Margaret Peachey Burbidge (1919)

1939

"non si svolsero cerimonie per la mia laurea, nell'estate del '39 era ovvio che l'Inghilterra andava incontro alla guerra con la Germania."

"Avendo letto un annuncio su The Observer per una ricerca di personale all'Università Carnegie per il Mt. Wilson Observatory feci domanda"

"La lettera di rifiuto diceva semplicemente che i posti al Carnegie Fellowship erano riservati agli uomini. Apparentemente alle donne non era concesso l'uso dei telescopi di Mt. Wilson"

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Synthesis of the Elements in Stars*

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"It is the stars, The stars above us, govern our conditions";
(*King Lear*, Act IV, Scene 3)

but perhaps

"The fault, dear Brutus, is not in our stars, But in ourselves,"
(*Julius Caesar*, Act I, Scene 2)

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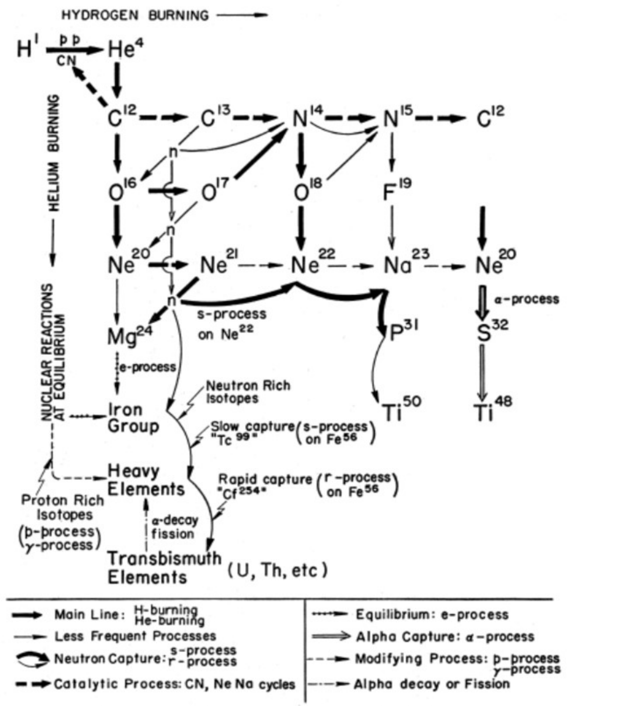
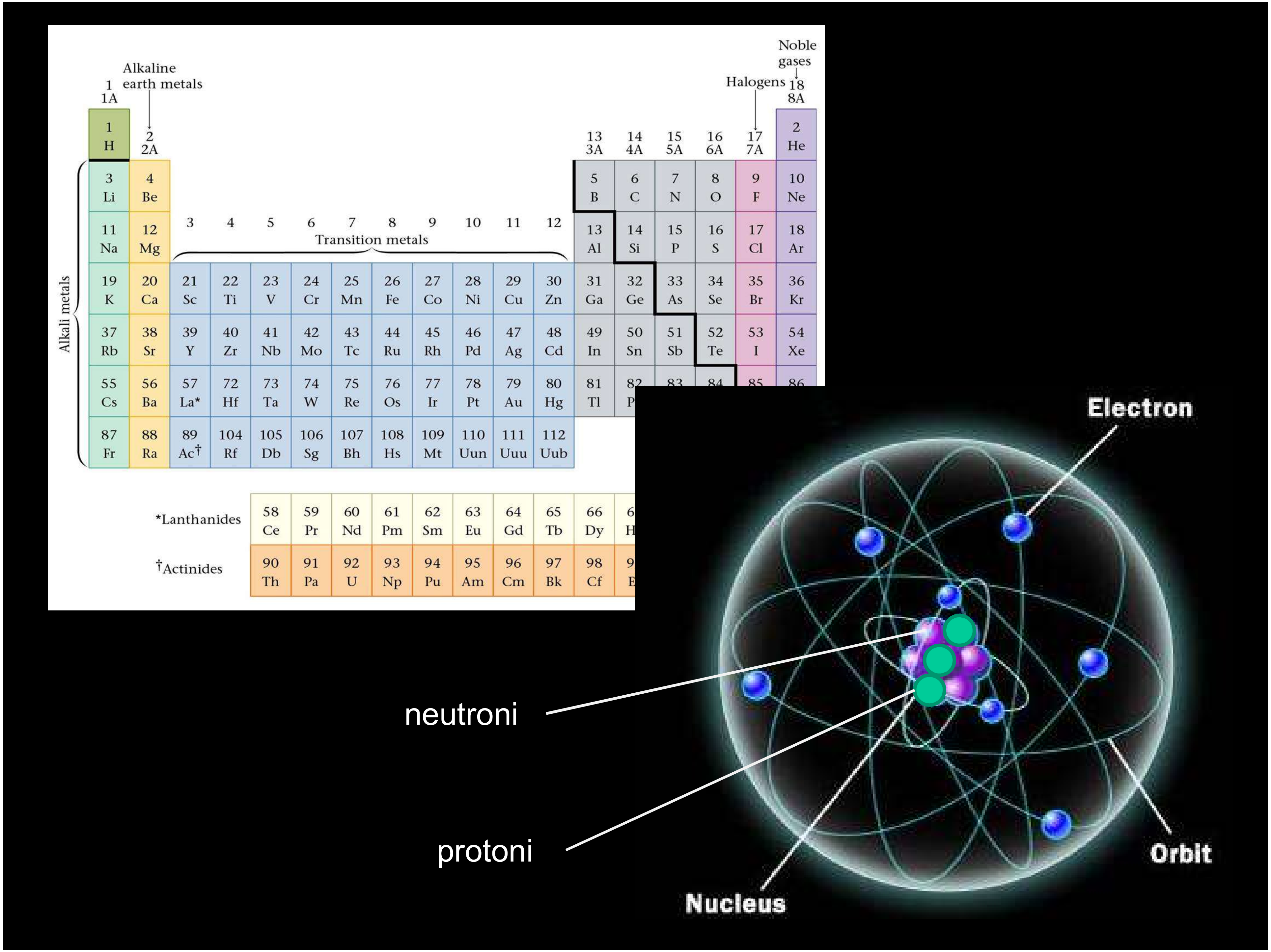
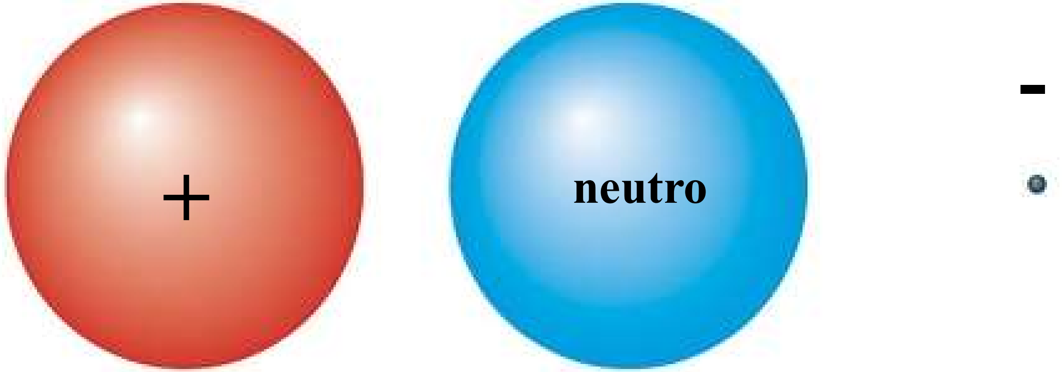
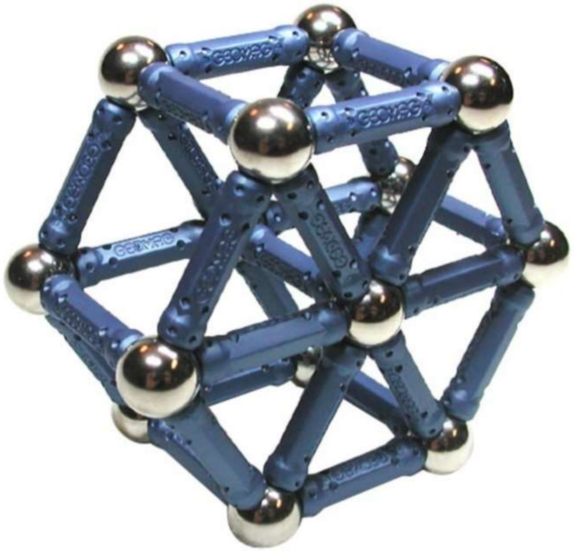


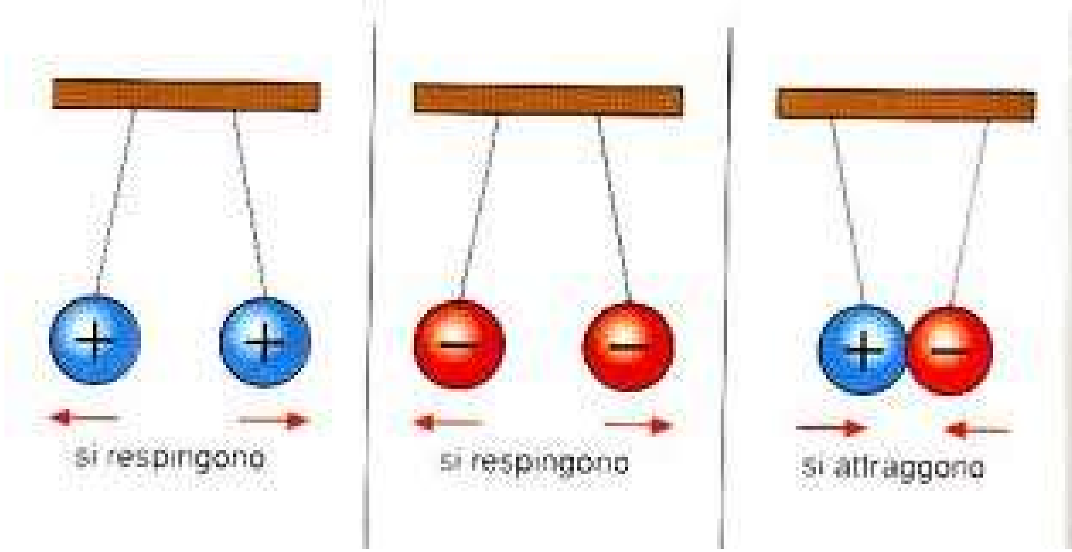
FIG. 1,2. A schematic diagram of the nuclear processes by which the synthesis of the elements in stars takes place. Elements synthesized by interactions with protons (hydrogen burning) are listed horizontally. Elements synthesized by interactions with alpha particles (helium burning) and by still more complicated processes are listed vertically. The details of the production of all of the known stable isotopes of carbon, nitrogen, oxygen, fluorine, neon, and sodium are shown completely. Neutron capture processes by which the highly charged heavy elements are synthesized are indicated by curved arrows. The production of radioactive Tc^{99} is indicated as an example for which there is astrophysical evidence of neutron captures at a slow rate over long periods of time in red giant stars. Similarly Cf^{254}, produced in supernovae, is an example of neutron synthesis at a rapid rate. The iron group is produced by a variety of nuclear reactions at equilibrium in the last stable stage of a star's evolution.


Alkaline earth metals
Alkali metals
Transition metals
Halogens
Noble gases
1 1A
2 2A
13 3A
14 4A
15 5A
16 6A
17 7A
18 8A
3 4 5 6 7 8 9 10 11 12
1 H
2 He
3 Li 4 Be 5 B 6 C 7 N 8 O 9 F 10 Ne
11 Na 12 Mg 13 Al 14 Si 15 P 16 S 17 Cl 18 Ar
19 K 20 Ca 21 Sc 22 Ti 23 V 24 Cr 25 Mn 26 Fe 27 Co 28 Ni 29 Cu 30 Zn 31 Ga 32 Ge 33 As 34 Se 35 Br 36 Kr
37 Rb 38 Sr 39 Y 40 Zr 41 Nb 42 Mo 43 Tc 44 Ru 45 Rh 46 Pd 47 Ag 48 Cd 49 In 50 Sn 51 Sb 52 Te 53 I 54 Xe
55 Cs 56 Ba 57 La* 72 Hf 73 Ta 74 W 75 Re 76 Os 77 Ir 78 Pt 79 Au 80 Hg 81 Tl
87 Fr 88 Ra 89 Ac† 104 Rf 105 Db 106 Sg 107 Bh 108 Hs 109 Mt 110 Uun 111 Uuu 112 Uub
*Lanthanides 58 Ce 59 Pr 60 Nd 61 Pm 62 Sm 63 Eu 64 Gd 65 Tb 66 Dy
†Actinides 90 Th 91 Pa 92 U 93 Np 94 Pu 95 Am 96 Cm 97 Bk 98 Cf
Electron
Orbit
Nucleus
neutroni
protoni



protone neutrone elettrone





La materia è composta da:

Alkaline earth metals

Noble gases

Halogens

Transition metals

Alkali metals

1 1A	2 2A	3	4	5	6	7	8	9	10	11	12	13 3A	14 4A	15 5A	16 6A	17 7A	18 8A
1 H																	2 He
3 Li	4 Be											5 B	6 C	7 N	8 O	9 F	10 Ne
11 Na	12 Mg											13 Al	14 Si	15 P	16 S	17 Cl	18 Ar
19 K	20 Ca	21 Sc	22 Ti	23 V	24 Cr	25 Mn	26 Fe	27 Co	28 Ni	29 Cu	30 Zn	31 Ga	32 Ge	33 As	34 Se	35 Br	36 Kr
37 Rb	38 Sr	39 Y	40 Zr	41 Nb	42 Mo	43 Tc	44 Ru	45 Rh	46 Pd	47 Ag	48 Cd	49 In	50 Sn	51 Sb	52 Te	53 I	54 Xe
55 Cs	56 Ba	57 La*	72 Hf	73 Ta	74 W	75 Re	76 Os	77 Ir	78 Pt	79 Au	80 Hg	81 Tl	82 Pb	83 Bi	84 Po	85 At	86 Rn
87 Fr	88 Ra	89 Ac†	104 Rf	105 Db	106 Sg	107 Bh	108 Hs	109 Mt	110 Uun	111 Uuu	112 Uub						

*Lanthanides	58 Ce	59 Pr	60 Nd	61 Pm	62 Sm	63 Eu	64 Gd	65 Tb	66 Dy	67 Ho	68 Er	69 Tm	70 Yb	71 Lu
†Actinides	90 Th	91 Pa	92 U	93 Np	94 Pu	95 Am	96 Cm	97 Bk	98 Cf	99 Es	100 Fm	101 Md	102 No	103 Lr

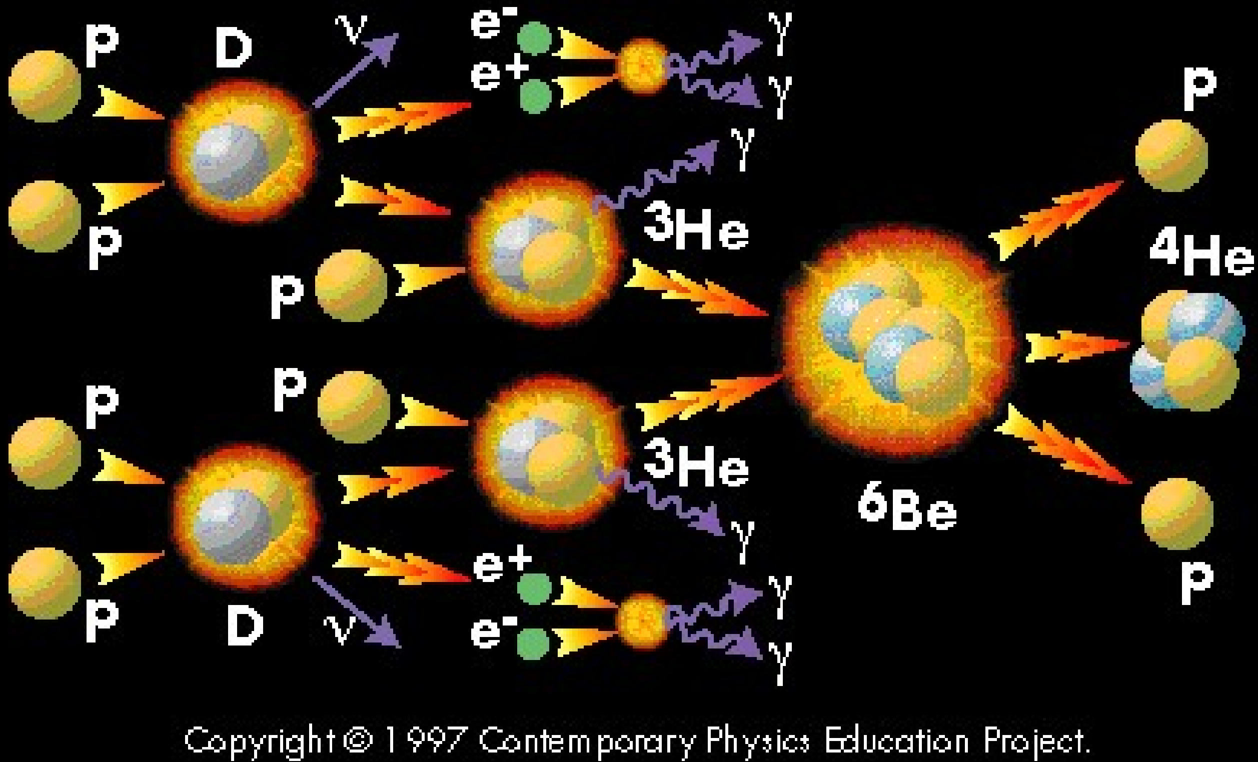
La catena protone protone

1000

1000

1000

1000



3972

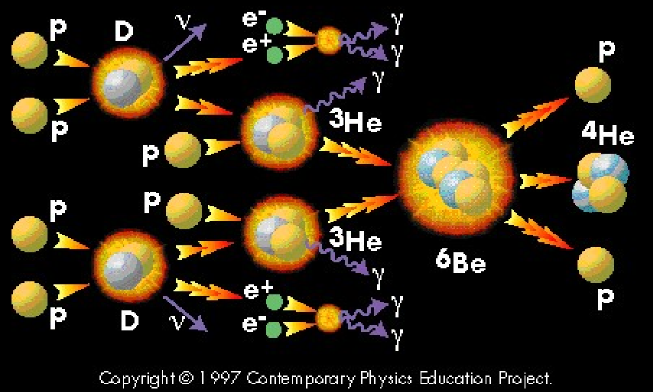
Abbiamo perso 27 unità di massa =
0.7 % della massa coinvolta nella reazione

1000

1000

1000

1000



3972

Abbiamo perso 27 unità di massa =
0.7 % della massa coinvolta nella reazione

$$\mathcal{E} = m\, c^2$$

$$E_{reazione} = 4 \cdot 10^{-12}\ J$$

Numero di atomi di idrogeno: 10^{57}

Ogni reazione coinvolge 4 atomi di idrogeno

Ogni reazione produce una energia di : $4 \cdot 10^{-12}\ J$

Il Sole emette : $4 \cdot 10^{26}\ J/s = 4 \cdot 10^{26}\ W$

Ad ogni secondo si verificano : 10^{38} *reazioni*

Con questo tasso il sole potrebbe vivere per 70 miliardi di anni

All’interno della stella avvengono delle reazioni tra le particelle chiamate reazioni nucleari:

$4\ {}^{1}H \rightarrow 2\ {}^{2}H + 2\ e^{+} + 2\ \nu_e$ (4,0 MeV + 1,0 MeV)
$2\ {}^{1}H + 2\ {}^{2}H \rightarrow 2\ {}^{3}He + 2\ \gamma$ (5,5 MeV)
$2\ {}^{3}He \rightarrow {}^{4}He + 2\ {}^{1}H$ (12,9 MeV)

$4\ {}^{1}H \rightarrow {}^{4}He + 2\ e^{+} + 2\ \nu_e + 2\ \gamma$ (26,7 MeV)