch^{ie}_{192} + \alpha$$

$$^{209}_{83}Bi^{*}_{126} + {}^{111}_{48}Cd_{63} \rightarrow {}^{320}_{131}Ch^{ie}_{189} \rightarrow {}^{320}_{128}Ch^{ie}_{192} + 3\beta^{+}$$

$$^{209}_{83}Bi^{*}_{126} + {}^{115}_{49}In_{66} \rightarrow {}^{324}_{132}Ch^{ie}_{192} \rightarrow {}^{320}_{130}Ch^{ie}_{190} + \alpha \rightarrow {}^{320}_{128}Ch^{ie}_{192} + \alpha + 2\beta^{+}$$

$$^{232}_{90}Th^{*}_{142} + {}^{88}_{38}Sr_{50} \rightarrow {}^{320}_{128}Ch^{ie}_{192}$$

$$^{232}_{90}Th^{*}_{142} + {}^{92}_{40}Zr_{52} \rightarrow {}^{324}_{130}Ch^{ie}_{194} \rightarrow {}^{320}_{128}Ch^{ie}_{192} + \alpha$$

$$^{235}_{92}U^{*}_{143} + {}^{85}_{37}Rb_{48} \rightarrow {}^{320}_{129}Ch^{ie}_{191} \rightarrow {}^{320}_{128}Ch^{ie}_{192} + \beta^{+}$$

$$^{235}_{92}U^{*}_{143} + {}^{89}_{39}Y_{50} \rightarrow {}^{324}_{131}Ch^{ie}_{193} \rightarrow {}^{320}_{129}Ch^{ie}_{191} + \alpha \rightarrow {}^{320}_{128}Ch^{ie}_{192} + \alpha + \beta^{+}$$

$$^{238}_{92}U^{*}_{146} + {}^{82}_{36}Kr_{46} \rightarrow {}^{320}_{128}Ch^{ie}_{192}$$

$$^{238}_{92}U^{*}_{146} + {}^{86}_{36}Kr_{50} \rightarrow {}^{324}_{128}Ch^{ie}_{196} \rightarrow {}^{320}_{126}Ch^{ie}_{194} + \alpha \rightarrow {}^{320}_{128}Ch^{ie}_{192} + \alpha + 2\beta$$

$$^{238}_{92}U^{*}_{146} + {}^{86}_{38}Sr_{48} \rightarrow {}^{324}_{130}Ch^{ie}_{194} \rightarrow {}^{320}_{128}Ch^{ie}_{192} + \alpha$$

The Synthetic Routes to the 130th Element:

$$^{141}_{56}Ba^{*}_{85} + {}^{185}_{75}\mathrm{Re}_{110} \rightarrow {}^{326}_{131}Ch^{ie}_{195} \rightarrow {}^{326}_{130}Ch^{ie}_{196} + \beta^{+}$$

$$^{141}_{56}Ba^{*}_{85} + {}^{189}_{76}Os_{113} \rightarrow {}^{330}_{132}Ch^{ie}_{198} \rightarrow {}^{326}_{130}Ch^{ie}_{196} + \alpha$$

$$^{209}_{83}Bi^{*}_{126} + {}^{117}_{50}Sn_{67} \rightarrow {}^{326}_{133}Ch^{ie}_{193} \rightarrow {}^{326}_{130}Ch^{ie}_{196} + 3\beta^{+}$$

$$^{209}_{83}Bi^{*}_{126} + {}^{121}_{51}Sb_{70} \rightarrow {}^{330}_{134}Ch^{ie}_{196} \rightarrow {}^{326}_{132}Ch^{ie}_{194} + \alpha \rightarrow {}^{326}_{130}Ch^{ie}_{196} + \alpha + 2\beta^{+}$$

$$^{232}_{90}Th^{*}_{142} + {}^{94}_{40}Zr_{54} \rightarrow {}^{326}_{130}Ch^{ie}_{196}$$

$$^{232}_{90}Th^{*}_{142} + {}^{98}_{42}Mo_{56} \rightarrow {}^{330}_{132}Ch^{ie}_{198} \rightarrow {}^{326}_{130}Ch^{ie}_{196} + \alpha$$

$$^{235}_{92}U^{*}_{143} + {}^{91}_{40}Zr_{51} \rightarrow {}^{326}_{132}Ch^{ie}_{194} \rightarrow {}^{326}_{130}Ch^{ie}_{196} + 2\beta^{+}$$

$$^{235}_{92}U^{*}_{143} + {}^{95}_{42}Mo_{53} \rightarrow {}^{330}_{134}Ch^{ie}_{196} \rightarrow {}^{326}_{132}Ch^{ie}_{194} + \alpha \rightarrow {}^{326}_{130}Ch^{ie}_{196} + \alpha + 2\beta^{+}$$

$$^{238}_{92}U^{*}_{146} + {}^{88}_{38}Sr_{50} \rightarrow {}^{326}_{130}Ch^{ie}_{196}$$

$$^{238}_{92}U^{*}_{146} + {}^{92}_{40}Zr_{52} \rightarrow {}^{300}_{132}Ch^{ie}_{198} \rightarrow {}^{326}_{130}Ch^{ie}_{196} + \alpha$$

The Synthetic Routes to the 132th Element:

$$^{141}_{56}Ba^{*}_{85} + {}^{191}_{77}Ir_{114} \rightarrow {}^{332}_{133}Ch^{ie}_{199} \rightarrow {}^{332}_{132}Ch^{ie}_{200} + \beta^{+}$$

$$^{141}_{56}Ba^{*}_{85} + {}^{195}_{78}Pt_{117} \rightarrow {}^{336}_{134}Ch^{ie}_{202} \rightarrow {}^{332}_{132}Ch^{ie}_{200} + \alpha$$

$$^{209}_{83}Bi^{*}_{126} + {}^{123}_{51}Sb_{72} \rightarrow {}^{332}_{134}Ch^{ie}_{198} \rightarrow {}^{332}_{132}Ch^{ie}_{200} + 2\beta^{+}$$

$$^{209}_{83}Bi^{*}_{126} + {}^{127}_{53}I_{74} \rightarrow {}^{336}_{136}Ch^{ie}_{200} \rightarrow {}^{332}_{134}Ch^{ie}_{198} + \alpha \rightarrow {}^{332}_{132}Ch^{ie}_{200} + \alpha + 2\beta^{+}$$

$$^{232}_{90}Th^{*}_{142} + {}^{100}_{44}Ru_{56} \rightarrow {}^{332}_{134}Ch^{ie}_{198} \rightarrow {}^{332}_{132}Ch^{ie}_{200} + 2\beta^{+}$$

$$^{232}_{90}Th^{*}_{142} + {}^{104}_{44}Ru_{60} \rightarrow {}^{336}_{134}Ch^{ie}_{202} \rightarrow {}^{332}_{132}Ch^{ie}_{200} + \alpha$$

$$^{235}_{92}U^{*}_{143} + {}^{97}_{42}Mo_{55} \rightarrow {}^{332}_{134}Ch^{ie}_{198} \rightarrow {}^{332}_{132}Ch^{ie}_{200} + 2\beta^{+}$$

$$^{235}_{92}U^{*}_{143} + {}^{101}_{44}Ru_{57} \rightarrow {}^{336}_{136}Ch^{ie}_{200} \rightarrow {}^{332}_{134}Ch^{ie}_{198} + \alpha \rightarrow {}^{332}_{132}Ch^{ie}_{200} + \alpha + 2\beta^{+}$$

$$^{238}_{92}U^{*}_{146} + {}^{94}_{40}Zr_{54} \rightarrow {}^{332}_{132}Ch^{ie}_{200}$$

$$^{238}_{92}U^{*}_{146} + {}^{98}_{42}Mo_{56} \rightarrow {}^{336}_{134}Ch^{ie}_{202} \rightarrow {}^{332}_{132}Ch^{ie}_{200} + \alpha$$

The Synthetic Routes to the 136th Element:

$$^{141}_{56}Ba^{*}_{85} + {}^{203}_{81}Tl_{122} \rightarrow {}^{344}_{137}Fy^{ie}_{207} \rightarrow {}^{344}_{136}Fy^{ie}_{208} + \beta^{+}$$

$$^{141}_{56}Ba^{*}_{85} + {}^{207}_{82}Pb_{125} \rightarrow {}^{348}_{138}Fy^{ie}_{210} \rightarrow {}^{344}_{136}Fy^{ie}_{208} + \alpha$$

$$^{209}_{83}Bi^{*}_{126} + {}^{135}_{56}Ba_{79} \rightarrow {}^{344}_{139}Ch^{ie}_{205} \rightarrow {}^{344}_{136}Fy^{ie}_{208} + 3\beta^{+}$$

$$^{209}_{83}Bi^{*}_{126} + {}^{139}_{57}La_{82} \rightarrow {}^{348}_{140}Ch^{ie}_{208} \rightarrow {}^{344}_{138}Fy^{ie}_{206} + \alpha \rightarrow {}^{344}_{136}Fy^{ie}_{208} + \alpha + 2\beta^{+}$$

$$^{232}_{90}Th^{*}_{142} + {}^{112}_{48}Cd_{64} \rightarrow {}^{344}_{138}Fy^{ie}_{206} \rightarrow {}^{344}_{137}Fy^{ie}_{207} + \beta^{+} \rightarrow {}^{344}_{136}Fy^{ie}_{208} + 2\beta^{+}$$

$$^{232}_{90}Th^{*}_{142} + {}^{116}_{48}Cd_{68} \rightarrow {}^{348}_{138}Fy^{ie}_{210} \rightarrow {}^{344}_{136}Fy^{ie}_{208} + \alpha$$

$$^{235}_{92}U^{*}_{143} + {}^{109}_{47}Ag_{62} \rightarrow {}^{344}_{139}Ch^{ie}_{205} \rightarrow {}^{344}_{136}Fy^{ie}_{208} + 3\beta^{+}$$

$$^{235}_{92}U^{*}_{143} + {}^{113}_{48}Cd_{65} \rightarrow {}^{348}_{140}Ch^{ie}_{208} \rightarrow {}^{344}_{138}Fy^{ie}_{206} + \alpha \rightarrow {}^{344}_{136}Fy^{ie}_{208} + \alpha + 2\beta^{+}$$

$$^{238}_{92}U^{*}_{146} + {}^{106}_{46}Pd_{60} \rightarrow {}^{344}_{138}Fy^{ie}_{206} \rightarrow {}^{344}_{137}Fy^{ie}_{207} + \beta^{+} \rightarrow {}^{344}_{136}Fy^{ie}_{208} + 2\beta^{+}$$

$$^{238}_{92}U^{*}_{146} + {}^{110}_{46}Pd_{64} \rightarrow {}^{348}_{138}Fy^{ie}_{210} \rightarrow {}^{344}_{136}Fy^{ie}_{208} + \alpha$$

The Synthetic Routes to the 137th Element:

$$^{141}_{56}Ba^{*}_{85} + {}^{205}_{81}Tl_{124} \rightarrow {}^{2\cdot173}_{137}Fy^{ie}_{209}$$

$$^{141}_{56}Ba^{*}_{85} + {}^{209}_{83}Bi^{*}_{126} \rightarrow {}^{350}_{139}Ch^{ie}_{211} \rightarrow {}^{2\cdot173}_{137}Fy^{ie}_{209} + \alpha$$

$$^{209}_{83}Bi^{*}_{126} + {}^{137}_{56}Ba_{81} \rightarrow {}^{346}_{139}Ch^{ie}_{207} \rightarrow {}^{346}_{137}Fy^{ie}_{209} + 2\beta^{+}$$

$$^{209}_{83}Bi^{*}_{126} + {}^{141}_{59}\mathrm{Pr}_{82} \rightarrow {}^{350}_{142}Ch^{ie}_{208} \rightarrow {}^{346}_{140}Ch^{ie}_{206} + \alpha \rightarrow {}^{346}_{137}Fy^{ie}_{209} + \alpha + 3\beta^{+}$$

$$^{232}_{90}Th^{*}_{142} + {}^{114}_{48}Pd_{66} \rightarrow {}^{346}_{138}Fy^{ie}_{208} \rightarrow {}^{346}_{137}Fy^{ie}_{209} + \beta^{+}$$

$$^{232}_{90}Th^{*}_{142} + {}^{118}_{50}Sn_{68} \rightarrow {}^{350}_{140}Ch^{ie}_{210} \rightarrow {}^{346}_{138}Fy^{ie}_{208} + \alpha \rightarrow {}^{346}_{137}Fy^{ie}_{209} + \alpha + \beta^{+}$$

$$^{235}_{92}U^{*}_{143} + {}^{111}_{48}Cd_{63} \rightarrow {}^{346}_{140}Ch^{ie}_{206} \rightarrow {}^{346}_{137}Fy^{ie}_{209} + 3\beta^{+}$$

$$^{235}_{92}U^{*}_{143} + {}^{115}_{49}In_{66} \rightarrow {}^{350}_{141}Ch^{ie}_{209} \rightarrow {}^{346}_{139}Ch^{ie}_{207} + \alpha \rightarrow {}^{346}_{137}Fy^{ie}_{209} + \alpha + 2\beta^{+}$$

$$^{238}_{92}U^{*}_{146} + {}^{108}_{46}Pd_{62} \rightarrow {}^{346}_{138}Fy^{ie}_{208} \rightarrow {}^{346}_{137}Fy^{ie}_{209} + \beta^{+}$$

$$^{238}_{92}U^{*}_{146} + {}^{112}_{48}Cd_{64} \rightarrow {}^{350}_{140}Ch^{ie}_{210} \rightarrow {}^{346}_{138}Fy^{ie}_{208} + \alpha \rightarrow {}^{346}_{137}Fy^{ie}_{209} + \alpha + \beta^{+}$$

The Synthetic Routes to the 138th Element:

$$^{141}_{56}Ba^{*}_{85} + {}^{207}_{82}Pb_{125} \rightarrow {}^{348}_{138}Fy^{ie}_{210}$$

$$^{141}_{59}\mathrm{Pr}_{82} + {}^{207}_{82}Pb_{125} \rightarrow {}^{348}_{141}Ch^{ie}_{207} \rightarrow {}^{348}_{138}Fy^{ie}_{210} + 3\beta^{+}$$

$$^{209}_{83}Bi^{*}_{126} + {}^{139}_{57}La_{82} \rightarrow {}^{348}_{140}Ch^{ie}_{208} \rightarrow {}^{348}_{138}Fy^{ie}_{210} + 2\beta^{+}$$

$$^{209}_{83}Bi^{*}_{126} + {}^{143}_{60}Nd_{83} \rightarrow {}^{352}_{143}Ch^{ie}_{209} \rightarrow {}^{348}_{141}Ch^{ie}_{207} + \alpha \rightarrow {}^{348}_{138}Fy^{ie}_{210} + \alpha + 3\beta^{+}$$

$$^{232}_{90}Th^{*}_{142} + {}^{116}_{48}Cd_{68} \rightarrow {}^{348}_{138}Fy^{ie}_{210}$$

$$^{232}_{90}Th^{*}_{142} + {}^{120}_{50}Sn_{70} \rightarrow {}^{352}_{140}Ch^{ie}_{212} \rightarrow {}^{348}_{138}Fy^{ie}_{210} + \alpha$$

$$^{235}_{92}U^{*}_{143} + {}^{113}_{48}Cd_{65} \rightarrow {}^{348}_{140}Ch^{ie}_{208} \rightarrow {}^{348}_{138}Fy^{ie}_{210} + 2\beta^{+}$$

$$^{235}_{92}U^{*}_{143} + {}^{117}_{50}Sn_{67} \rightarrow {}^{352}_{142}Ch^{ie}_{210} \rightarrow {}^{348}_{140}Ch^{ie}_{208} + \alpha \rightarrow {}^{348}_{138}Fy^{ie}_{210} + \alpha + 2\beta^{+}$$

$$^{238}_{92}U^{*}_{146} + {}^{110}_{46}Pd_{64} \rightarrow {}^{348}_{138}Fy^{ie}_{210}$$

$$^{238}_{92}U^{*}_{146} + {}^{114}_{48}Cd_{66} \rightarrow {}^{352}_{140}Ch^{ie}_{212} \rightarrow {}^{348}_{138}Fy^{ie}_{210} + \alpha$$

The Synthetic Routes to the 141th Element:

$$^{141}_{56}Ba^{*}_{85} + {}^{213}_{85}At^{*}_{158} \rightarrow {}^{354}_{141}Ch^{ie}_{213}$$

$$^{209}_{83}Bi^{*}_{126} + {}^{145}_{60}Nd_{85} \rightarrow {}^{354}_{143}Ch^{ie}_{211} \rightarrow {}^{354}_{141}Ch^{ie}_{213} + 2\beta^{+}$$

$$^{232}_{90}Th^{*}_{142} + {}^{122}_{50}Sb_{72} \rightarrow {}^{354}_{140}Ch^{ie}_{214} \rightarrow {}^{354}_{141}Ch^{ie}_{213} + \beta$$

$$^{232}_{90}Th^{*}_{142} + {}^{122}_{52}Te_{70} \rightarrow {}^{354}_{142}Ch^{ie}_{212} \rightarrow {}^{354}_{141}Ch^{ie}_{213} + \beta^{+}$$

$$^{232}_{90}Th^{*}_{142} + {}^{126}_{52}Te_{74} \rightarrow {}^{358}_{142}Ch^{ie}_{216} \rightarrow {}^{354}_{140}Ch^{ie}_{214} + \alpha \rightarrow {}^{354}_{141}Ch^{ie}_{213} + \alpha + \beta$$

$$^{232}_{90}Th^{*}_{142} + {}^{126}_{54}Xe_{72} \rightarrow {}^{358}_{144}Ch^{ie}_{214} \rightarrow {}^{354}_{142}Ch^{ie}_{212} + \alpha \rightarrow {}^{354}_{141}Ch^{ie}_{213} + \alpha + \beta^{+}$$

$$^{235}_{92}U^{*}_{143} + {}^{119}_{50}Sn_{69} \rightarrow {}^{354}_{142}Ch^{ie}_{212} \rightarrow {}^{354}_{141}Ch^{ie}_{213} + \beta^{+}$$

$$^{235}_{92}U^{*}_{143} + {}^{123}_{52}Te_{71} \rightarrow {}^{358}_{144}Ch^{ie}_{214} \rightarrow {}^{354}_{142}Ch^{ie}_{212} + \alpha \rightarrow {}^{354}_{141}Ch^{ie}_{213} + \alpha + \beta^{+}$$

$$^{238}_{92}U^{*}_{146} + {}^{116}_{49}In^{*}_{67} \rightarrow {}^{354}_{141}Ch^{ie}_{213}$$

$$^{238}_{92}U^{*}_{146} + {}^{116}_{50}Sn_{66} \rightarrow {}^{354}_{142}Ch^{ie}_{212} \rightarrow {}^{354}_{141}Ch^{ie}_{213} + \beta^{+}$$

$$^{238}_{92}U^{*}_{146} + {}^{120}_{52}Te_{68} \rightarrow {}^{358}_{144}Ch^{ie}_{214} \rightarrow {}^{354}_{142}Ch^{ie}_{212} + \alpha \rightarrow {}^{354}_{141}Ch^{ie}_{213} + \alpha + \beta^{+}$$

The Synthetic Routes to the 146th Element:

$$^{141}_{56}Ba^{*}_{85} + {}^{229}_{90}Th^{*}_{139} \rightarrow {}^{370}_{146}Ch^{ie}_{224}$$

$$^{141}_{56}Ba^{*}_{85} + {}^{233}_{92}U^{*}_{141} \rightarrow {}^{374}_{148}Ch^{ie}_{226} \rightarrow {}^{370}_{146}Ch^{ie}_{224} + \alpha$$

$$^{209}_{83}Bi^{*}_{126} + {}^{161}_{66}Dy_{95} \rightarrow {}^{370}_{149}Ch^{ie}_{221} \rightarrow {}^{370}_{146}Ch^{ie}_{224} + 3\beta^{+}$$

$$^{209}_{83}Bi^{*}_{126} + {}^{165}_{67}Ho_{98} \rightarrow {}^{374}_{150}Ch^{ie}_{224} \rightarrow {}^{370}_{148}Ch^{ie}_{222} + \alpha \rightarrow {}^{370}_{146}Ch^{ie}_{224} + \alpha + 2\beta^{+}$$

$$^{232}_{90}Th^{*}_{142} + {}^{138}_{56}Ba_{82} \rightarrow {}^{370}_{146}Ch^{ie}_{224}$$

$$^{232}_{90}Th^{*}_{142} + {}^{142}_{58}Te_{84} \rightarrow {}^{374}_{148}Ch^{ie}_{226} \rightarrow {}^{370}_{146}Ch^{ie}_{224} + \alpha$$

$$^{235}_{92}U^{*}_{143} + {}^{135}_{56}Ba_{79} \rightarrow {}^{370}_{148}Ch^{ie}_{222} \rightarrow {}^{370}_{146}Ch^{ie}_{224} + 2\beta^{+}$$

$$^{235}_{92}U^{*}_{143} + {}^{139}_{57}La_{82} \rightarrow {}^{374}_{149}Ch^{ie}_{225} \rightarrow {}^{370}_{147}Ch^{ie}_{223} + \alpha \rightarrow {}^{370}_{146}Ch^{ie}_{224} + \alpha + \beta^{+}$$

$$^{238}_{92}U^{*}_{146} + {}^{132}_{54}Xe_{78} \rightarrow {}^{370}_{146}Ch^{ie}_{224}$$

$$^{238}_{92}U^{*}_{146} + {}^{136}_{56}Ba_{80} \rightarrow {}^{374}_{148}Ch^{ie}_{226} \rightarrow {}^{370}_{146}Ch^{ie}_{224} + \alpha$$

The Synthetic Routes to the 157th Element:

$$^{141}_{56}Ba^{*}_{85} + {}^{259}_{101}Md^{*}_{158} \rightarrow {}^{400}_{157}Ch^{ie}_{243}$$

$$^{141}_{56}Ba^{*}_{85} + {}^{263}_{103}Lr^{*}_{160} \rightarrow {}^{404}_{159}Ch^{ie}_{245} \rightarrow {}^{400}_{157}Ch^{ie}_{243} + \alpha$$

$$^{209}_{83}Bi^{*}_{126} + {}^{191}_{77}Ir_{114} \rightarrow {}^{400}_{160}Ch^{ie}_{240} \rightarrow {}^{400}_{157}Ch^{ie}_{243} + 3\beta^{+}$$

$$^{209}_{83}Bi^{*}_{126} + {}^{195}_{78}Pt_{117} \rightarrow {}^{404}_{161}Ch^{ie}_{243} \rightarrow {}^{400}_{159}Ch^{ie}_{241} + \alpha \rightarrow {}^{400}_{157}Ch^{ie}_{243} + \alpha + 2\beta^{+}$$

$$^{232}_{90}Th^{*}_{142} + {}^{168}_{68}Er_{100} \rightarrow {}^{400}_{158}Ch^{ie}_{242} \rightarrow {}^{400}_{157}Ch^{ie}_{243} + \beta^{+}$$

$$^{232}_{90}Th^{*}_{142} + {}^{172}_{70}Yb_{102} \rightarrow {}^{404}_{160}Ch^{ie}_{244} \rightarrow {}^{400}_{158}Ch^{ie}_{242} + \alpha \rightarrow {}^{400}_{157}Ch^{ie}_{243} + \alpha + \beta^{+}$$

$$^{235}_{92}U^{*}_{143} + {}^{165}_{67}Ho_{98} \rightarrow {}^{400}_{159}Ch^{ie}_{241} \rightarrow {}^{400}_{157}Ch^{ie}_{243} + 2\beta^{+}$$

$$^{235}_{92}U^{*}_{143} + {}^{169}_{69}Tm_{100} \rightarrow {}^{404}_{161}Ch^{ie}_{243} \rightarrow {}^{400}_{159}Ch^{ie}_{241} + \alpha \rightarrow {}^{400}_{157}Ch^{ie}_{243} + \alpha + 2\beta^{+}$$

$$^{238}_{92}U^{*}_{146} + {}^{162}_{65}Tb^{*}_{97} \rightarrow {}^{400}_{157}Ch^{ie}_{243}$$

$$^{238}_{92}U^{*}_{146} + {}^{162}_{66}Dy_{96} \rightarrow {}^{400}_{158}Ch^{ie}_{242} \rightarrow {}^{400}_{157}Ch^{ie}_{243} + \beta^{+}$$

$$^{238}_{92}U^{*}_{146} + {}^{166}_{68}Er_{98} \rightarrow {}^{404}_{160}Ch^{ie}_{244} \rightarrow {}^{400}_{158}Ch^{ie}_{242} + \alpha \rightarrow {}^{400}_{157}Ch^{ie}_{243} + \alpha + \beta^{+}$$

The Synthetic Routes to the 168th Element:

$$^{141}_{56}Ba^{*}_{85} + {}^{279}_{109}Mt^{*}_{170} \rightarrow {}^{420}_{165}Ch^{ie}_{255} \rightarrow {}^{420}_{168}Ch^{ie}_{252} + 3\beta$$

$$^{141}_{56}Ba^{*}_{85} + {}^{283}_{111}Rg^{*}_{172} \rightarrow {}^{424}_{167}Ch^{ie}_{257} \rightarrow {}^{420}_{165}Ch^{ie}_{255} + \alpha \rightarrow {}^{420}_{168}Ch^{ie}_{252} + \alpha + 3\beta$$

$$^{141}_{56}Ba^{*}_{85} + {}^{283}_{112}Cn^{*}_{171} \rightarrow {}^{424}_{168}Ch^{ie}_{256} \rightarrow {}^{420}_{166}Ch^{ie}_{254} + \alpha \rightarrow {}^{420}_{168}Ch^{ie}_{252} + \alpha + 2\beta$$

$$^{209}_{83}Bi^{*}_{126} + {}^{211}_{85}At^{*}_{126} \rightarrow {}^{420}_{168}Ch^{ie}_{252}$$

$$^{209}_{83}Bi^{*}_{126} + {}^{215}_{86}Rn^{*}_{129} \rightarrow {}^{424}_{169}Ch^{ie}_{255} \rightarrow {}^{420}_{167}Ch^{ie}_{253} + \alpha \rightarrow {}^{420}_{168}Ch^{ie}_{252} + \alpha + \beta$$

$$^{232}_{90}Th^{*}_{142} + {}^{188}_{76}Os_{112} \rightarrow {}^{420}_{166}Ch^{ie}_{254} \rightarrow {}^{420}_{168}Ch^{ie}_{252} + 2\beta$$

$$^{232}_{90}Th^{*}_{142} + {}^{192}_{76}Or_{116} \rightarrow {}^{424}_{166}Ch^{ie}_{258} \rightarrow {}^{420}_{164}Ch^{ie}_{256} + \alpha \rightarrow {}^{420}_{168}Ch^{ie}_{252} + \alpha + 4\beta$$

$$^{232}_{90}Th^{*}_{142} + {}^{192}_{78}Pt_{114} \rightarrow {}^{424}_{168}Ch^{ie}_{256} \rightarrow {}^{420}_{166}Ch^{ie}_{254} + \alpha \rightarrow {}^{420}_{168}Ch^{ie}_{252} + \alpha + 2\beta$$

$$^{235}_{92}U^{*}_{143} + {}^{185}_{75}\mathrm{Re}_{112} \rightarrow {}^{420}_{167}Ch^{ie}_{255} \rightarrow {}^{420}_{168}Ch^{ie}_{252} + \beta$$

$$^{235}_{92}U^{*}_{143} + {}^{189}_{76}\mathrm{Re}_{113} \rightarrow {}^{424}_{168}Ch^{ie}_{256} \rightarrow {}^{420}_{166}Ch^{ie}_{254} + \alpha \rightarrow {}^{420}_{168}Ch^{ie}_{252} + \alpha + 2\beta$$

$$^{238}_{92}U^{*}_{146} + {}^{182}_{74}W_{112} \rightarrow {}^{420}_{166}Ch^{ie}_{254} \rightarrow {}^{420}_{168}Ch^{ie}_{252} + 2\beta$$

$$^{238}_{92}U^{*}_{146} + {}^{186}_{76}Os_{110} \rightarrow {}^{424}_{168}Ch^{ie}_{256} \rightarrow {}^{420}_{166}Ch^{ie}_{254} + \alpha \rightarrow {}^{420}_{168}Ch^{ie}_{252} + \alpha + 2\beta$$

The Synthetic Routes to the 169th Element:

$$^{141}_{56}Ba^{*}_{85} + {}^{285}_{112}Cn^{*}_{173} \rightarrow {}^{426}_{168}Ch^{ie}_{258} \rightarrow {}^{426}_{169}Ch^{ie}_{257} + \beta$$

$$^{141}_{56}Ba^{*}_{85} + {}^{289}_{114}Lr^{ie}_{175} \rightarrow {}^{430}_{170}Ch^{ie}_{260} \rightarrow {}^{426}_{168}Ch^{ie}_{258} + \alpha \rightarrow {}^{426}_{169}Ch^{ie}_{257} + \alpha + \beta$$

$$^{209}_{83}Bi^{*}_{126} + {}^{221}_{86}Rn^{*}_{135} \rightarrow {}^{430}_{169}Ch^{ie}_{261} \rightarrow {}^{426}_{167}Ch^{ie}_{259} + \alpha \rightarrow {}^{426}_{169}Ch^{ie}_{257} + \alpha + 2\beta$$

$$^{209}_{83}Bi^{*}_{126} + {}^{221}_{87}Rn^{*}_{134} \rightarrow {}^{430}_{170}Ch^{ie}_{260} \rightarrow {}^{426}_{168}Ch^{ie}_{258} + \alpha \rightarrow {}^{426}_{169}Ch^{ie}_{257} + \alpha + \beta$$

$$^{232}_{90}Th^{*}_{142} + {}^{194}_{78}Pt_{116} \rightarrow {}^{426}_{168}Ch^{ie}_{258} \rightarrow {}^{426}_{169}Ch^{ie}_{257} + \beta$$

$$^{232}_{90}Th^{*}_{142} + {}^{198}_{78}Pt_{120} \rightarrow {}^{430}_{168}Ch^{ie}_{262} \rightarrow {}^{426}_{166}Ch^{ie}_{260} + \alpha \rightarrow {}^{426}_{169}Ch^{ie}_{257} + \alpha + 3\beta$$

$$^{232}_{90}Th^{*}_{142} + {}^{198}_{80}Hg_{118} \rightarrow {}^{430}_{170}Ch^{ie}_{260} \rightarrow {}^{426}_{168}Ch^{ie}_{258} + \alpha \rightarrow {}^{426}_{169}Ch^{ie}_{257} + \alpha + \beta$$

$$^{235}_{92}U^{*}_{143} + {}^{191}_{77}Ir_{114} \rightarrow {}^{426}_{169}Ch^{ie}_{257}$$

$$^{235}_{92}U^{*}_{143} + {}^{195}_{78}Pt_{117} \rightarrow {}^{430}_{170}Ch^{ie}_{260} \rightarrow {}^{426}_{168}Ch^{ie}_{258} + \alpha \rightarrow {}^{426}_{169}Ch^{ie}_{257} + \alpha + \beta$$

$$^{238}_{92}U^{*}_{146} + {}^{188}_{76}Os_{112} \rightarrow {}^{426}_{168}Ch^{ie}_{258} \rightarrow {}^{426}_{169}Ch^{ie}_{257} + \beta$$

$$^{238}_{92}U^{*}_{146} + {}^{192}_{76}Os_{116} \rightarrow {}^{430}_{168}Ch^{ie}_{262} \rightarrow {}^{426}_{166}Ch^{ie}_{260} + \alpha \rightarrow {}^{426}_{169}Ch^{ie}_{257} + \alpha + 3\beta$$

$$^{238}_{92}U^{*}_{146} + {}^{192}_{78}Pt_{114} \rightarrow {}^{430}_{170}Ch^{ie}_{260} \rightarrow {}^{426}_{168}Ch^{ie}_{258} + \alpha \rightarrow {}^{426}_{169}Ch^{ie}_{257} + \alpha + \beta$$

The Synthetic Routes to the 173th Element:

$$^{141}_{56}Ba^{*}_{85} + {}^{294}_{117}Ts^{ie}_{177} \rightarrow {}^{435}_{173}Ch^{ie}_{262}$$

$$^{141}_{56}Ba^{*}_{85} + {}^{294}_{118}Og^{ie}_{176} \rightarrow [{}^{435}_{174}Ch^{ie}_{261}] \rightarrow {}^{435}_{173}Ch^{ie}_{262} + \beta^{+}$$

$$^{141}_{56}Ba^{*}_{85} + {}^{298}_{119}Ch^{ie}_{179} \rightarrow [{}^{439}_{175}Ch^{ie}_{264}] \rightarrow {}^{435}_{173}Ch^{ie}_{262} + \alpha$$

$$^{209}_{83}Bi^{*}_{126} + {}^{226}_{88}Ra^{*}_{138} \rightarrow {}^{435}_{171}Ch^{ie}_{264} \rightarrow {}^{435}_{172}Ch^{ie}_{263} + \beta \rightarrow {}^{435}_{173}Ch^{ie}_{262} + 2\beta$$

$$^{209}_{83}Bi^{*}_{126} + {}^{230}_{90}Th^{*}_{140} \rightarrow {}^{439}_{173}Ch^{ie}_{266} \rightarrow {}^{435}_{171}Ch^{ie}_{264} + \alpha \rightarrow {}^{435}_{173}Ch^{ie}_{262} + \alpha + 2\beta$$

$$^{232}_{90}Th^{*}_{142} + {}^{203}_{81}Tl_{122} \rightarrow {}^{435}_{171}Ch^{ie}_{264} \rightarrow {}^{435}_{172}Ch^{ie}_{263} + \beta \rightarrow {}^{435}_{173}Ch^{ie}_{262} + 2\beta$$

$$^{232}_{90}Th^{*}_{142} + {}^{207}_{82}Pb_{125} \rightarrow {}^{439}_{172}Ch^{ie}_{267} \rightarrow {}^{435}_{170}Ch^{ie}_{265} + \alpha \rightarrow {}^{435}_{173}Ch^{ie}_{262} + \alpha + 3\beta$$

$$^{235}_{92}U^{*}_{143} + {}^{200}_{80}Hg_{120} \rightarrow {}^{435}_{172}Ch^{ie}_{263} \rightarrow {}^{435}_{173}Ch^{ie}_{262} + \beta$$

$$^{235}_{92}U^{*}_{143} + {}^{204}_{82}Pb_{122} \rightarrow {}^{439}_{174}Ch^{ie}_{265} \rightarrow {}^{435}_{172}Ch^{ie}_{263} + \alpha \rightarrow {}^{435}_{173}Ch^{ie}_{262} + \alpha + \beta$$

$$^{238}_{92}U^{*}_{146} + {}^{197}_{81}Tl^{*}_{116} \rightarrow {}^{435}_{173}Ch^{ie}_{262}$$

$$^{238}_{92}U^{*}_{146} + {}^{197}_{79}Au_{118} \rightarrow {}^{435}_{171}Ch^{ie}_{264} \rightarrow {}^{435}_{172}Ch^{ie}_{263} + \beta \rightarrow {}^{435}_{173}Ch^{ie}_{262} + 2\beta$$

The numbers in red color seems to correlate each other in some meanings.

It should be worthy to synthesize the 119th, 120th, 125th, 126th and 137th elements preferentially. More important and feasible routes to synthesized them should be as follows, among which the synthetic routes to 126th element are the most important and meaningful.

$$^{141}_{56}Ba^{*}_{85} + {}^{157}_{64}Gd_{93} \rightarrow {}^{298}_{120}Ch^{ie}_{178} \rightarrow {}^{298}_{119}Ch^{ie}_{179} + \beta^{+}$$

$$^{238}_{92}U^{*}_{146} + {}^{60}_{27}Co^{*}_{33} \rightarrow {}^{298}_{119}Ch^{ie}_{179}$$

$$^{141}_{56}Ba^{*}_{85} + {}^{159}_{65}Tb_{94} \rightarrow {}^{300}_{121}Ch^{ie}_{179} \rightarrow {}^{300}_{120}Ch^{ie}_{180} + \beta^{+}$$

$$^{232}_{90}Th^{*}_{142} + {}^{68}_{30}Zn_{38} \rightarrow {}^{300}_{120}Ch^{ie}_{180}$$

$$^{238}_{92}U^{*}_{146} + {}^{62}_{28}Ni_{34} \rightarrow {}^{300}_{120}Ch^{ie}_{180}$$

$$^{141}_{56}Ba^{*}_{85} + {}^{169}_{69}Tm_{100} \rightarrow {}^{310}_{125}Ch^{ie}_{185}$$

$$^{141}_{59}\mathrm{Pr}_{82} + {}^{169}_{69}Tm_{100} \rightarrow {}^{310}_{128}Ch^{ie}_{182} \rightarrow {}^{310}_{125}Ch^{ie}_{185} + 3\beta^{+}$$

$$^{235}_{92}U^{*}_{143} + {}^{75}_{33}As_{42} \rightarrow {}^{310}_{125}Ch^{ie}_{185}$$

$$^{141}_{56}Ba^{*}_{85} + {}^{173}_{70}Yb_{103} \rightarrow {}^{314}_{126}Ch^{ie}_{188}$$

$$^{141}_{59}\mathrm{Pr}_{82} + {}^{173}_{70}Yb_{103} \rightarrow {}^{314}_{129}Ch^{ie}_{185} \rightarrow {}^{314}_{126}Ch^{ie}_{188} + 3\beta^{+}$$

$$^{232}_{90}Th^{*}_{142} + {}^{82}_{36}Kr_{46} \rightarrow {}^{314}_{126}Ch^{ie}_{188}$$

$$^{235}_{92}U^{*}_{143} + {}^{79}_{35}Br_{44} \rightarrow {}^{314}_{127}Ch^{ie}_{187} \rightarrow {}^{314}_{126}Ch^{ie}_{188} + \beta^{+}$$

$$^{235}_{92}U^{*}_{143} + {}^{83}_{36}Kr_{47} \rightarrow {}^{318}_{128}Ch^{ie}_{190} \rightarrow {}^{314}_{126}Ch^{ie}_{188} + \alpha$$

$$^{238}_{92}U^{*}_{146} + {}^{76}_{34}Se_{42} \rightarrow {}^{314}_{126}Ch^{ie}_{188}$$

$$^{141}_{56}Ba^{*}_{85} + {}^{205}_{81}Tl_{124} \rightarrow {}^{2\cdot173}_{137}Fy^{ie}_{209}$$

$$^{141}_{56}Ba^{*}_{85} + {}^{209}_{83}Bi^{*}_{126} \rightarrow {}^{350}_{139}Ch^{ie}_{211} \rightarrow {}^{2\cdot173}_{137}Fy^{ie}_{209} + \alpha$$

$$^{209}_{83}Bi^{*}_{126} + {}^{137}_{56}Ba_{81} \rightarrow {}^{346}_{139}Ch^{ie}_{207} \rightarrow {}^{2\cdot173}_{137}Fy^{ie}_{209} + 2\beta^{+}$$

$$^{238}_{92}U^{*}_{146} + {}^{112}_{48}Cd_{64} \rightarrow {}^{350}_{140}Ch^{ie}_{210} \rightarrow {}^{346}_{138}Fy^{ie}_{208} + \alpha \rightarrow {}^{346}_{137}Fy^{ie}_{209} + \alpha + \beta^{+}$$

The most important and meanngful synthetic route:

$$^{141}_{56}Ba^{*}_{85} + {}^{173}_{70}Yb_{103} \rightarrow {}^{314}_{126}Ch^{ie}_{188}$$

4. Discussion and Conclusion

It is supposed by us the natural end of the elements is the 112th element Cn, and the 113-173th elements were called “the ideal extended elements (*ie*)” or “the frontier of the elements”. It should be very difficult or even impossible to synthesize the ideal extended elements beyond the 118 element Og, but it should be important and meaningful to explore the frontier of the elements and establish suitable theories. The meanings for exploration of the frontier of the elements are comparable to those for explorations of the frontier and origin of the universe or the deepest nature of elementary particles. However, our theoretical explorations of the frontier of the elements are almost costless, but the explorations of the universe and elementary particles are extremely expensive.

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Appendix I: Research and Writing History

Section	Page	Writing Period	Location	Version
Whole Paper	1-5	2022/10/28-30	Chengdu	viXra:2210.0146v1
Whole Paper	1-15	2022/10/28-11/10	Chengdu	viXra:2210.0146v2
Note: date was recorded according to Beijing Time.				