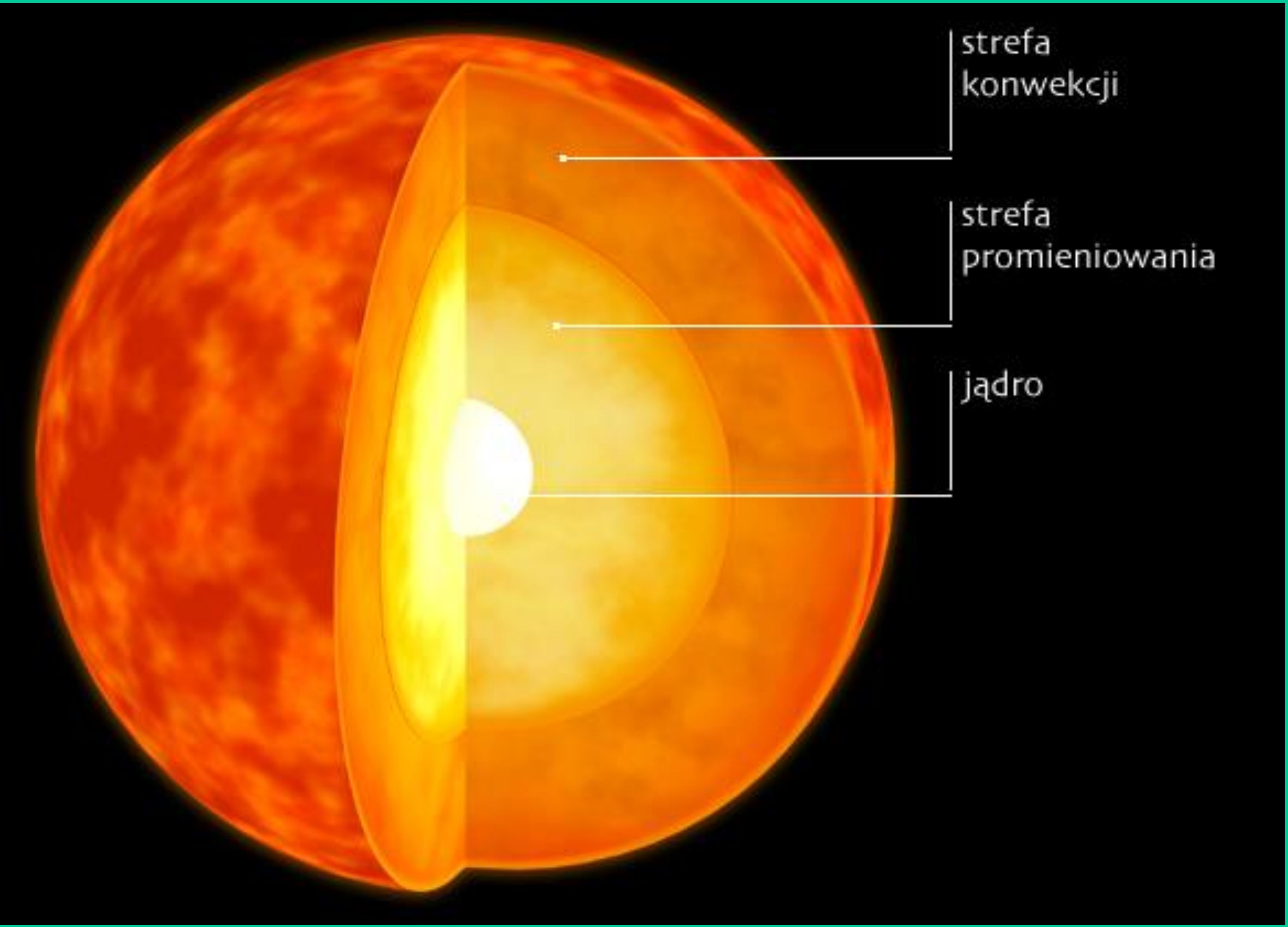
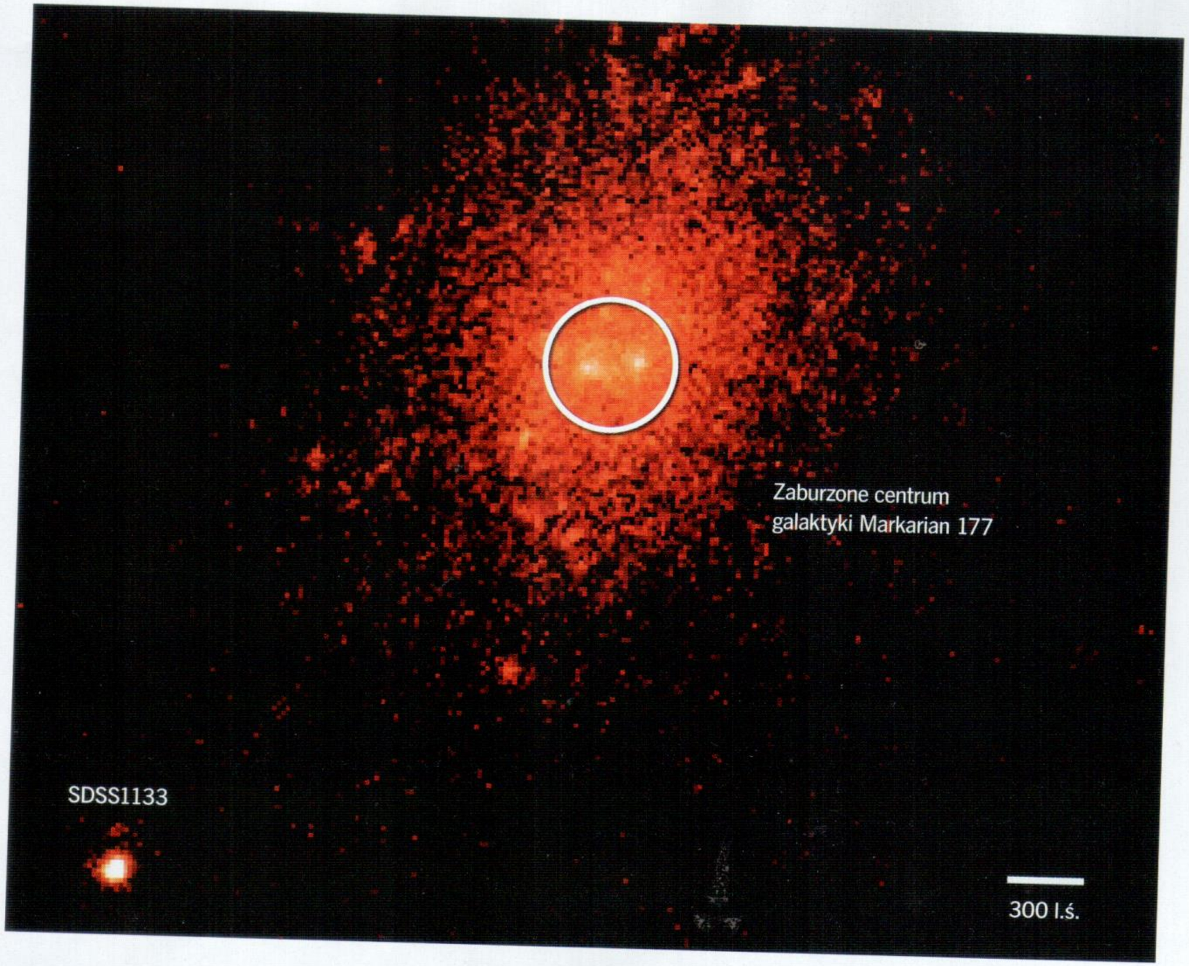
UKŁAD OKRESOWY

PIERWIASTKÓW



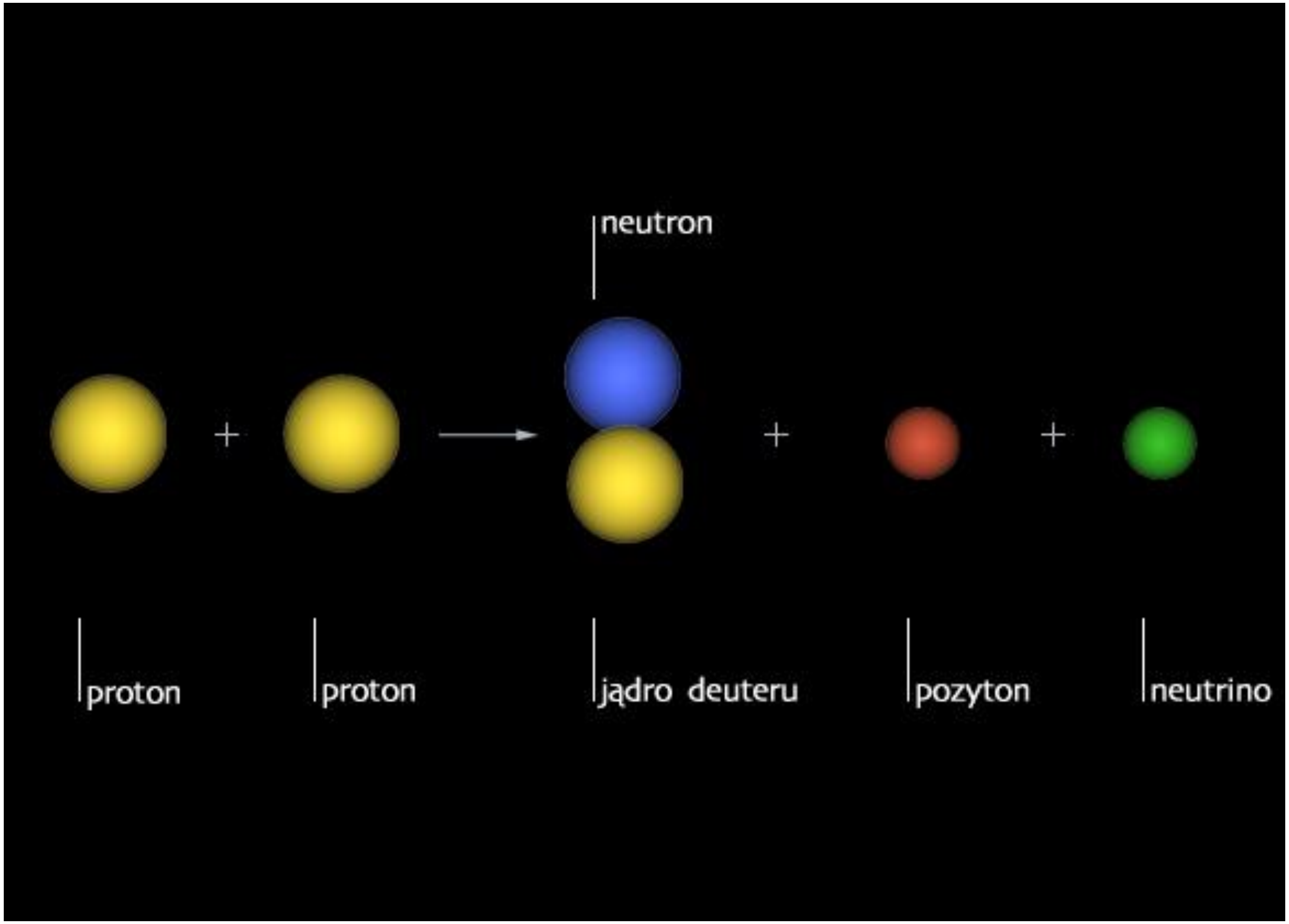
strefa
konwekcji
strefa
promieniowania
jądro

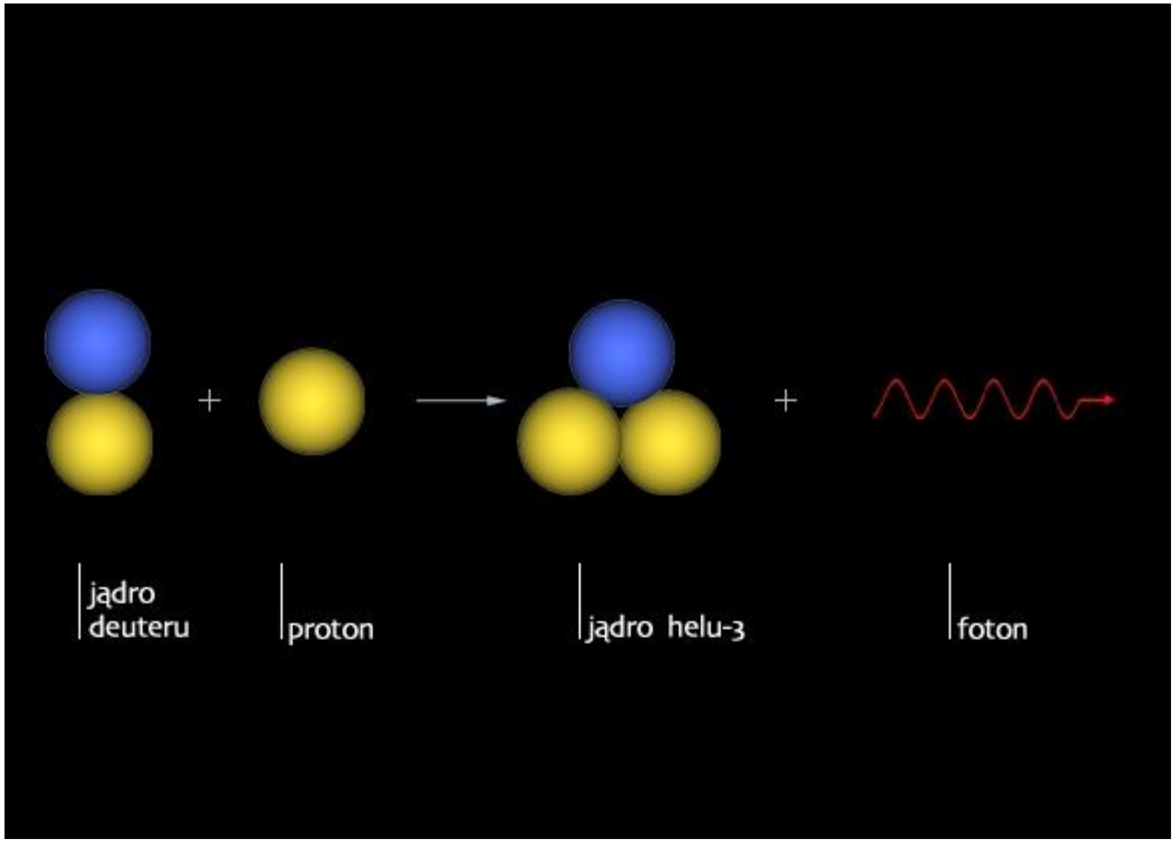


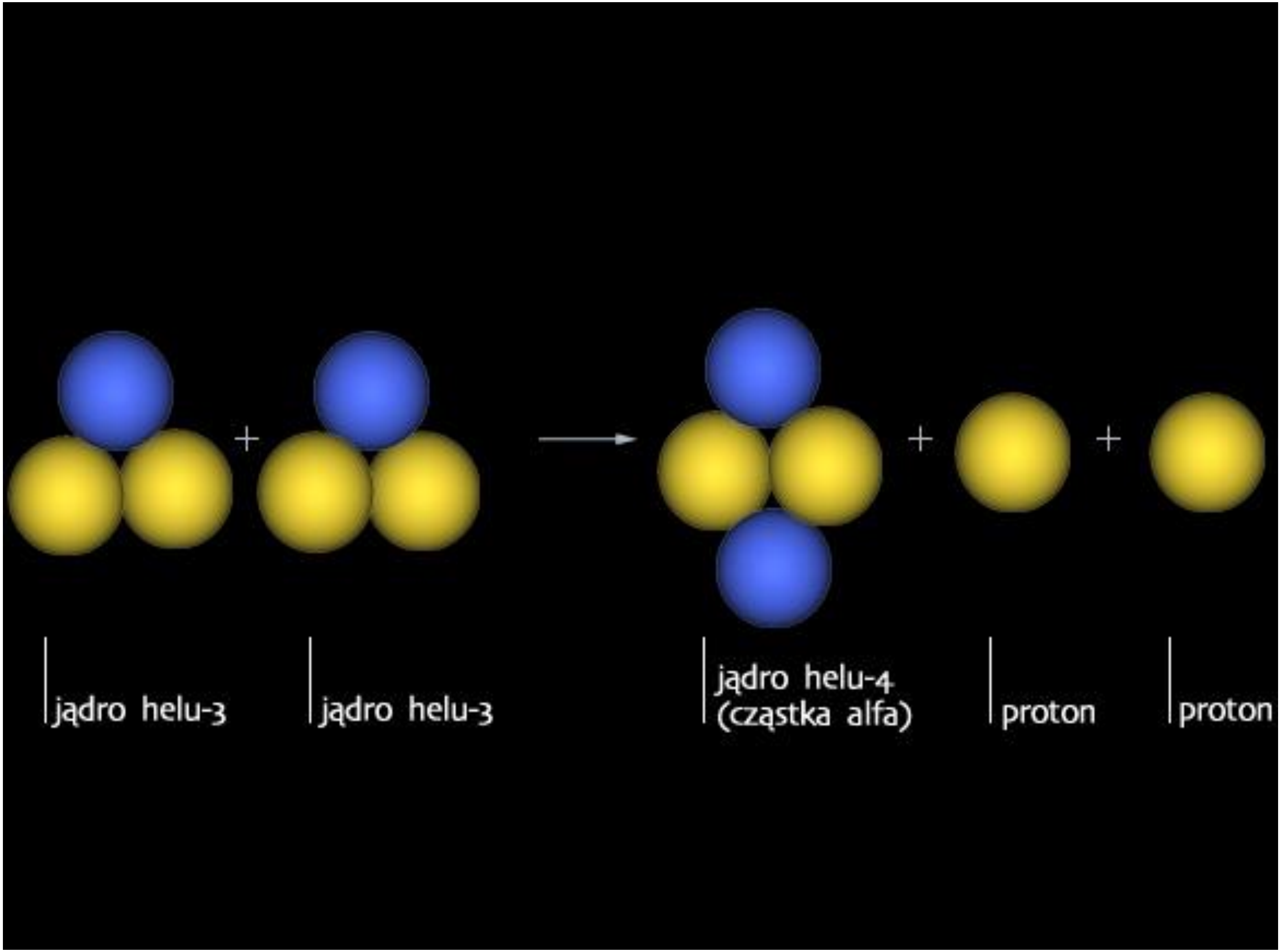
Obraz karłowatej galaktyki Markarian 177, uzyskany w bliskiej podczerwieni przez teleskop Keck II. Obok (poniżej na lewo) tajemniczy obiekt SDSS1133, prawdopodobnie będący wypchniętą centralną dziurą Markariana. Jasne punkty w centrum galaktyki to obszary narodzin nowych gwiazd.

Fot. NASA; David Shane/Flickr.com; ESA/Hubble

z wodoru tworzą się gwiazdy i galaktyki
galatyki ulegają kolizji
w centrum są czarne dziury
synteza pierwiastków w gwiazdach


neutron
proton
proton
jądro deuteru
pozyton
neutrino


jądro
deuteru
proton
jądro helu-3
foton


jądro helu-3
jądro helu-3
jądro helu-4
(cząstka alfa)
proton
proton

Synteza pierwiastków - reakcje jądrowe

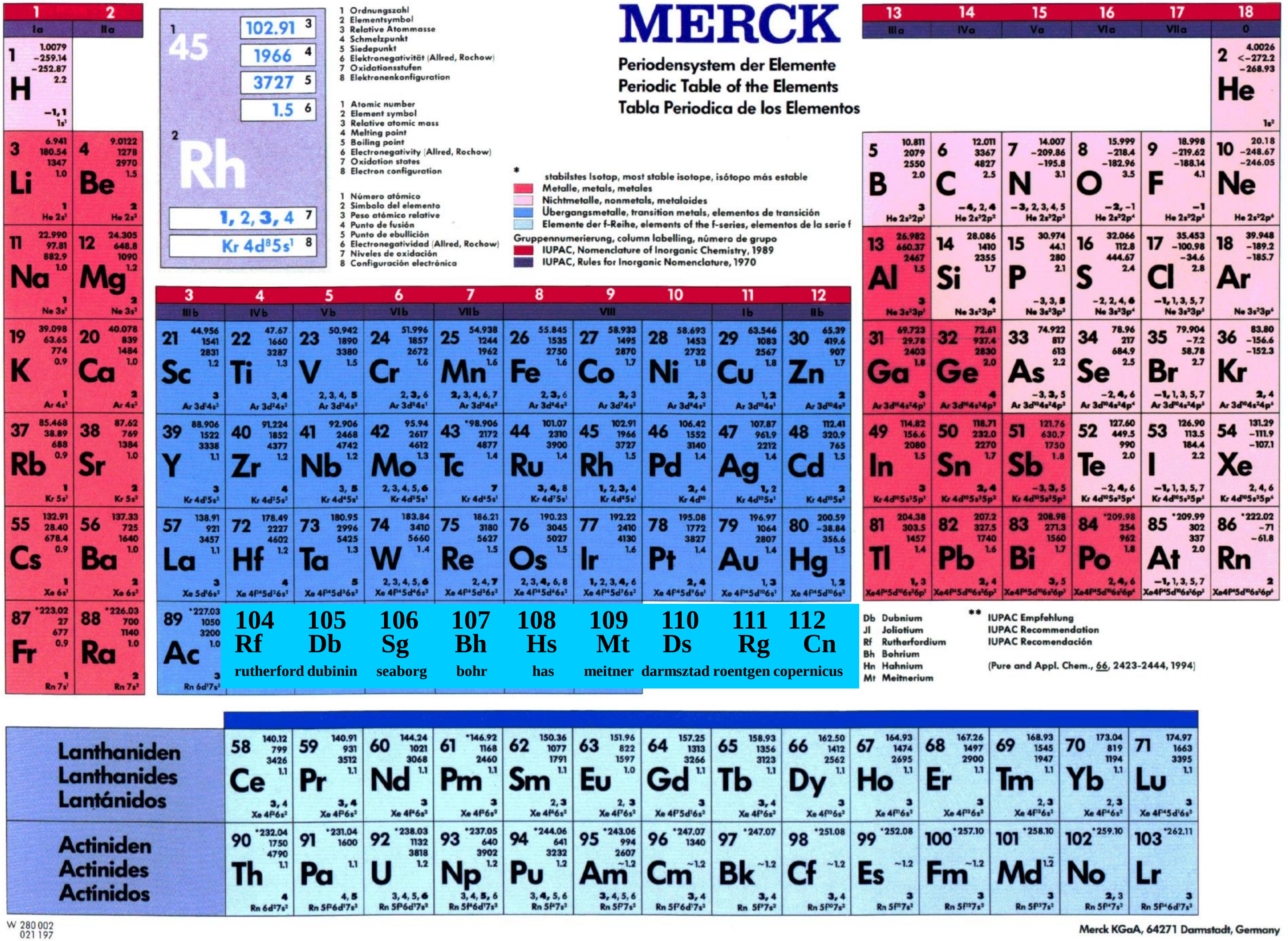
$$ {}^{1}_{1}H + {}^{1}_{1}H = {}^{2}_{1}D + e^{+} $$

$$ {}^{2}_{1}D + {}^{1}_{1}H = {}^{3}_{2}He $$

$$ {}^{3}_{2}He + {}^{3}_{2}He = {}^{4}_{2}He + 2\,{}^{1}_{1}H $$

$$ {}^{4}_{2}He + {}^{4}_{2}He = {}^{8}_{4}Be $$

$$ {}^{8}_{4}Be + {}^{4}_{2}He = {}^{12}_{6}C $$


MERCK
Periodensystem der Elemente
Periodic Table of the Elements
Tabla Periodica de los Elementos
1 Ordnungszahl
2 Elementsymbol
3 Relative Atommasse
4 Schmelzpunkt
5 Siedepunkt
6 Elektronegativität (Allred, Rochow)
7 Oxidationsstufen
8 Elektronenkonfiguration
1 Atomic number
2 Element symbol
3 Relative atomic mass
4 Melting point
5 Boiling point
6 Electronegativity (Allred, Rochow)
7 Oxidation states
8 Electron configuration
1 Número atómico
2 Símbolo del elemento
3 Peso atómico relative
4 Punto de fusión
5 Punto de ebullición
6 Electronegatividad (Allred, Rochow)
7 Niveles de oxidación
8 Configuración electrónica
45 Rh 102.91 1966 3727 1.5 1, 2, 3, 4 Kr 4d⁸5s¹
* stabilstes Isotop, most stable isotope, isótopo más estable
Metalle, metals, metales
Nichtmetalle, nonmetals, metaloides
Übergangsmetalle, transition metals, elementos de transición
Elemente der f-Reihe, elements of the f-series, elementos de la serie f
Gruppennumerierung, column labelling, número de grupo
IUPAC, Nomenclature of Inorganic Chemistry, 1989
IUPAC, Rules for Inorganic Nomenclature, 1970
104 Rf rutherford
105 Db dubinin
106 Sg seaborg
107 Bh bohr
108 Hs has
109 Mt meitner
110 Ds darmsztad
111 Rg roentgen
112 Cn copernicus
Db Dubnium
Jl Joliotium
Rf Rutherfordium
Bh Bohrium
Hn Hahnium
Mt Meitnerium
** IUPAC Empfehlung
IUPAC Recommendation
IUPAC Recomendación
(Pure and Appl. Chem., 66, 2423-2444, 1994)
Lanthaniden
Lanthanides
Lantánidos
Actiniden
Actinides
Actínidos
W 280 002
021 197
Merck KGaA, 64271 Darmstadt, Germany

Copernicum, Cn

-odkryty w 1996 roku w Darmstadt, Niemcy

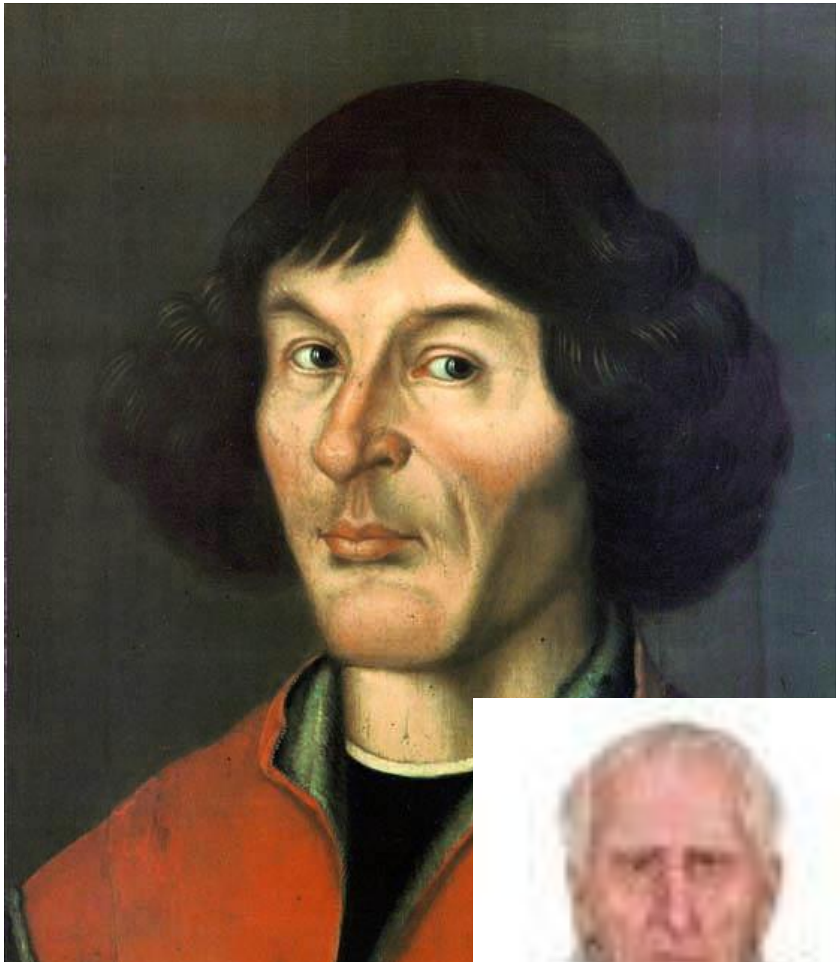
- przez naukowców z Niemiec, Finlandii, Rosji i Słowacji pod kierunkiem Sigurda Hofmana

- 277 razy cięższy od wodoru

-powtaje np. przez fuzję jądrową ołowiu 208 i cynku 70.

-rozpada się po ułamku sekundy, nie występuje w naturze

-uznany przez Międzynarodowa Unia Chemii Czystej i Stosowanej w 2010 roku



112

227

Cn

$Rn5f^{14}6d^{10}7s^{2}$

Discovery of Elements 113 and 115

A calcium-48 ion is accelerated to a high velocity in a cyclotron and directed at an americium-243 target. The accelerated calcium-48 ion collides into an americium-243 target atom (above) and creates the new 115 element that begins decaying with the emission of alpha particles into element 113.

Group members include (left to right): Philip Wilk, Jackie Kenneally, Ken Moody, Dawn Shaughnessy, Mark Stoyer, Nancy Stoyer, and John Wild (retired). Two retirees not pictured are Jerry Landrum and Ron Lougheed.

https://pls.llnl.gov/research-and-development/nuclear-science/project-highlights/livermorium/elements-113-and-115

When will elements 113 and 115 be named?

We don't know when the elements will be named. The naming of new elements is a long process governed by the International Union of Pure and Applied Chemistry (IUPAC). Any discovery of new elements must first be confirmed by an independent laboratory and established beyond a reasonable doubt. Afterwards, the research team that discovered the element is asked to propose a name and symbol for the element. The proposed name is then reviewed by a panel of experts and, if all goes well, finally approved by the IUPAC. This naming process can take many years. For example, element 110 was discovered in 1995 and received its name, darmstadtium (Ds), in 2003, while element 106 was discovered in 1974 but was not officially named as seaborgium (Sg) until 1997.

https://pls.llnl.gov/research-and-development/nuclear-science/project-highlights/livermorium/elements-113-and-115

The man-made elements 114 and 116, which contain 114 and 116 protons per atom, respectively, are now officially called flerovium (Fl) and livermorium (Lv).

The names were chosen to honor the laboratories that first created the elements: the Flerov Laboratory of Nuclear Reactions in Dubna, Russia, and Lawrence Livermore National Laboratory in Livermore, Calif.

June 01, 2012

How long did it take to discover elements 113, 114, 115, 116, and 118?

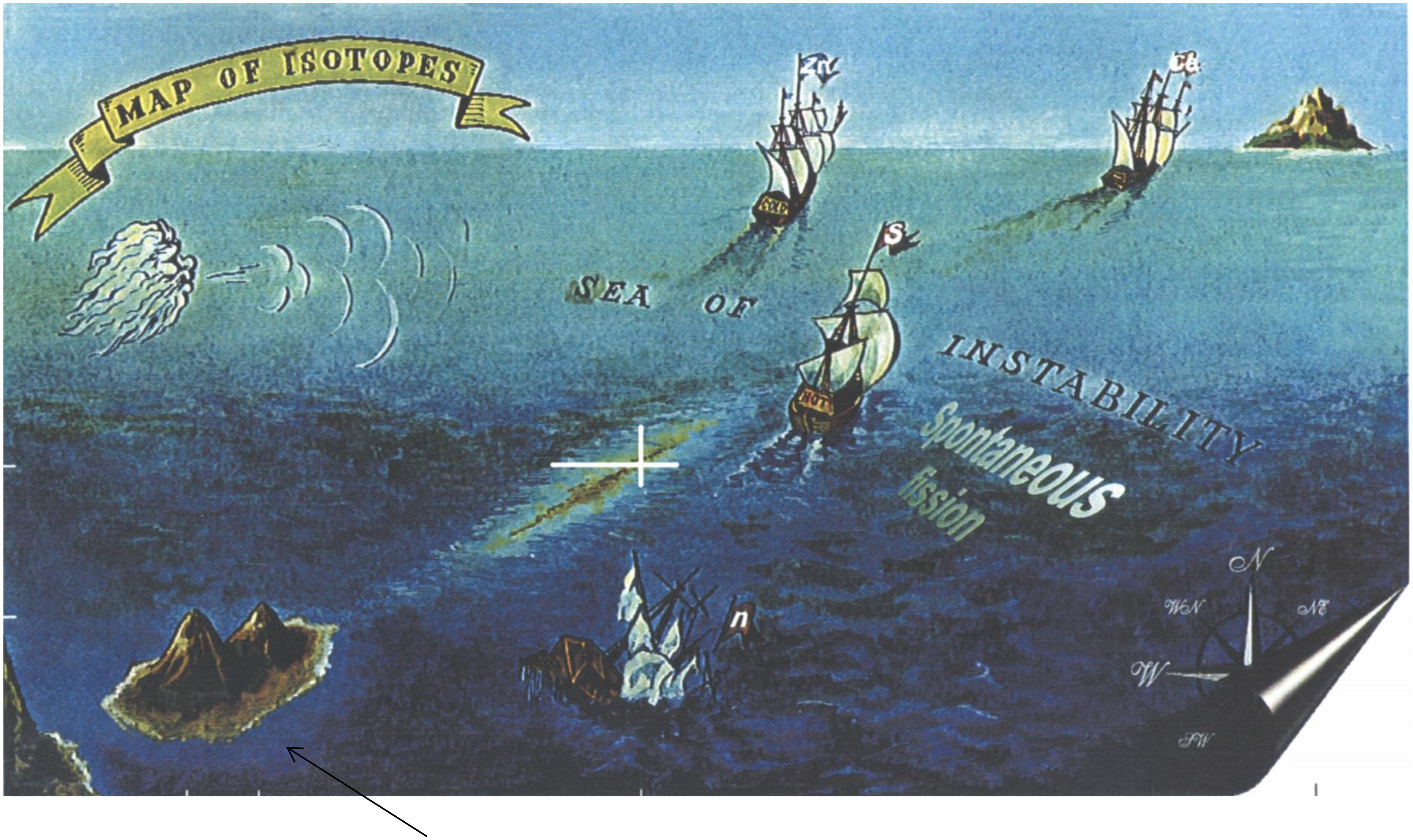
Elements 113 and 115—The experiment began on July 14, 2003, and ended on August 10, 2003. In that time, four atoms of element 115 were produced that decayed after a given time, thereby producing element 113, which also decayed and so on. However, years of successful experiments, previous to the 115 and 113 discovery, were needed to show that the experiment could be successful. More than a year was then spent to clean the target material, ship it to Russia, make the target, and run the experiment.

Element 114—The first element 114 experiment lasted about one year, and two atoms were discovered during that time.

Element 116—The element 116 experiment also lasted about one year, and three atoms were discovered during that time.

Element 118—Element 118 was produced during two separate experiments, each one lasting for several months. A total of three atoms were discovered in both experiments combined.

https://pls.llnl.gov/research-and-development/nuclear-science/project-highlights/livermorium/elements-113-and-115



ciężkie pierwiastki, liczba atomowa powyżej 120

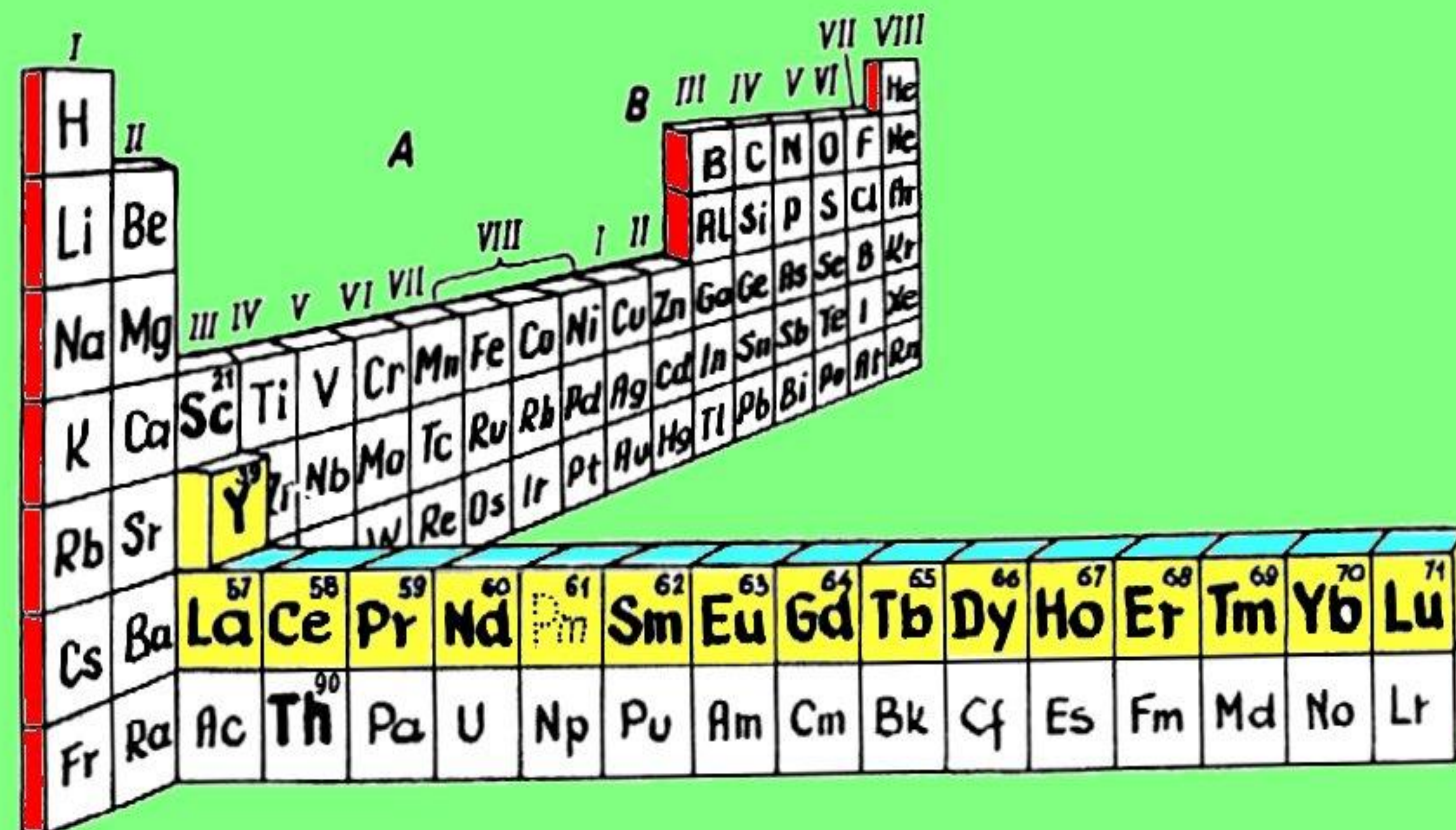
https://pls.llnl.gov/research-and-development/nuclear-science/project-highlights/livermorium/elements-113-and-115

Piotr Gogolewski, 2004

Układ okresowy pierwiastków

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
H 1 Wodór																	He 2 Hel
Li 3 Lit	Be 4 Beryl											B 5 Bor	C 6 Węgiel	N 7 Azot	O 8 Tlen	F 9 Fluor	Ne 10 Neon
Na 11 Sód	Mg 12 Magnez											Al 13 Glin	Si 14 Krzem	P 15 Fosfor	S 16 Siarka	Cl 17 Chlor	Ar 18 Argon
K 19 Potas	Ca 20 Wapń	Sc 21 Skand	Ti 22 Tytan	V 23 Wanad	Cr 24 Chrom	Mn 25 Mangan	Fe 26 Żelazo	Co 27 Kobalt	Ni 28 Nikiel	Cu 29 Miedź	Zn 30 Cynk	Ga 31 Gal	Ge 32 German	As 33 Arsen	Se 34 Selen	Br 35 Brom	Kr 36 Krypton
Rb 37 Rubid	Sr 38 Stront	Y 39 Itr	Zr 40 Cyrkon	Nb 41 Niob	Mo 42 Molibden	Tc 43 Technet	Ru 44 Ruten	Rh 45 Rod	Pd 46 Pallad	Ag 47 Srebro	Cd 48 Kadm	In 49 Ind	Sn 50 Cyna	Sb 51 Antymon	Te 52 Tellur	I 53 Jod	Xe 54 Ksenon
Cs 55 Cez	Ba 56 Bar	*	Hf 72 Hafn	Ta 73 Tantal	W 74 Wolfram	Re 75 Ren	Os 76 Osm	Ir 77 Iryd	Pt 78 Platyna	Au 79 Złoto	Hg 80 Rtęć	Tl 81 Tal	Pb 82 Ołów	Bi 83 Bizmut	Po 84 Polon	At 85 Astat	Rn 86 Radon
Fr 87 Frans	Ra 88 Rad	**	Rf 104 Rutherford	Db 105 Dubn	Sg 106 Seaborg	Bh 107 Bohr	Hs 108 Has	Mt 109 Meitner	Ds 110 Darms.	Rg 111 Roent.	Uub 112	Uut 113	Uuq 114	Uup 115	Uuh 116	Uus 117	Uuo 118

Lantanowce	La 57 Lantan	Ce 58 Cer	Pr 59 Prazeodym	Nd 60 Neodym	Pm 61 Promet	Sm 62 Samar	Eu 63 Europ	Gd 64 Gadolin	Tb 65 Terb	Dy 66 Dysproz	Ho 67 Holm	Er 68 Erb	Tm 69 Tul	Yb 70 Iterb	Lu 71 Lutet
Aktynowce	Ac 89 Aktyn	Th 90 Tor	Pa 91 Protaktyn	U 92 Uran	Np 93 Neptun	Pu 94 Pluton	Am 95 Ameryk	Cm 96 Kiur	Bk 97 Berkel	Cf 98 Kaliforn	Es 99 Einstein	Fm 100 Ferm	Md 101 Mendelew	No 102 Nobel	Lr 103 Lorens



I
II
A
B
III IV V VI VII
VIII
I II
III IV V VI VII VIII
H He
Li Be B C N O F Ne
Na Mg Al Si P S Cl Ar
K Ca Sc Ti V Cr Mn Fe Co Ni Cu Zn Ga Ge As Se Br Kr
Rb Sr Y Zr Nb Mo Tc Ru Rh Pd Ag Cd In Sn Sb Te I Xe
Cs Ba Hf Ta W Re Os Ir Pt Au Hg Tl Pb Bi Po At Rn
Fr Ra
21
39
57 La
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
Ac
90 Th
Pa U Np Pu Am Cm Bk Cf Es Fm Md No Lr

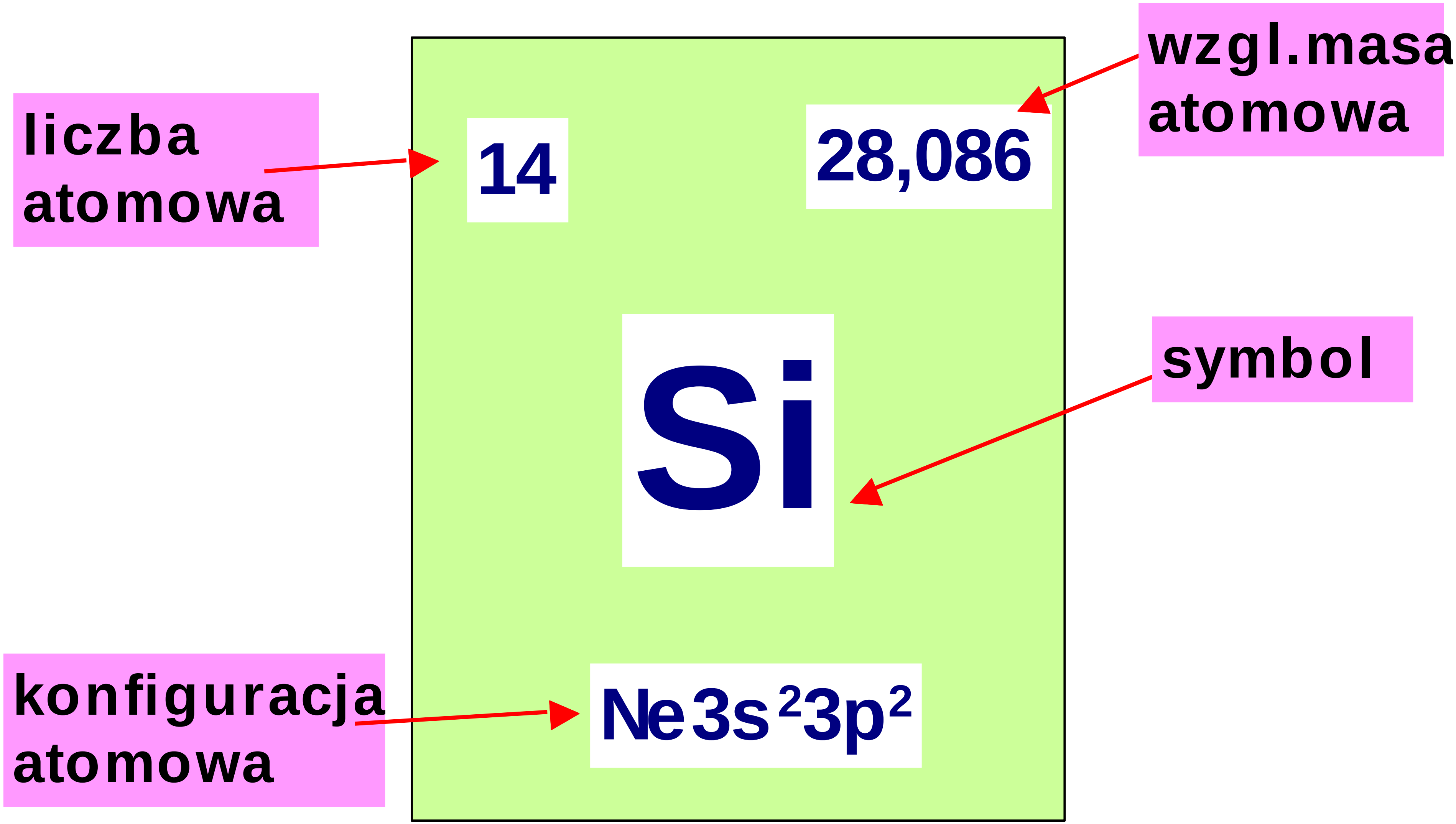
18

Czãdowi Ùstôw Pierwińców

Stanisław Geppert, 2003

		2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	
1	1 H Wòdzyk																	2 He Él
2	3 Li Lët	4 Be Beril											5 B Bòr	6 C Wãdżel	7 N Tãcheń	8 O Krziseń	9 F Fluòr	10 Ne Néón
3	11 Na Natrijô	12 Mg Magnéz											13 Al Aluminijô	14 Si Krzém	15 P Fòsfòr	16 S Sarka	17 Cl Chlor	18 Ar Argón
4	19 K Kali	20 Ca Kalcéń	21 Sc Skónd	22 Ti Titan	23 V Wônôd	24 Cr Chróm	25 Mn Mangan	26 Fe Żelazło	27 Co Kobalt	28 Ni Nikel	29 Cu Kòper	30 Zn Cynk	31 Ga Gôl	32 Ge Germón	33 As Arsén	34 Se Selén	35 Br Bróm	36 Kr Kriptón
5	37 Rb Rubid	38 Sr Starnt	39 Y Éter	40 Zr Cyrkón	41 Nb Niób	42 Mo Molibdén	43 Tc Technet	44 Ru Ruten	45 Rh Ród	46 Pd Pallôd	47 Ag Strzébro	48 Cd Kadm	49 In Jind	50 Sn Cëna	51 Sb Antimón	52 Te Tellur	53 I Jód	54 Xe Ksenón
6	55 Cs Céz	56 Ba Bar	*	72 Hf Hafen	73 Ta Tantôl	74 W Wòlfram	75 Re Rén	76 Os Òsm	77 Ir Jirid	78 Pt Platina	79 Au Złoto	80 Hg Tãż	81 Tl Tôl	82 Pb Òłów	83 Bi Bizmùt	84 Po Pòlón	85 At Astat	86 Rn Redón
7	87 Fr Frãs	88 Ra Rôd	**	104 Rf Ruther-ford	105 Db Dubn	106 Sg Seabórg	107 Bh Bòhr	108 Hs Has	109 Mt Meitner	110 Uun	111 Uuu	112 Uub						

* Lantanowce	57 La Lantón	58 Ce Cer	59 Pr Praze-òdim	60 Nd Neòdim	61 Pm Promet	62 Sm Samar	63 Eu Europ	64 Gd Gadolin	65 Tb Terb	66 Dy Dispóz	67 Ho Hòlm	68 Er Érb	69 Tm Tul	70 Yb Éterb	71 Lu Lutet



liczba atomowa
14
28,086
wzgl.masa atomowa
Si
symbol
konfiguracja atomowa
Ne3s²3p²

Liczby kwantowe i rozmieszczenie elektronów w atomie

n	l	typ orbitala	m	liczba orbitali	m_s	Maks. liczba elektronów podpowłoki	powłoki
1	0	s	0	1	+1/2, -1/2	2	2
2	0	s	0	1	+1/2, -1/2	2	8
	1	p	-1, 0, 1	3	+1/2, -1/2	6	
3	0	s	0	1	+1/2, -1/2	2	18
	1	p	-1, 0, 1	3	+1/2, -1/2	6	
	2	d	-2, -1, 0, 1, 2	5	+1/2, -1/2	10	
4	0	s	0	1	+1/2, -1/2	2	32
	1	p	-1, 0, 1	3	+1/2, -1/2	6	
	2	d	-2, -1, 0, 1, 2	5	+1/2, -1/2	10	
	3	f	-3,-2, -1, 0, 1, 2, 3	7	+1/2, -1/2	14	

liczby kwantowe

n – główna, l – orbitalna, m – magnetyczna, m_s – spinowa

Liczby kwantowe

n głowna liczba kwantowa (kwantuje energię)

n od 1 do 7

l orbitalna (kwantuje moment pędu-kształt orb.)

l od 0 do n-1

m magnetyczna (kwantuje rzut momentu pędu na kierunek pola magnetycznego)

m od -l do +l

m_s spinowa (kwantuje rzut momentu spinowego)

+1/2, -1/2

Kolejnośc zapełniania powłok elektronowych