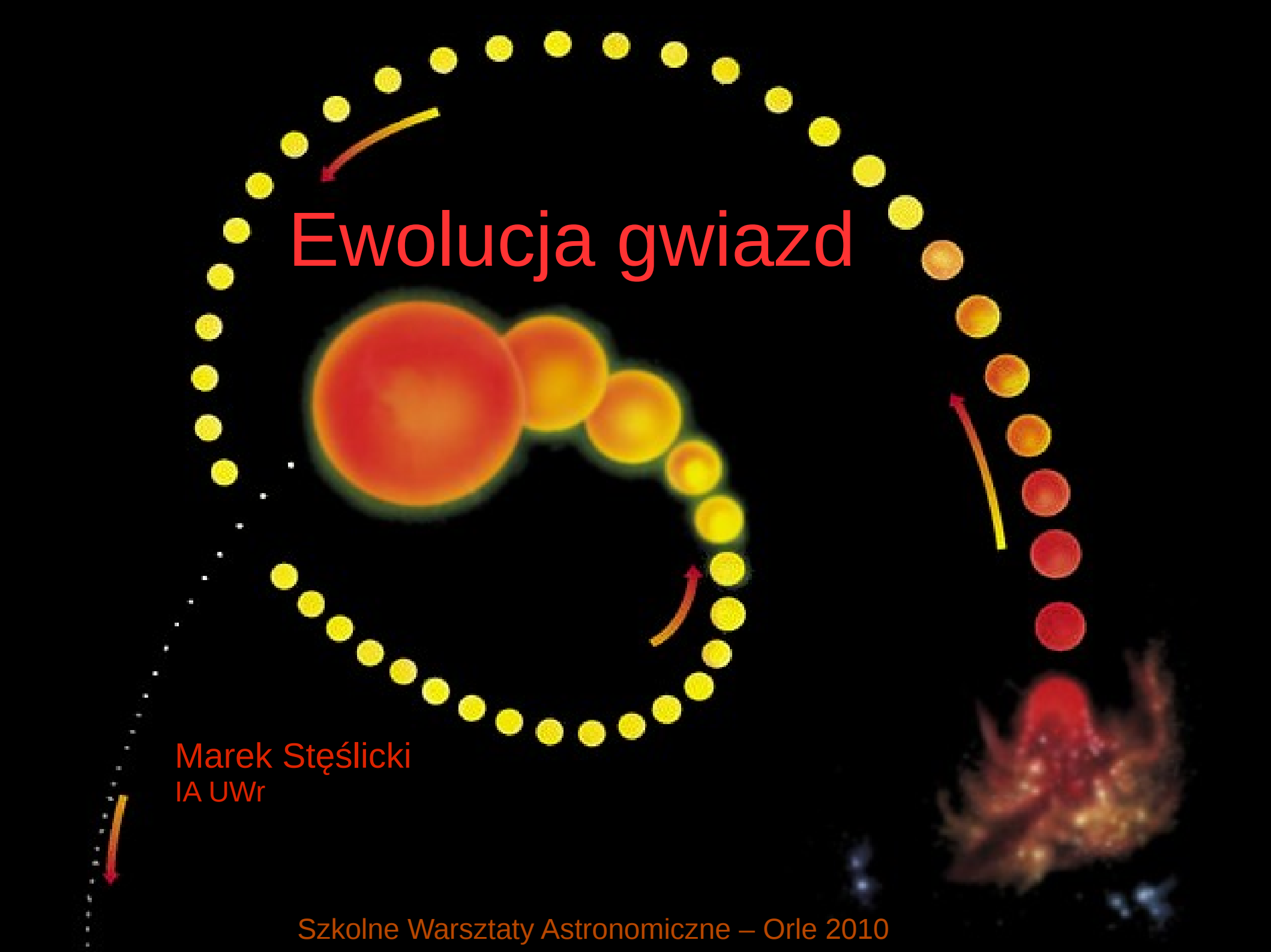
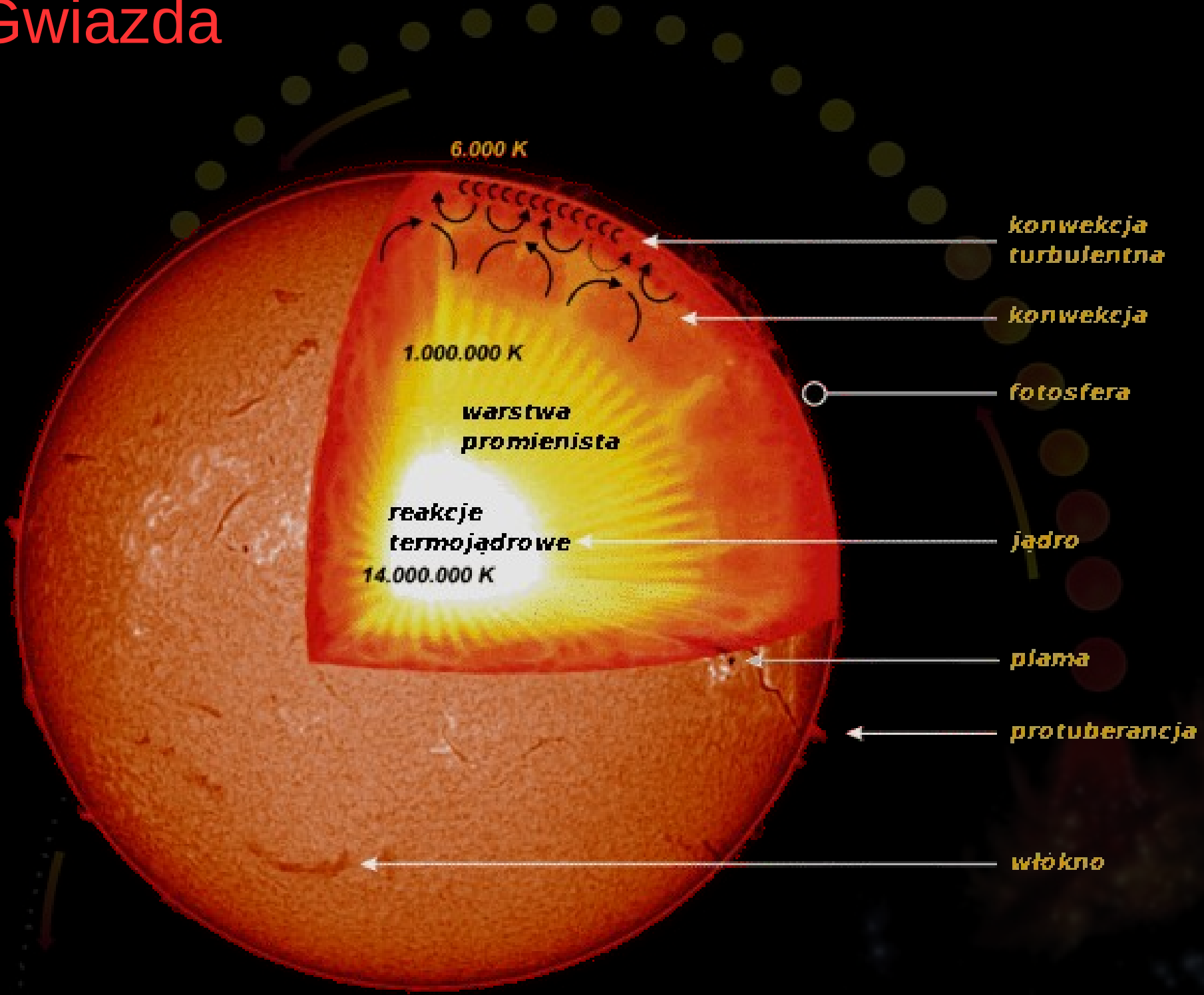
Ewolucja gwiazd



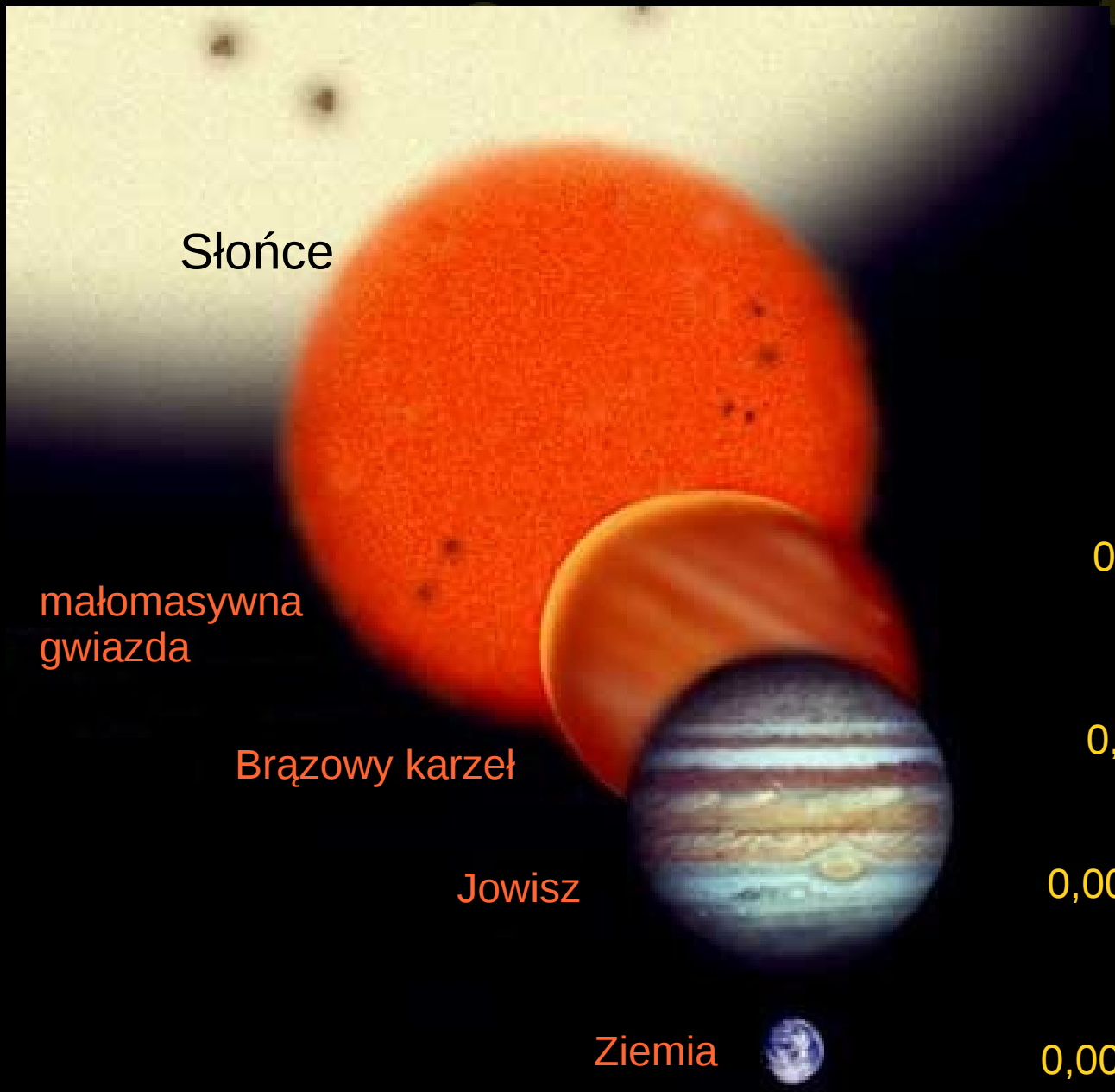
Marek Stęślicki
IA UWr

Szkolne Warsztaty Astronomiczne – Orle 2010

Gwiazda


6.000 K
konwekcja turbulentna
konwekcja
1.000.000 K
fotosfera
warstwa promienista
reakcje termojądrowe
14.000.000 K
jądro
plama
protuberancja
włókno

Gwiazda – dolna granica masy



Słońce

1 $M_\odot$ 332 946 M_z

małomasywna gwiazda

0,15 $M_\odot$ 50 000 M_z

Brązowy karzeł

0,045 $M_\odot$ 15 000 M_z

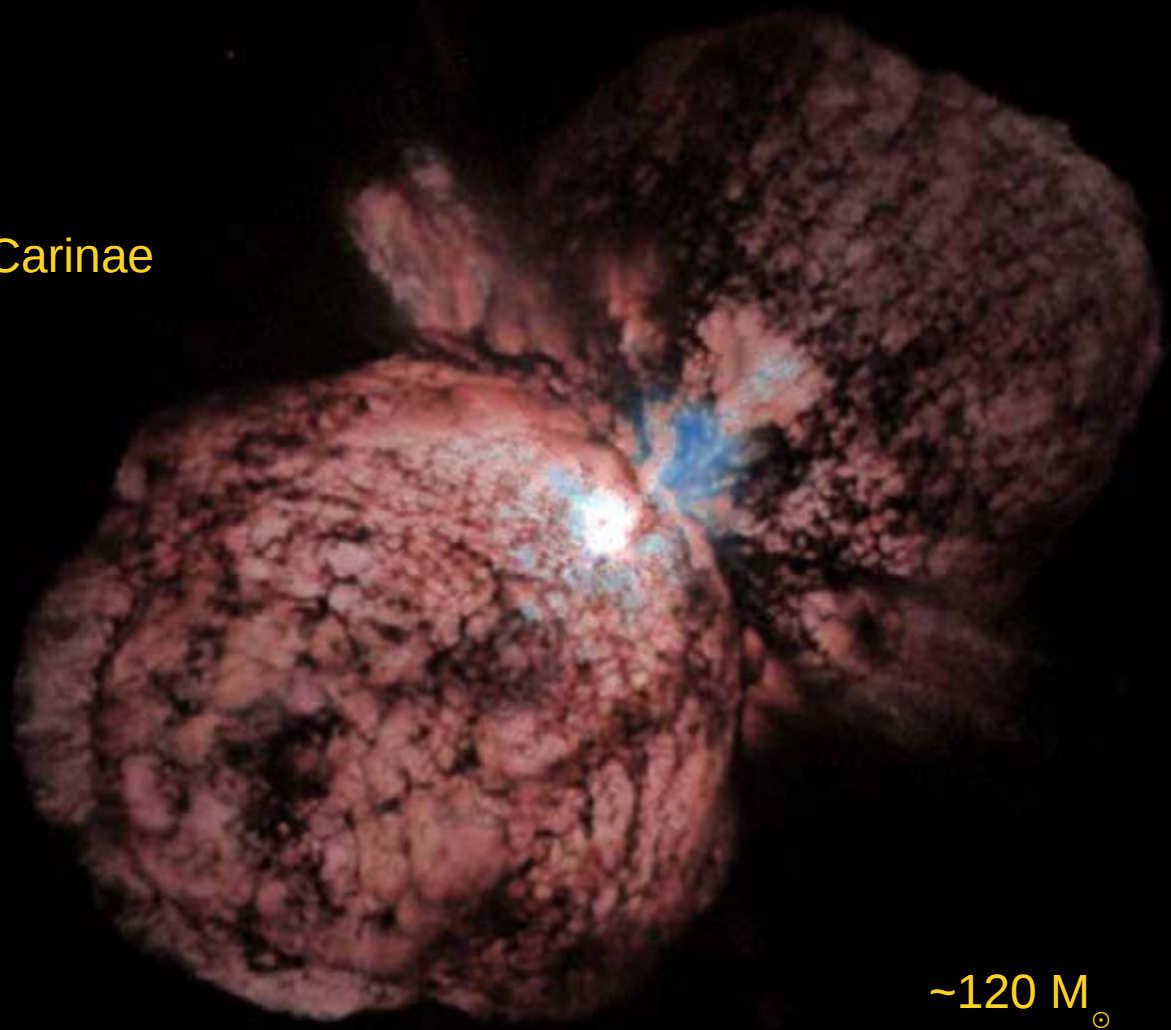
Jowisz

0,00096 $M_\odot$ 318 M_z

Ziemia

0,000003 $M_\odot$ 1 M_z

Gwiazda – górna granica masy



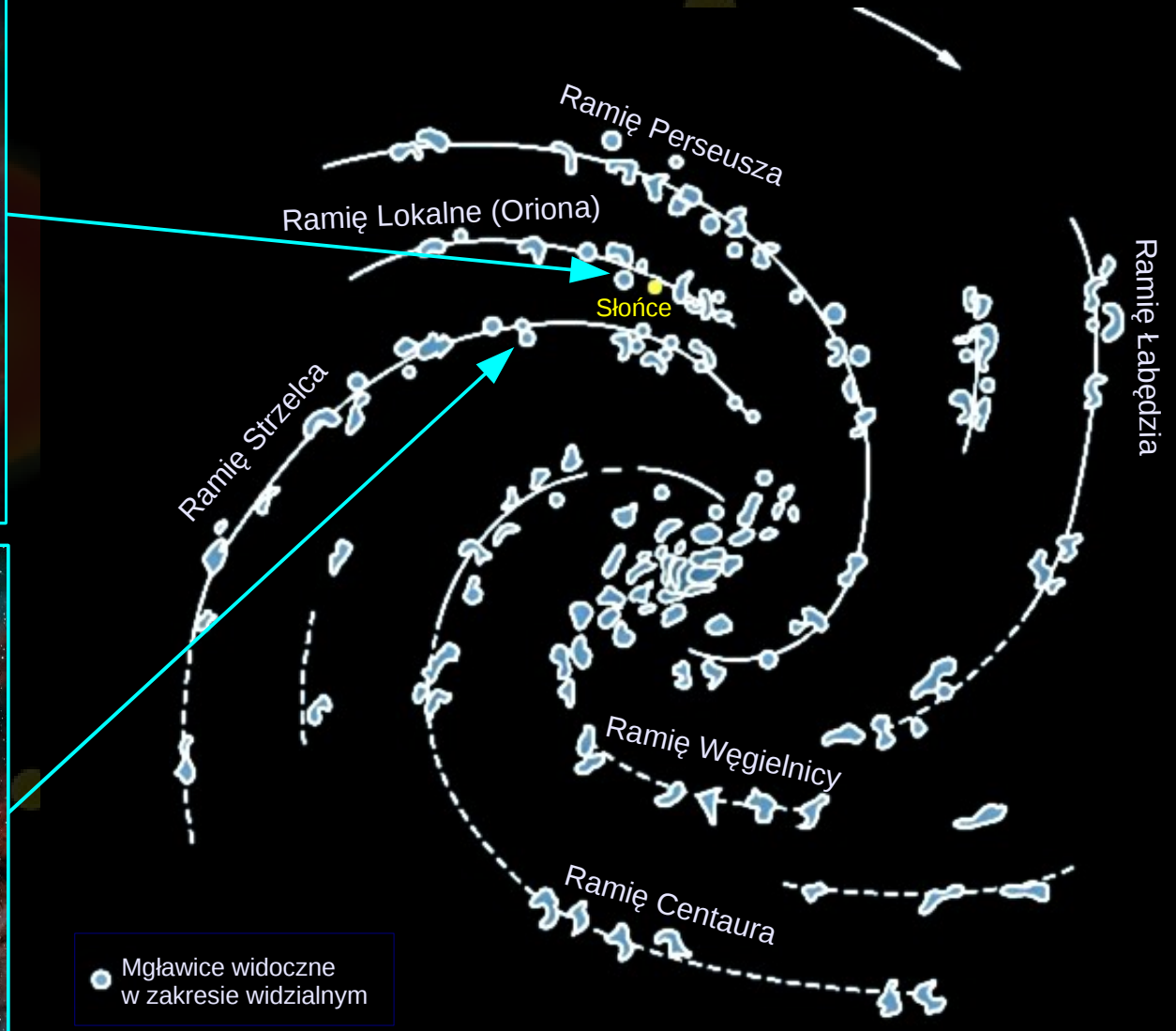
η Carinae

~120 $M_{\odot}$ ~400 000 000 M_{z}

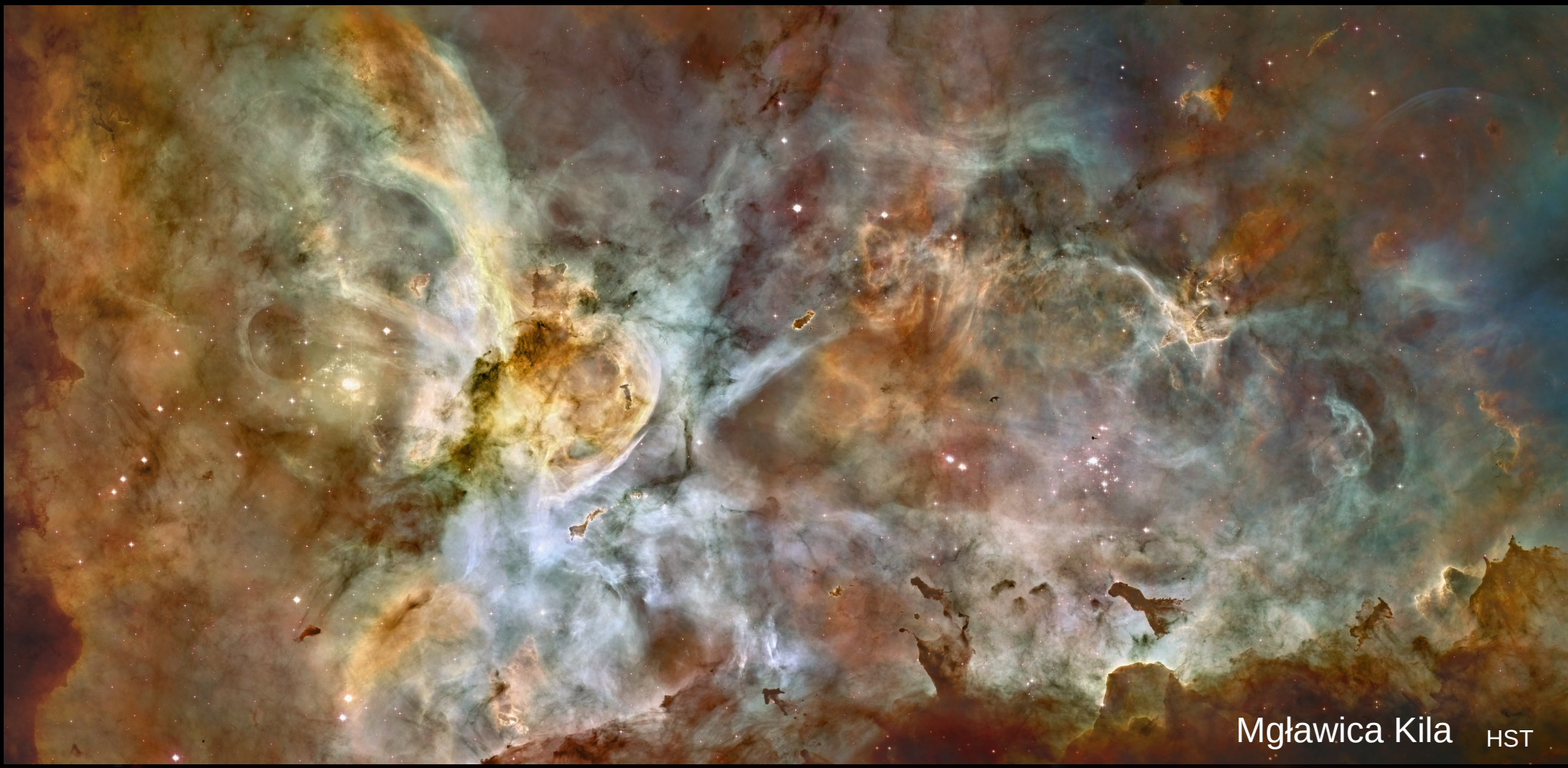
Obłoki molekularne w Drodze Mlecznej

Mgławica w Orionie, HST

Mgławica w Kilu, ESO La Silla



Narodziny gwiazd



Mgławica Oriona

Powstawanie gwiazd

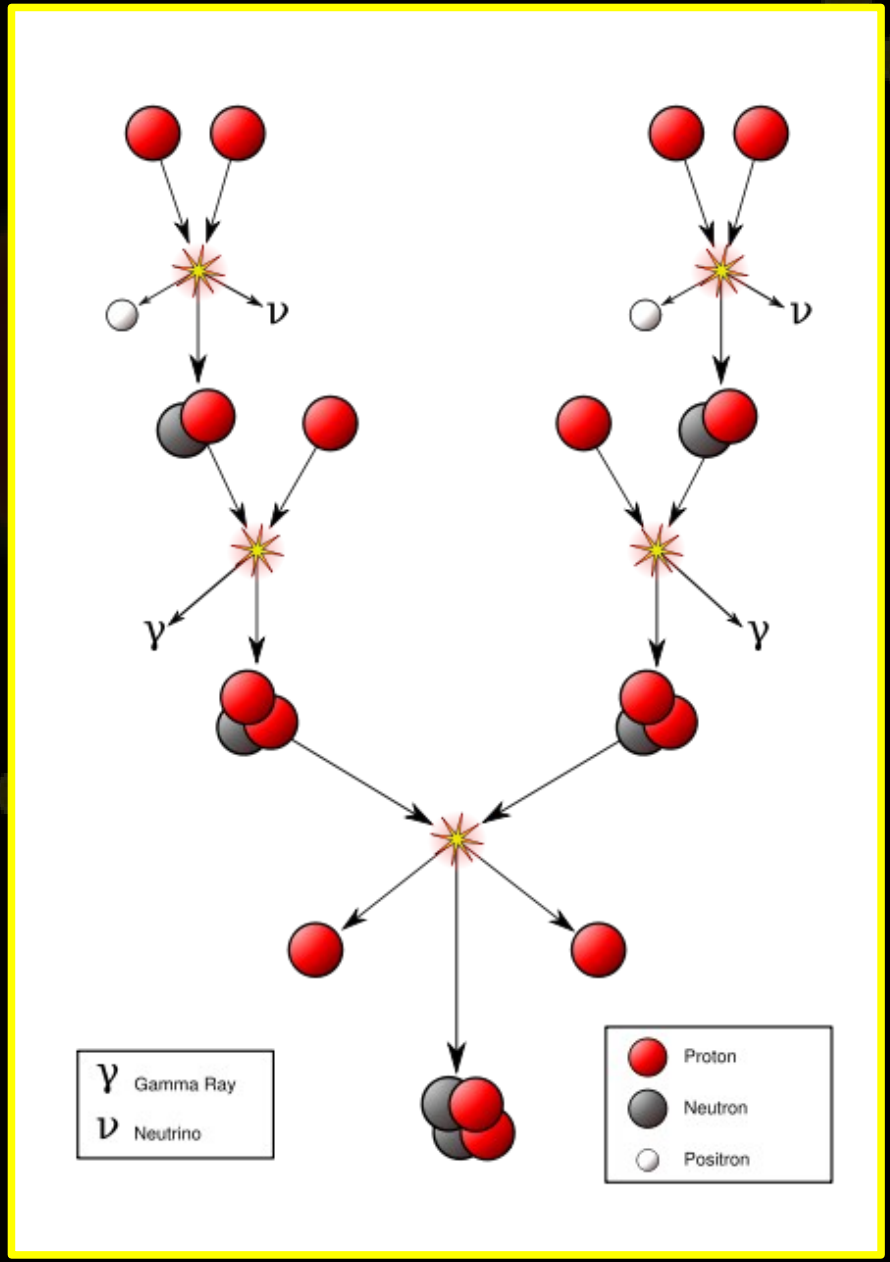
Powstawanie gwiazd

Formowanie się nowej gwiazdy

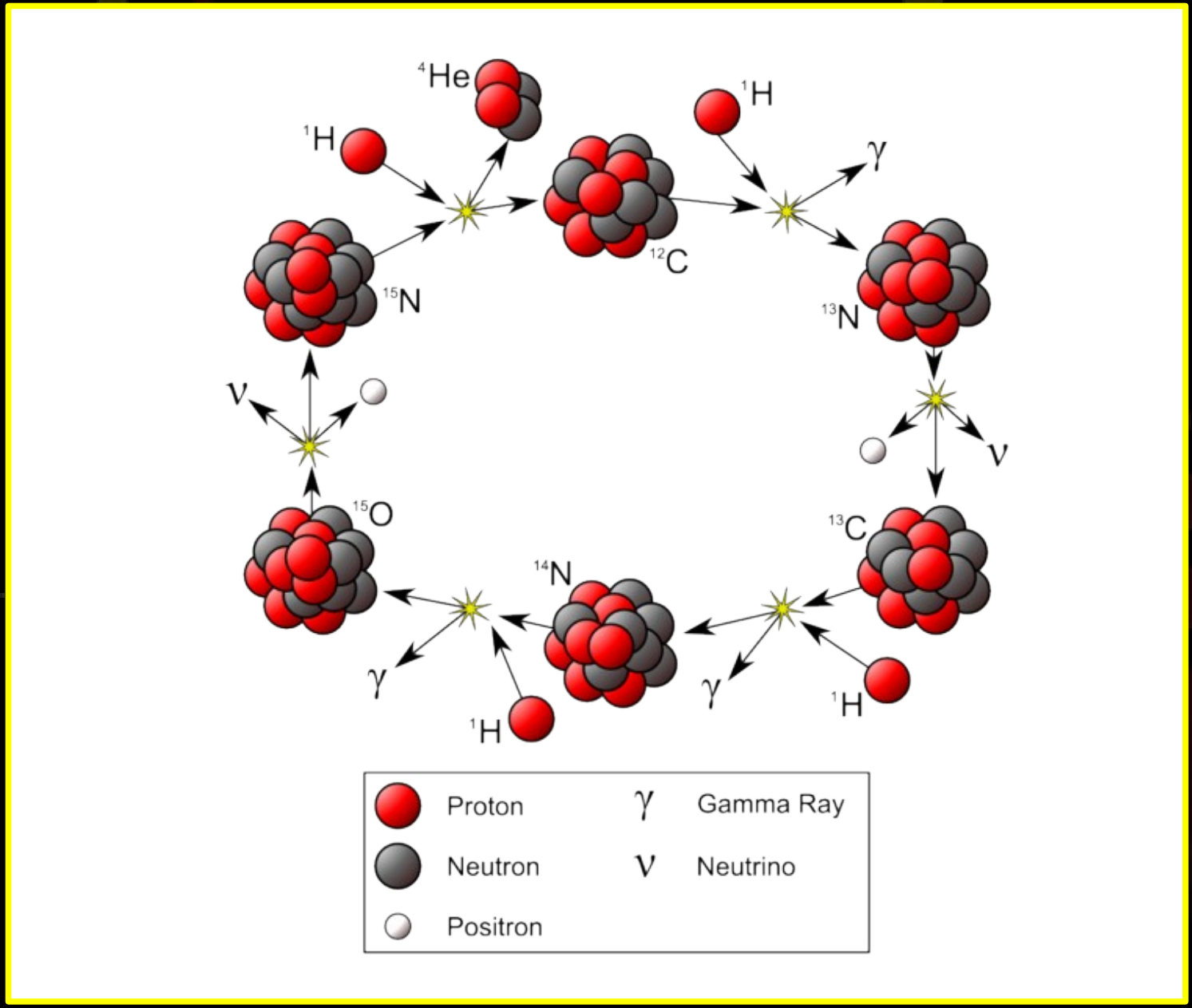
Formowanie się nowej gwiazdy

Reakcje termojądrowe

Cykl p-p

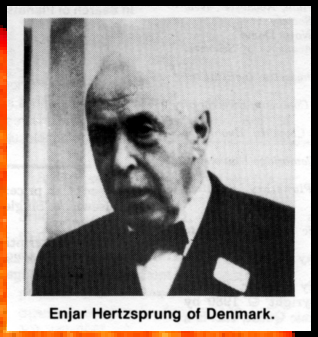


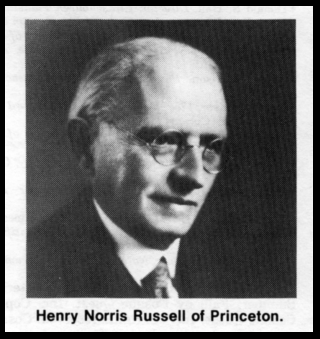
Cykl CNO

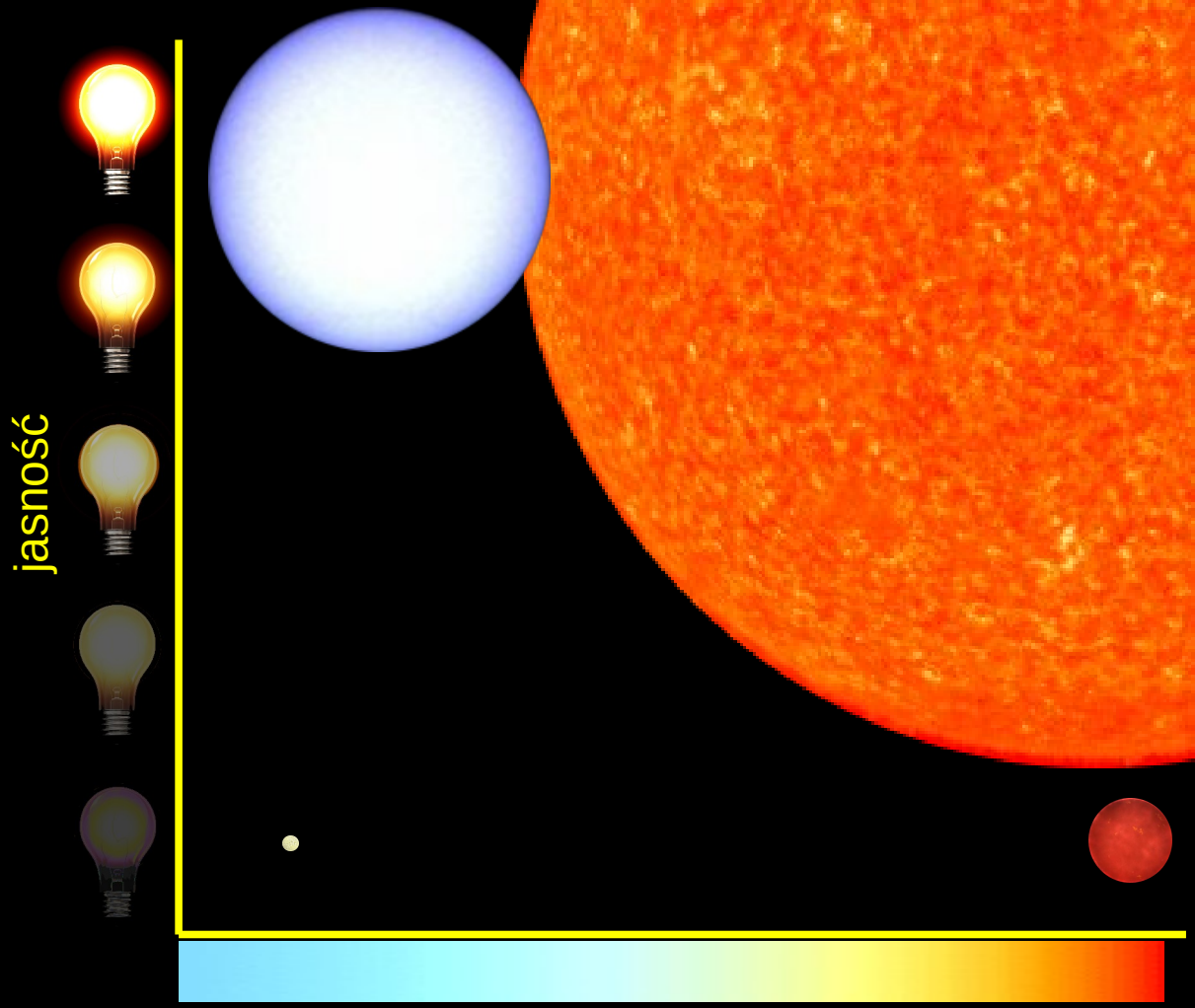

^{4}He
^{1}H
^{12}C
^{1}H
γ
^{15}N
^{13}N
ν
ν
^{15}O
^{13}C
^{14}N
γ
γ
^{1}H
^{1}H
Proton
Neutron
Positron
γ
Gamma Ray
ν
Neutrino

Plejady

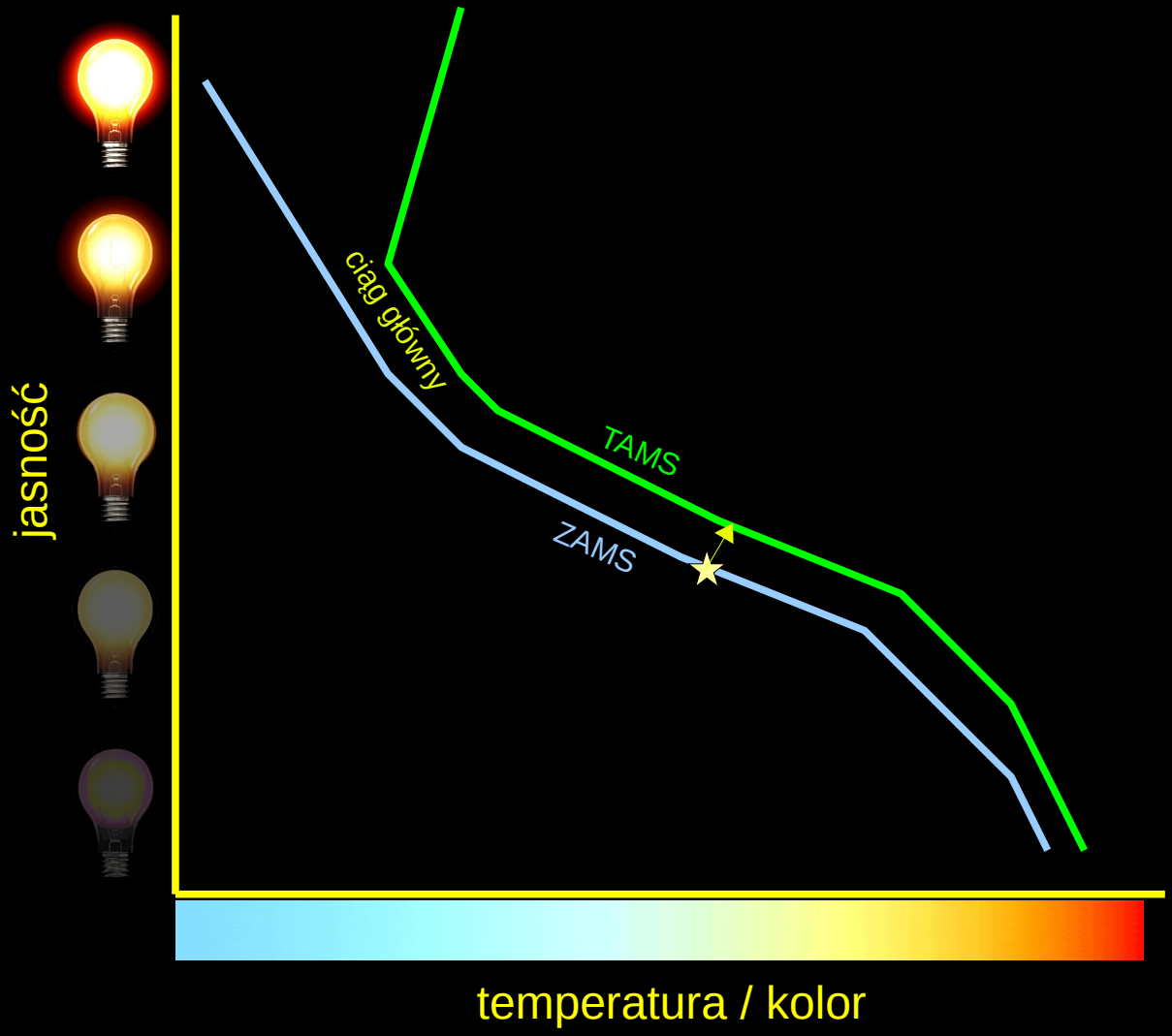
Wykres Hertzsprungla-Rassella


Enjar Hertzsprung of Denmark.

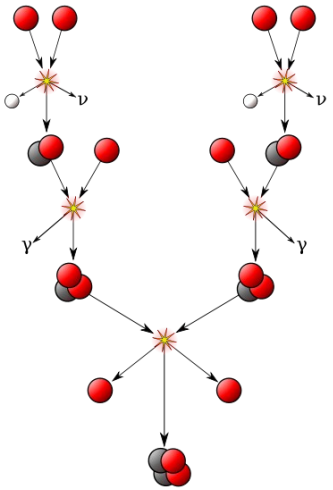

Henry Norris Russell of Princeton.



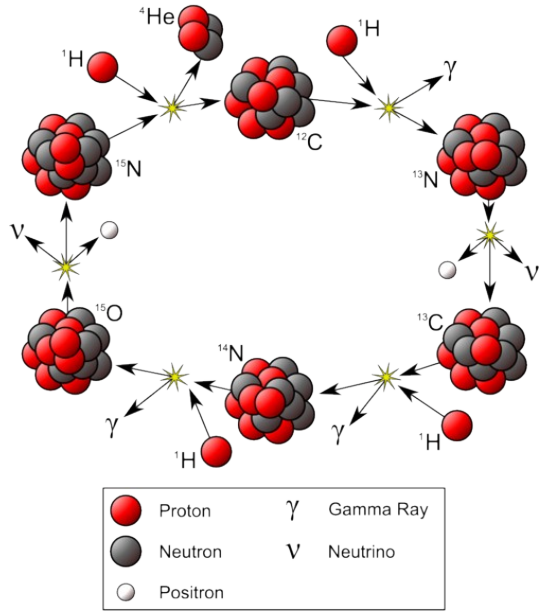
Ciąg główny



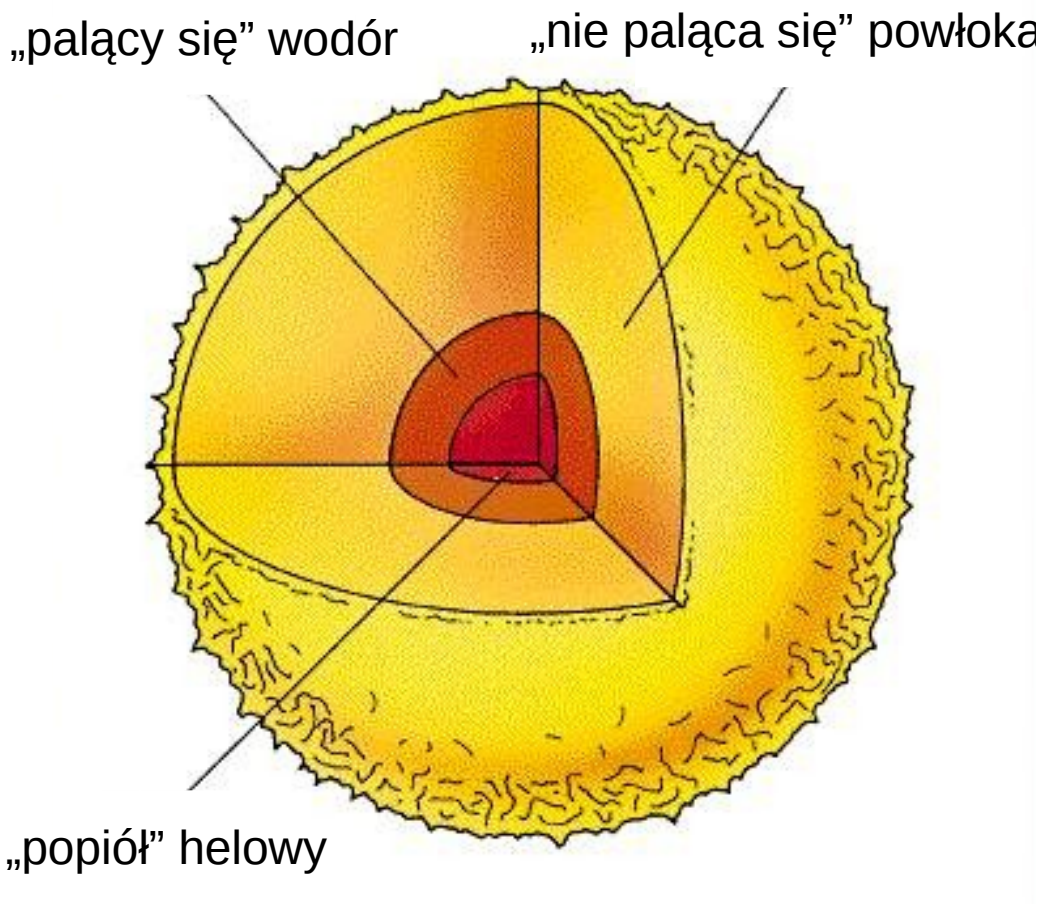
Cykl p-p



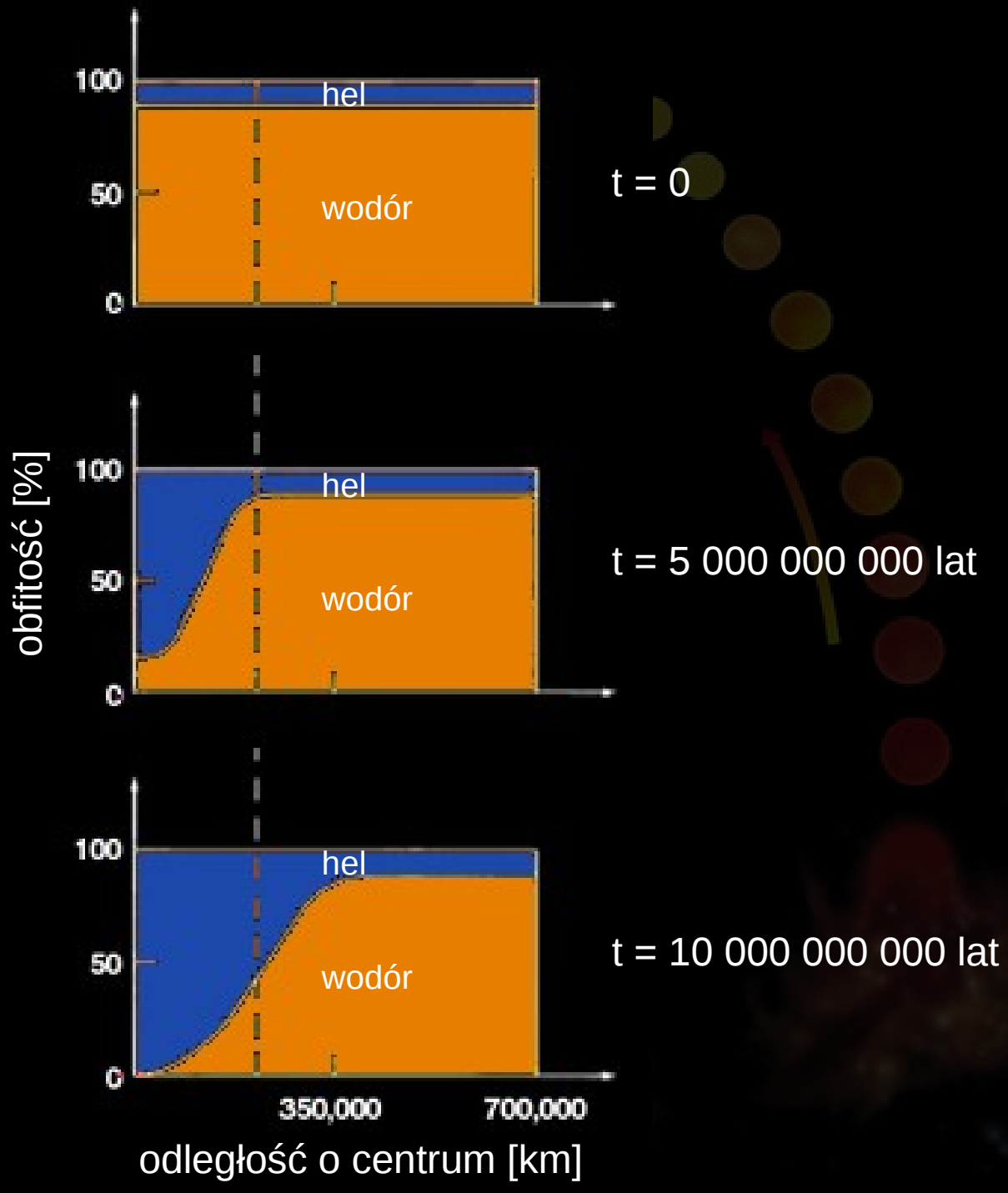
Cykl CNO



Ewolucja mało masywnych gwiazd

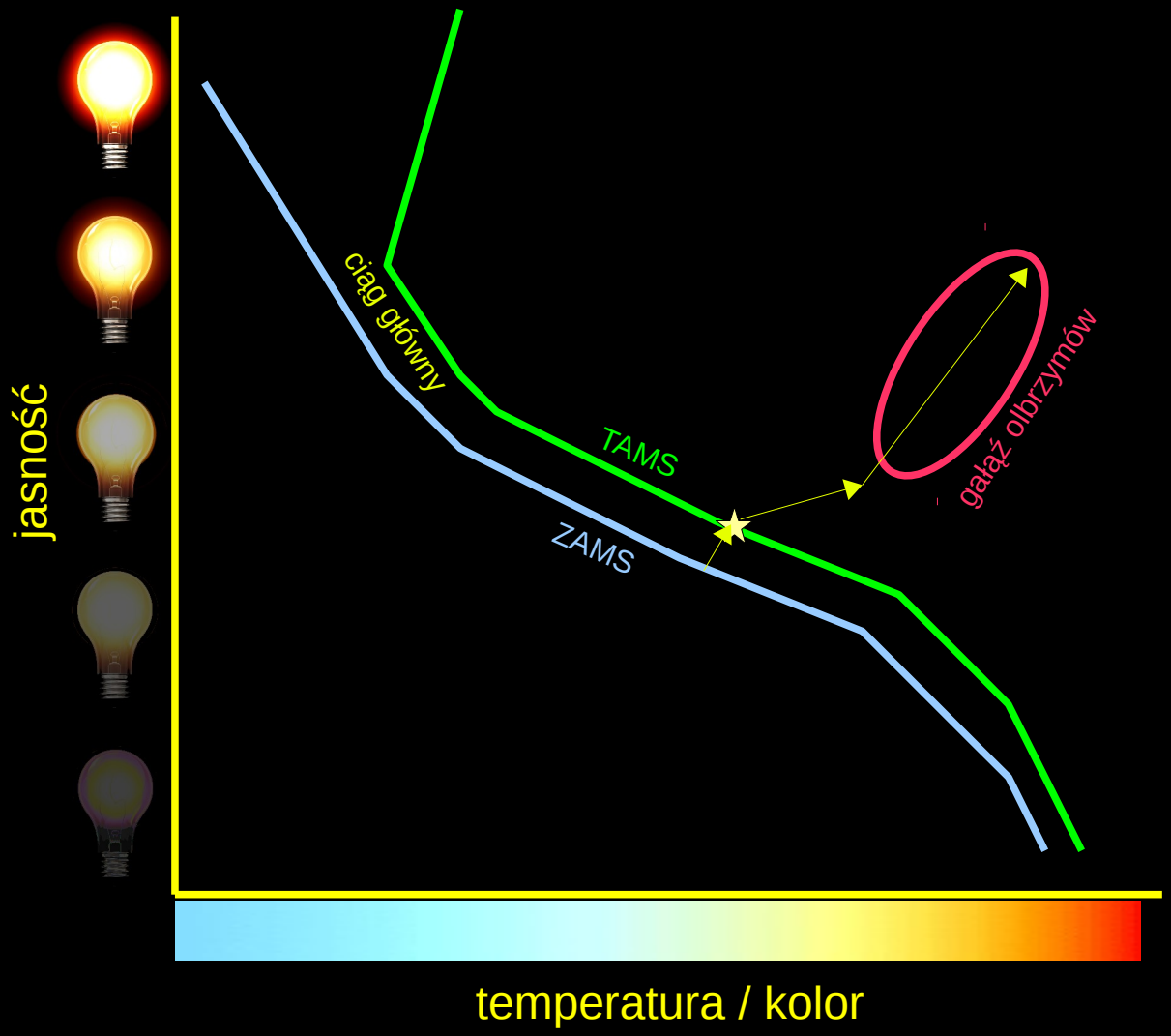


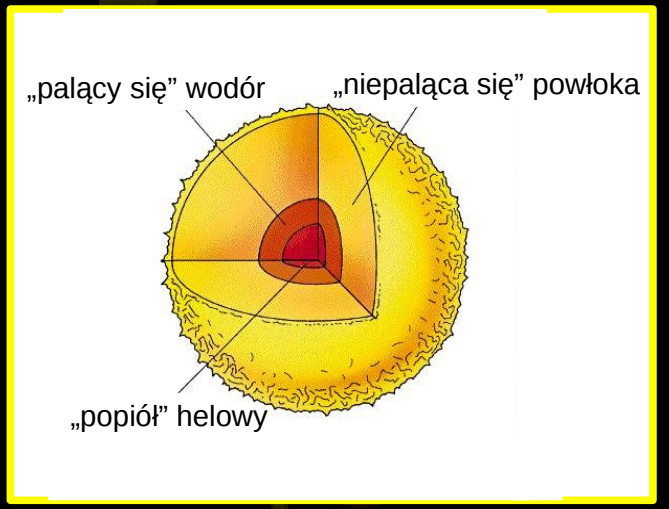
Ewolucja mało masywnych gwiazd



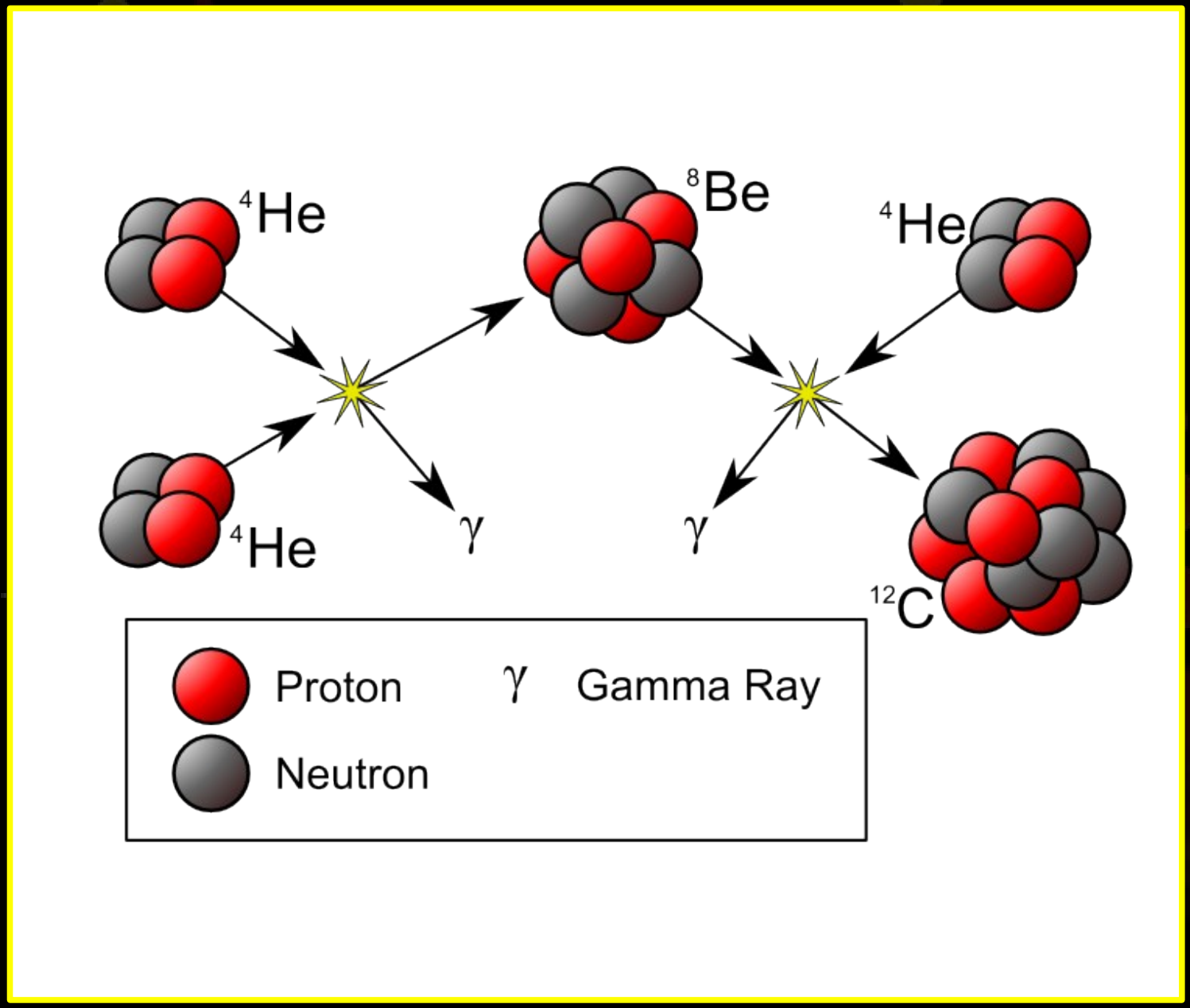
Słońce jako czerwony olbrzym

Olbrzymy

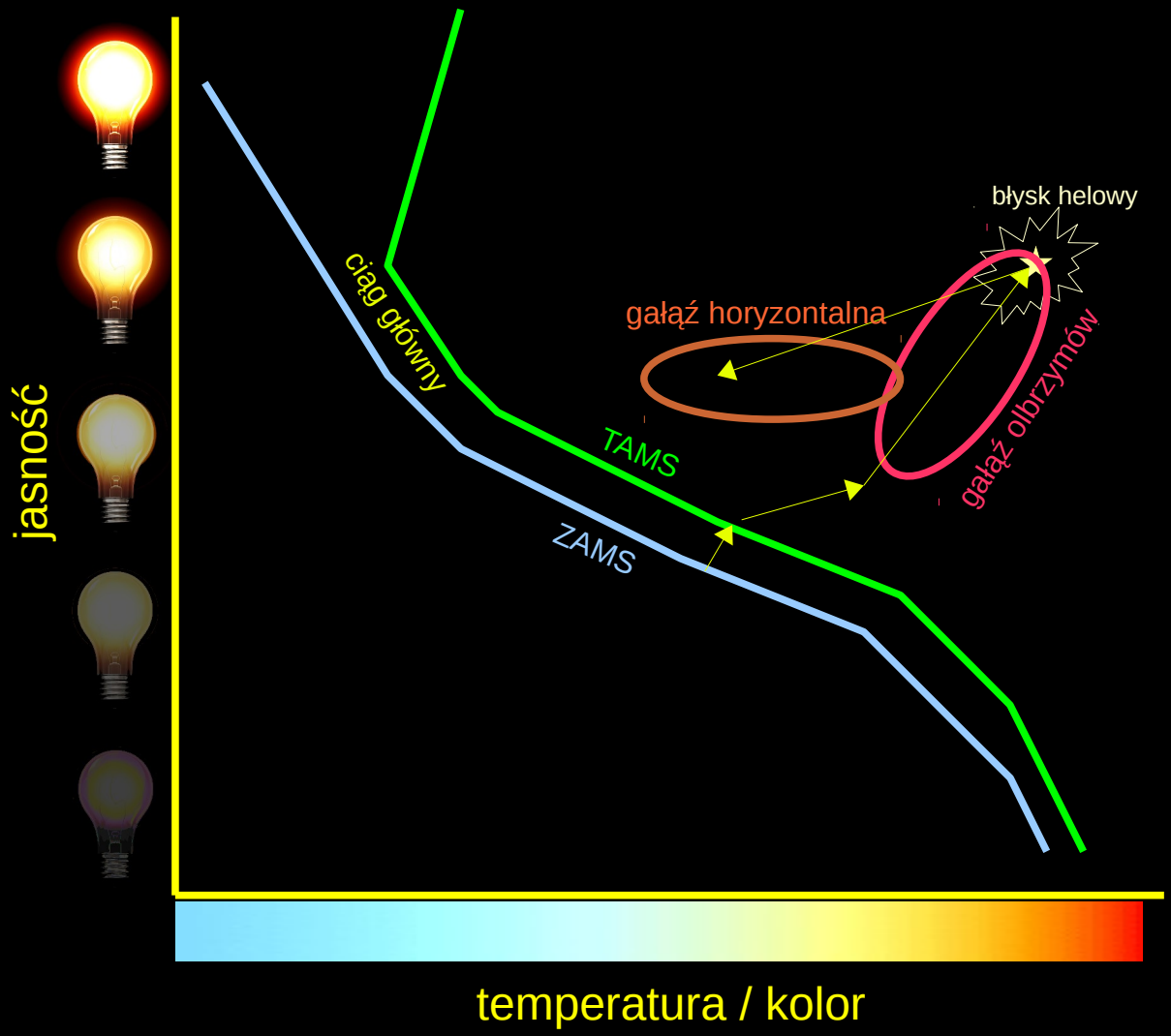

jasność
ciąg główny
TAMS
ZAMS
gałąź olbrzymów
temperatura / kolor

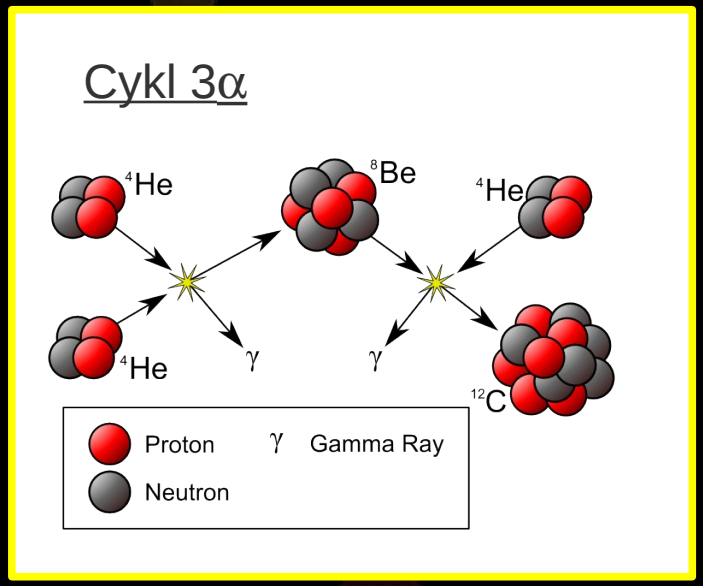

„palący się” wodór
„niepaląca się” powłoka
„popiół” helowy

Cykl 3α

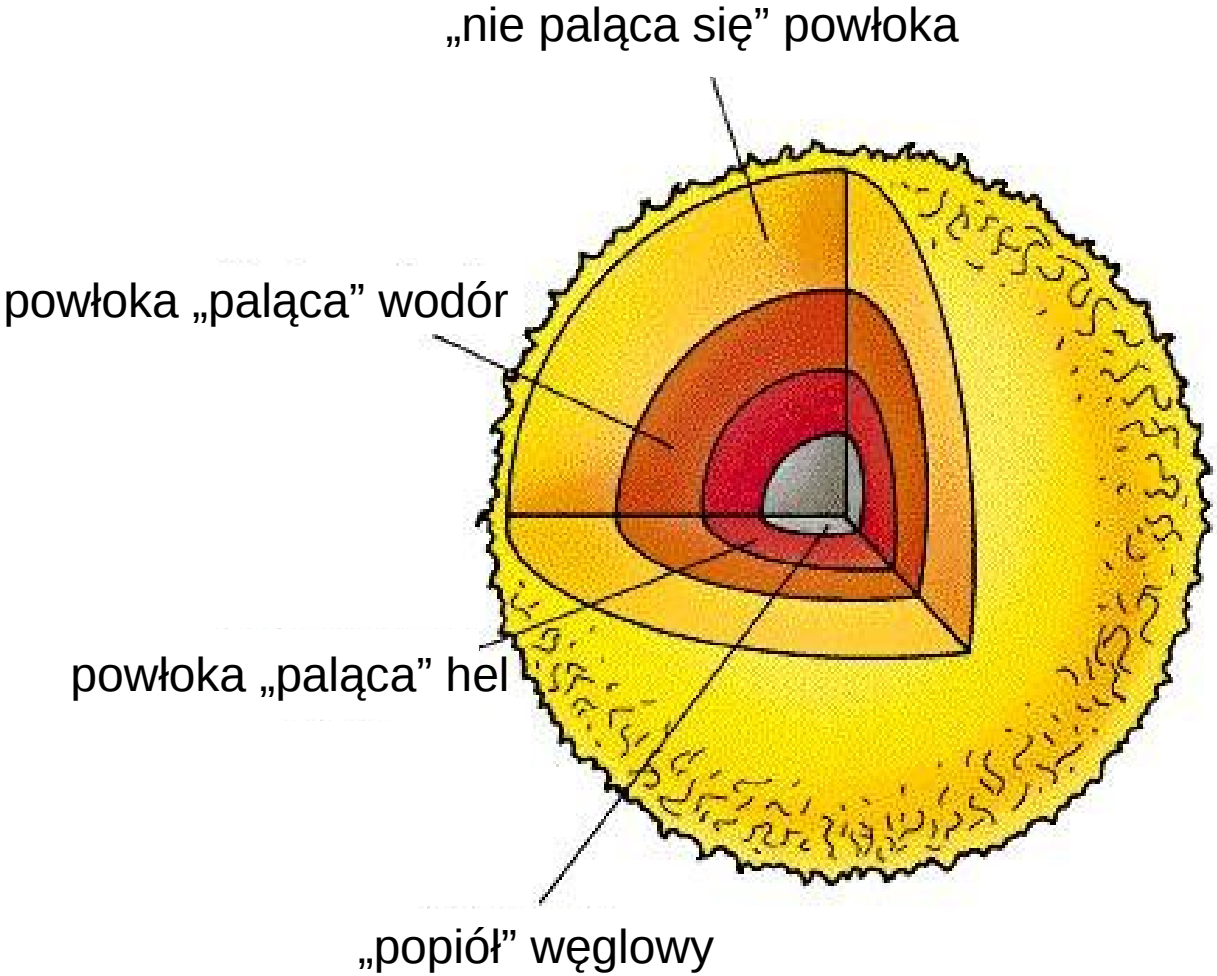


Słońce jako czerwony olbrzym

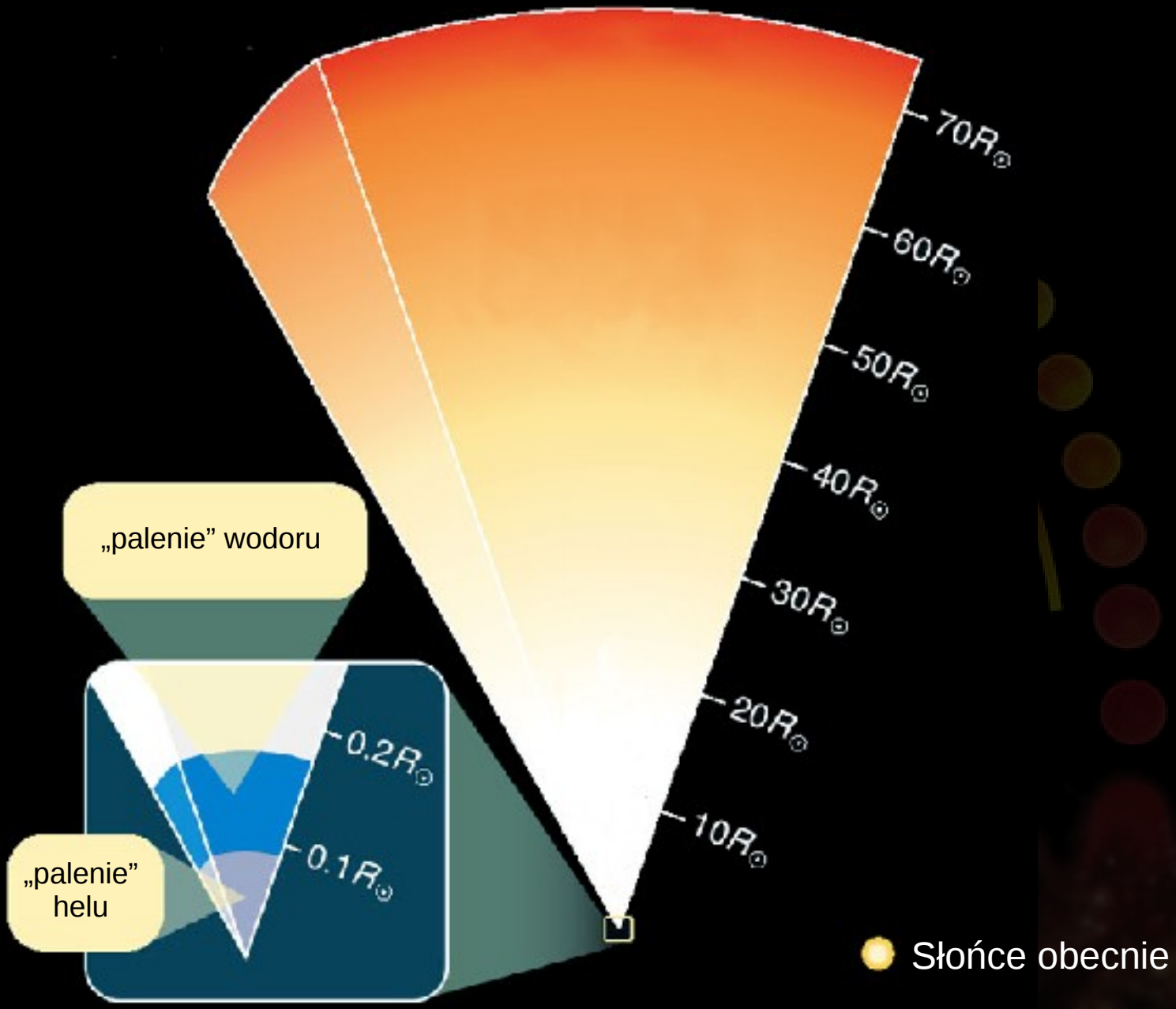




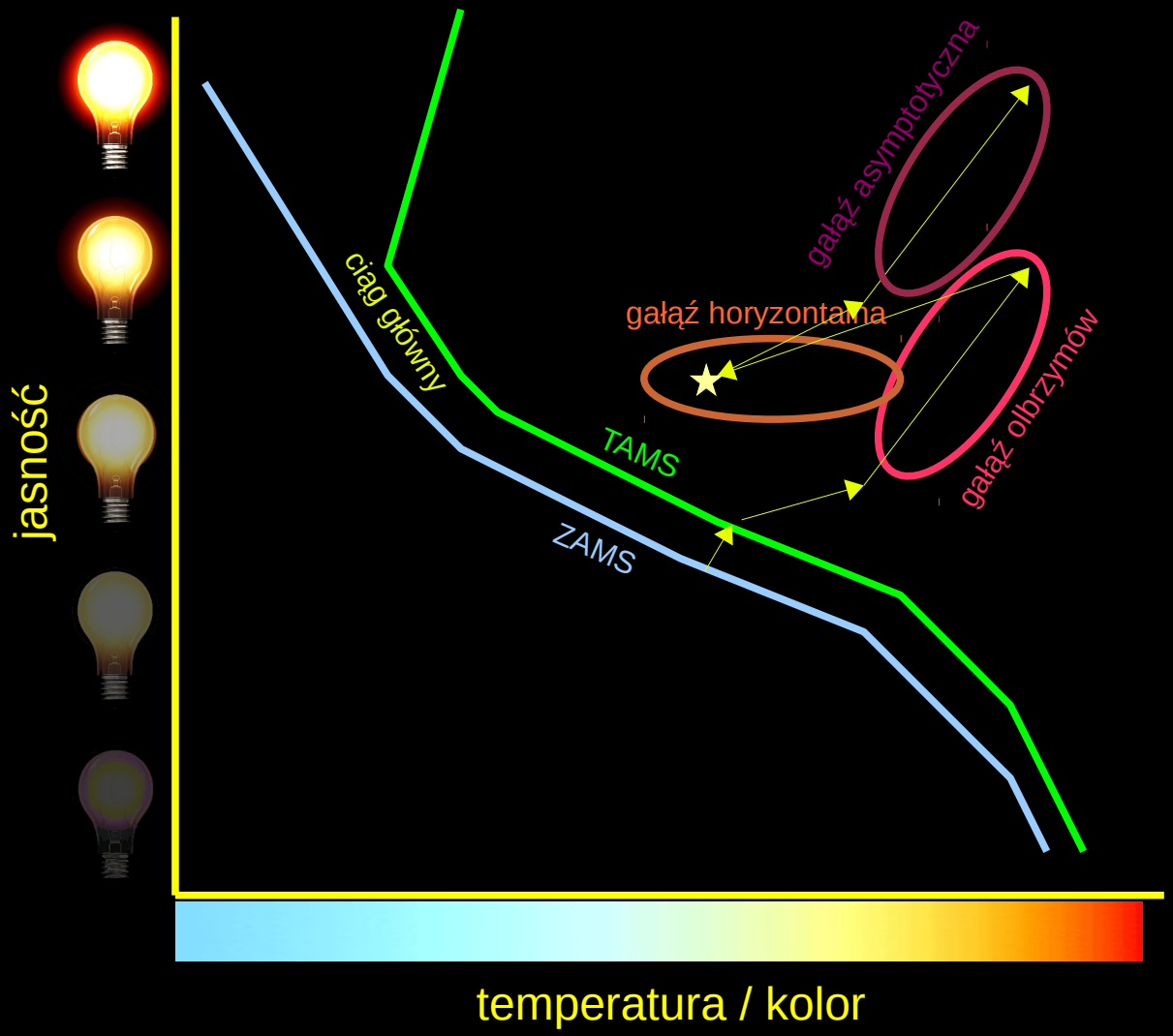
Powrót do olbrzymów

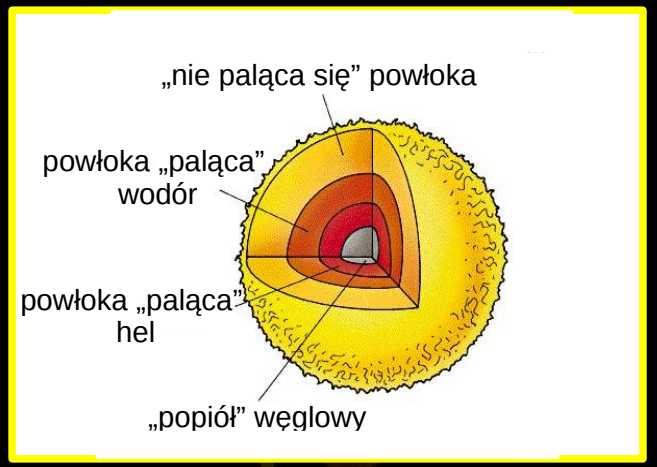


Powrót do olbrzymów

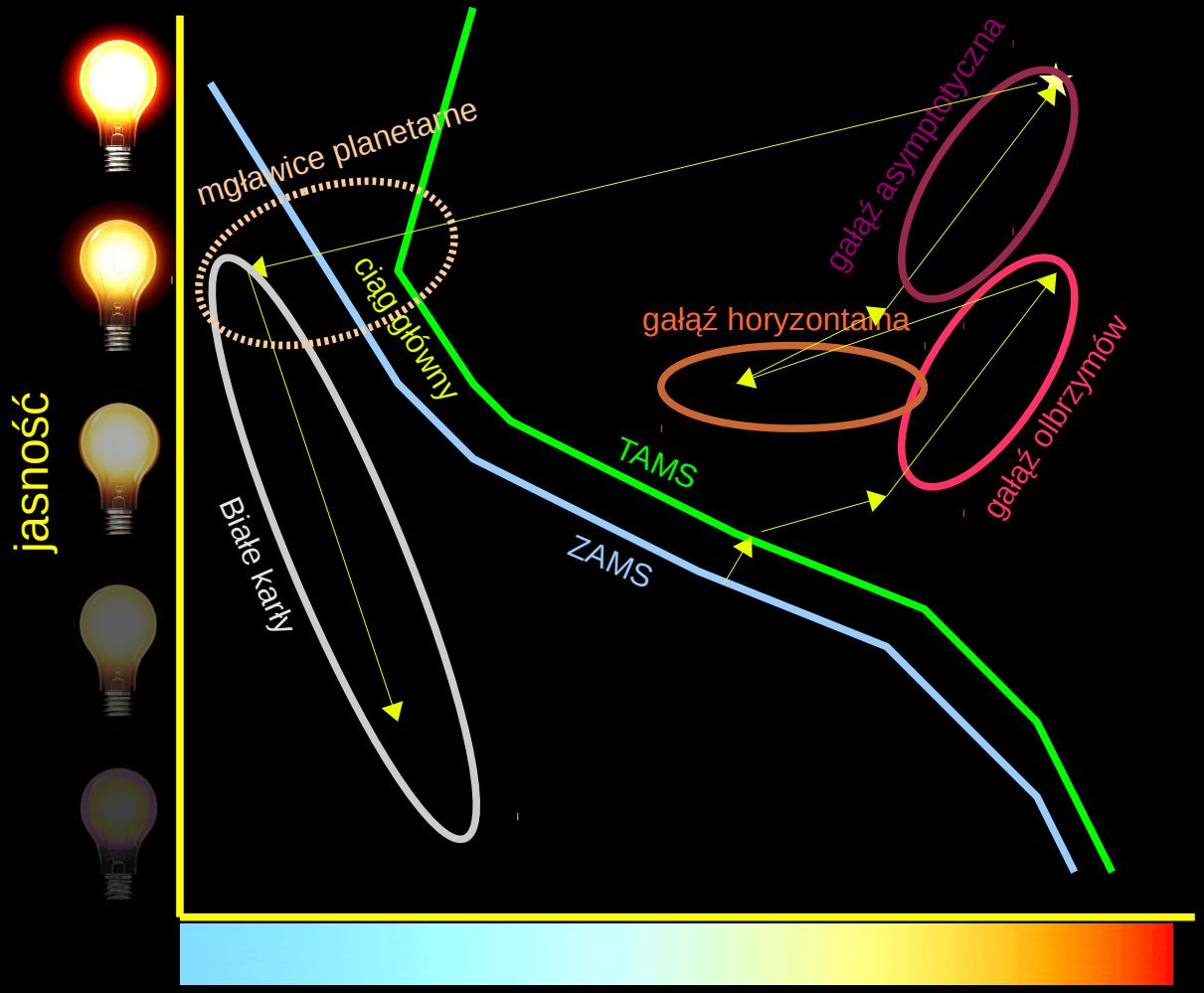


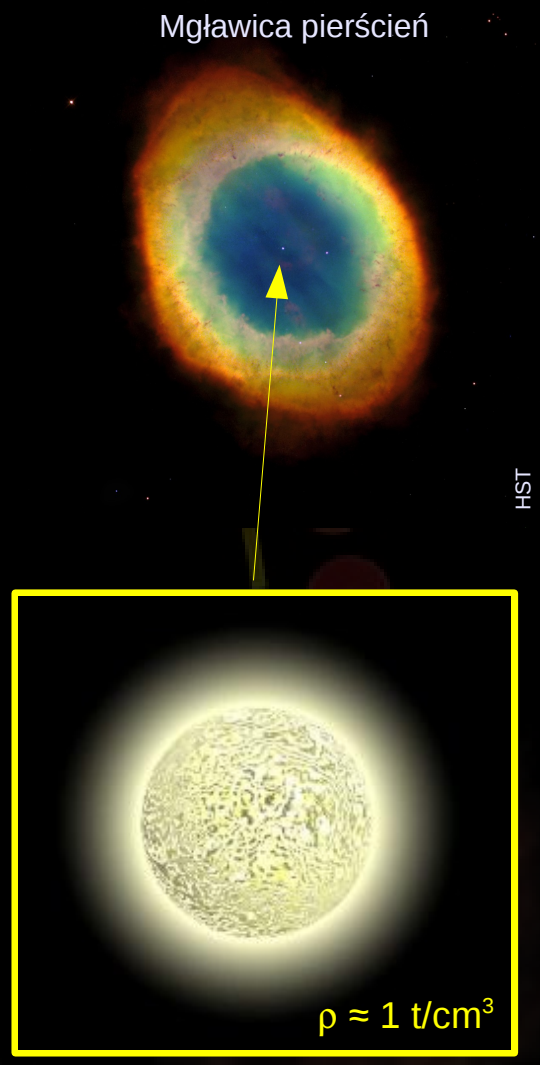
Powrót do olbrzymów





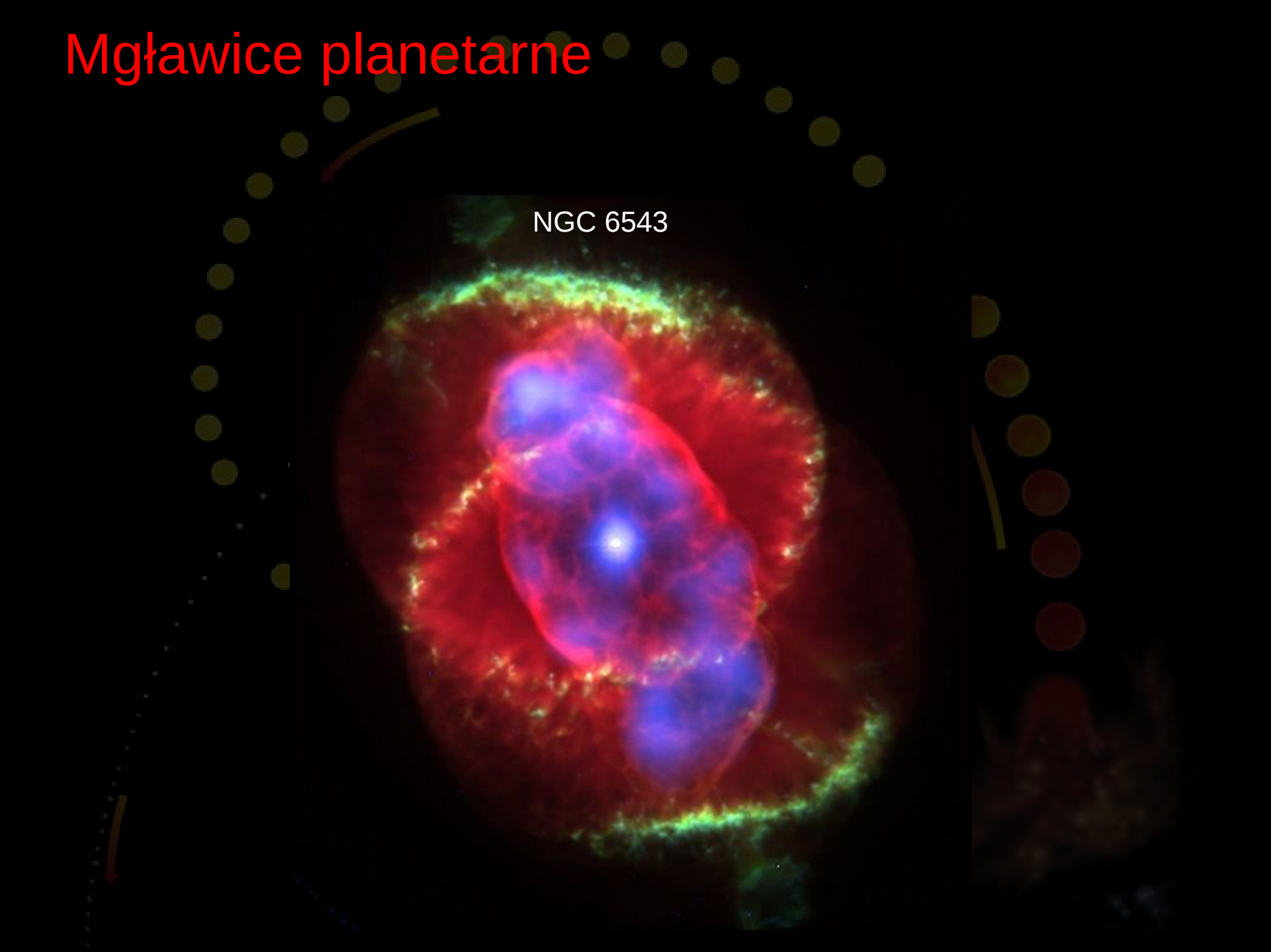
Mgławice planetarne i białe karły



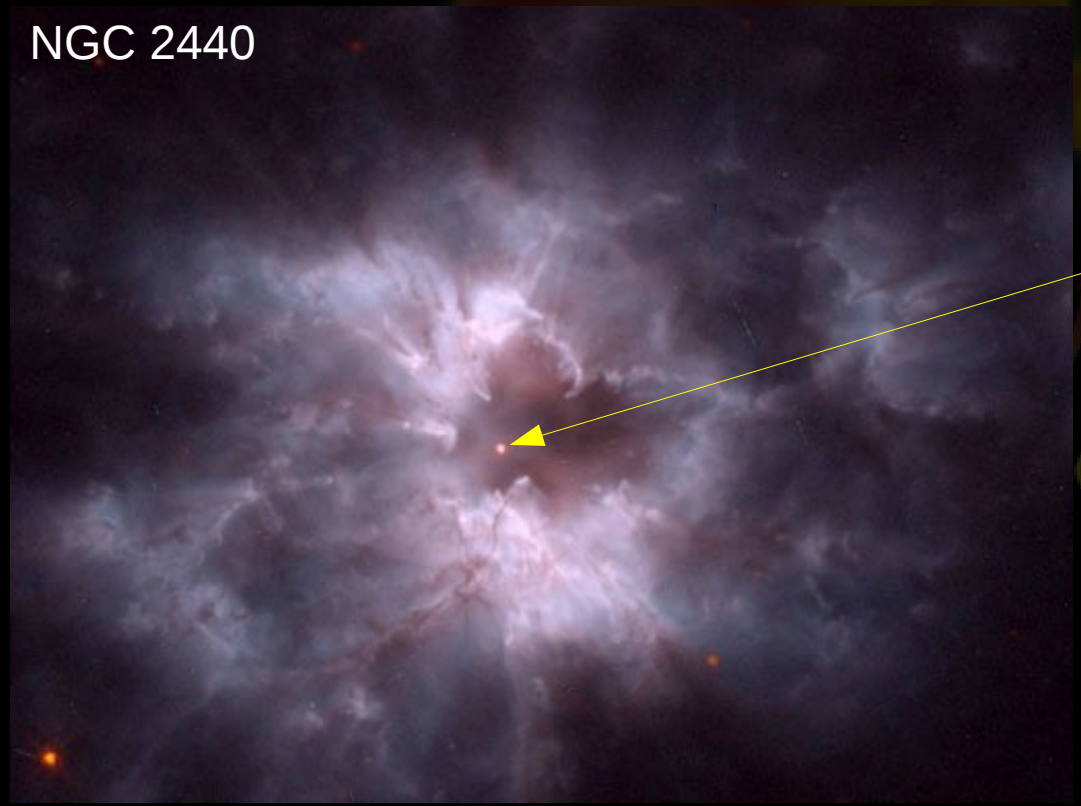


Mgławice planetarne

Mgławice planetarne

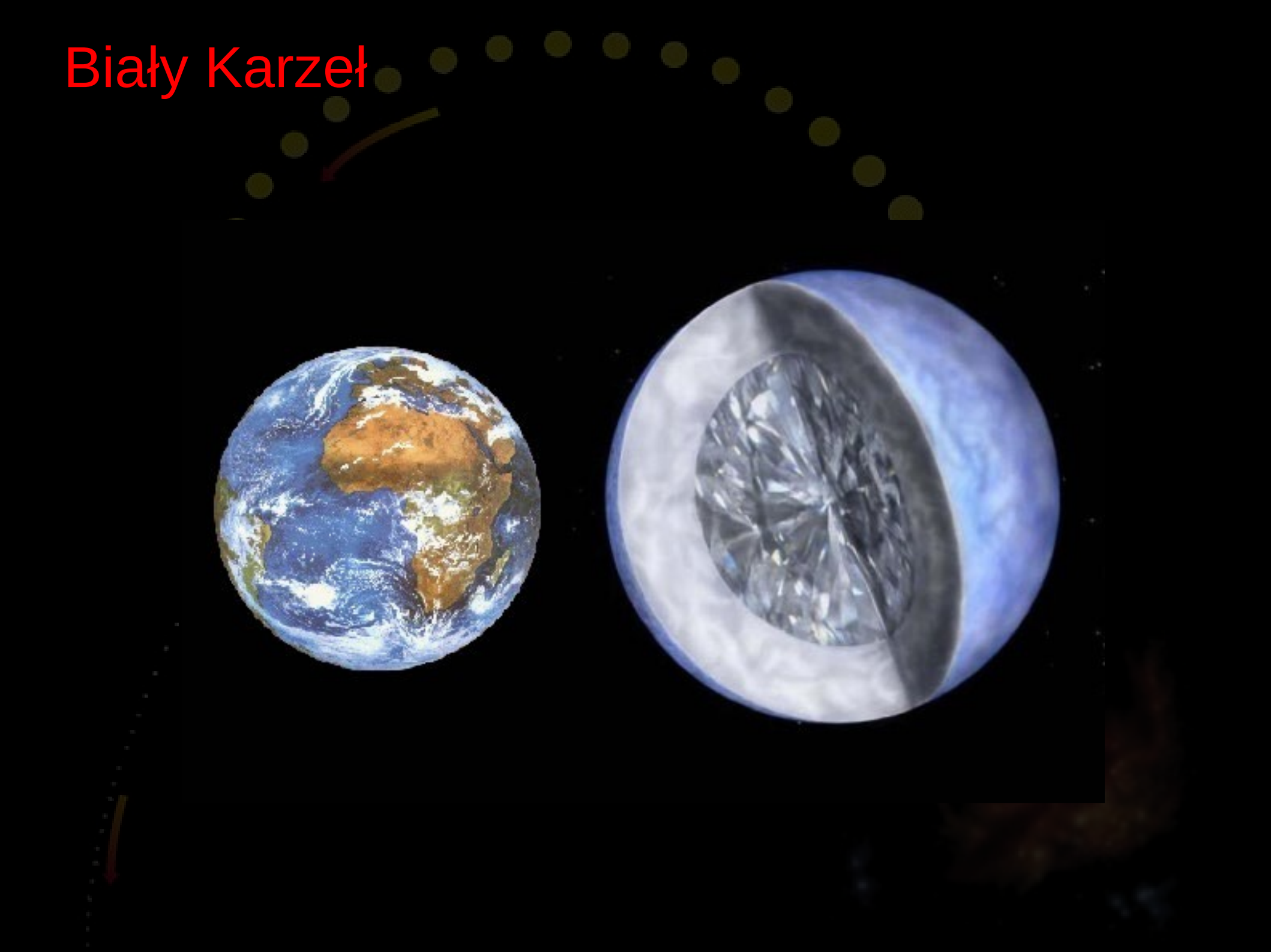


Białe Karły

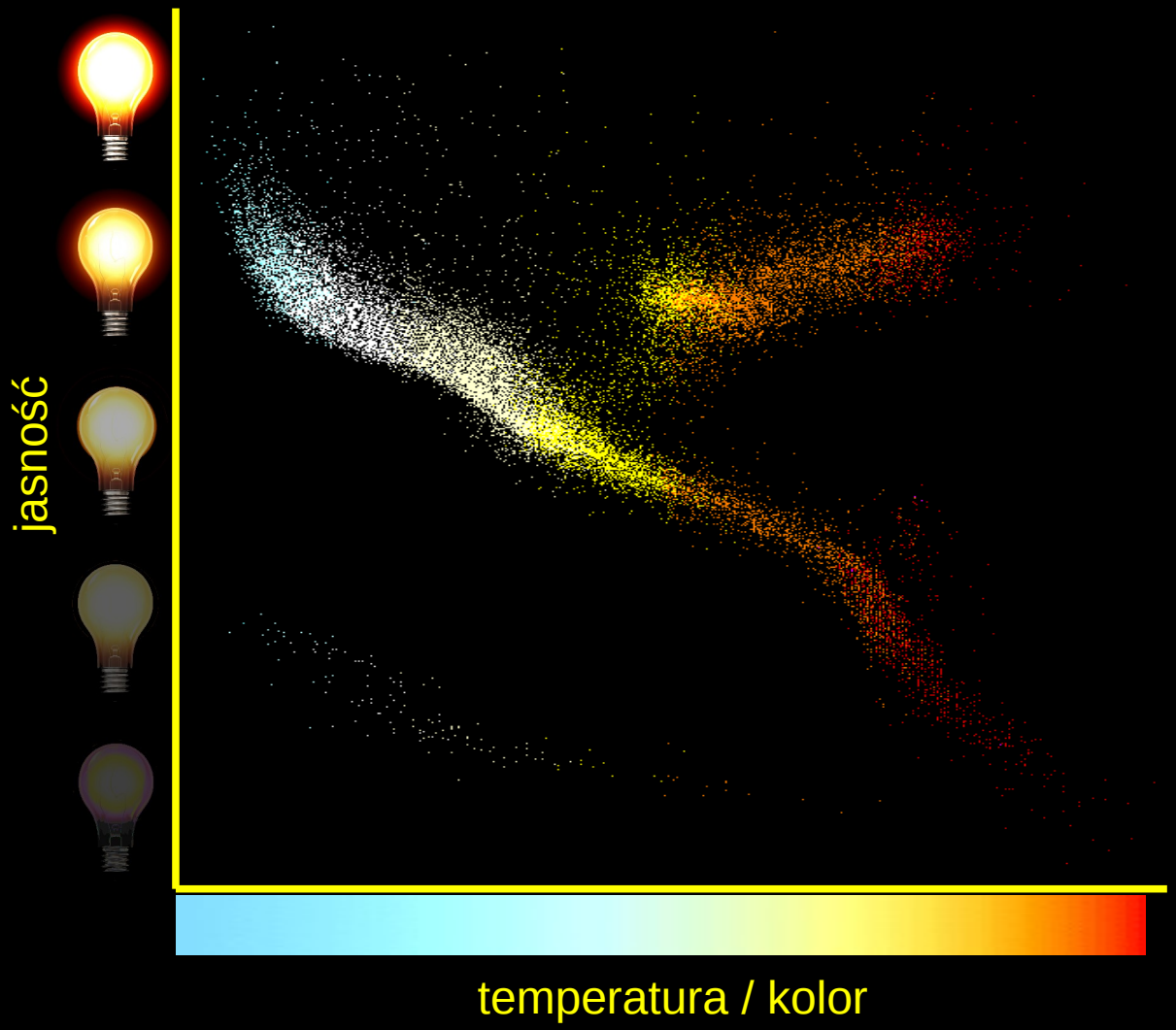


$\rho \approx 1\ t/cm^3$

Biały Karzeł



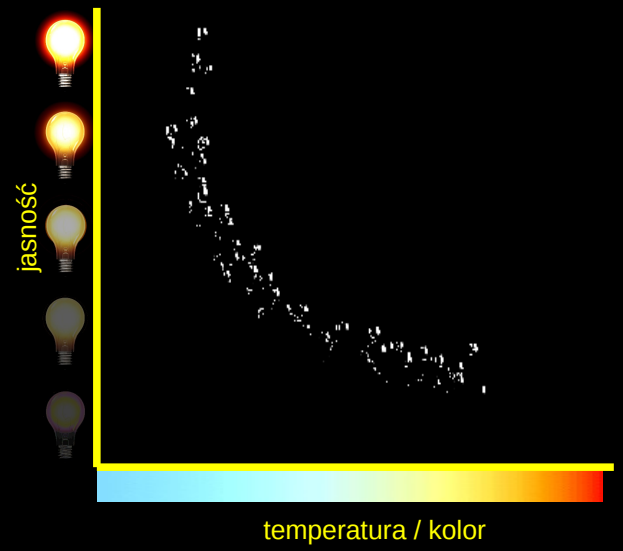
Wykres H-R dla Galaktyki



Wykresy H-R dla gromad gwiazd

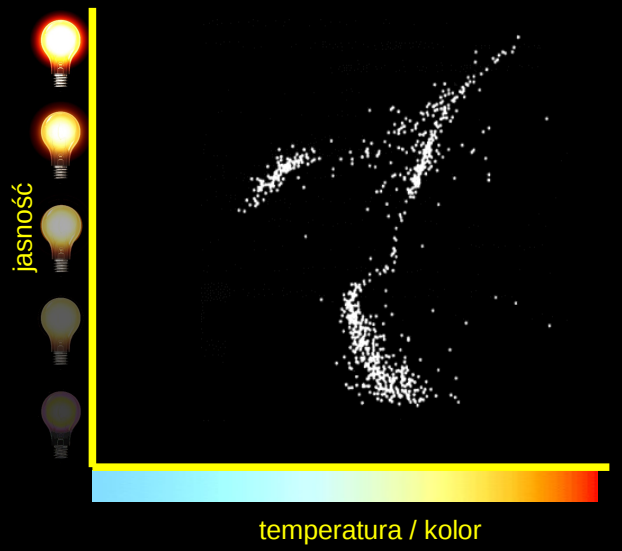
Gromada otwarta χ Persei

wiek gromady ~ 11 mln. lat

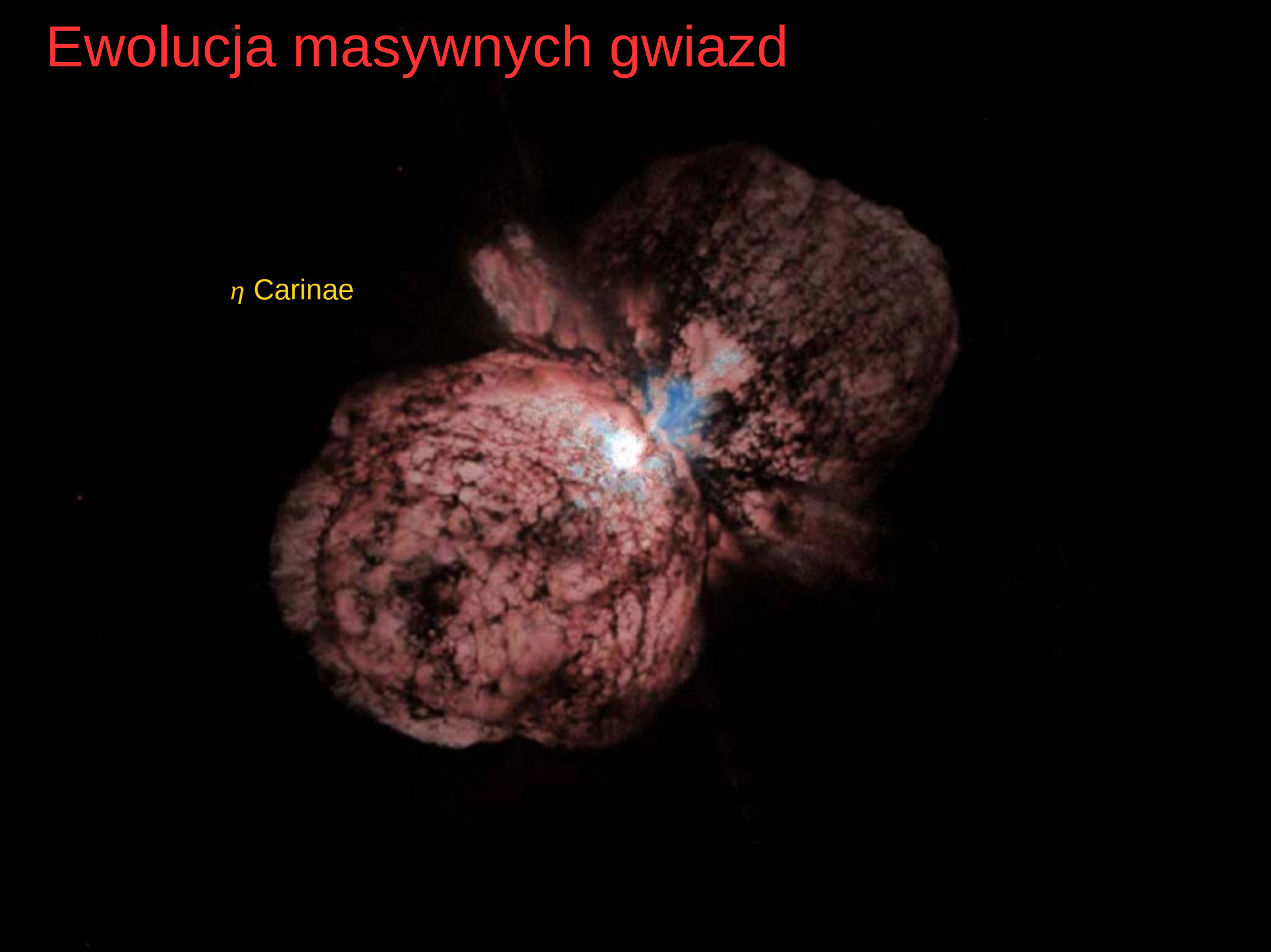


Gromada kulista M13

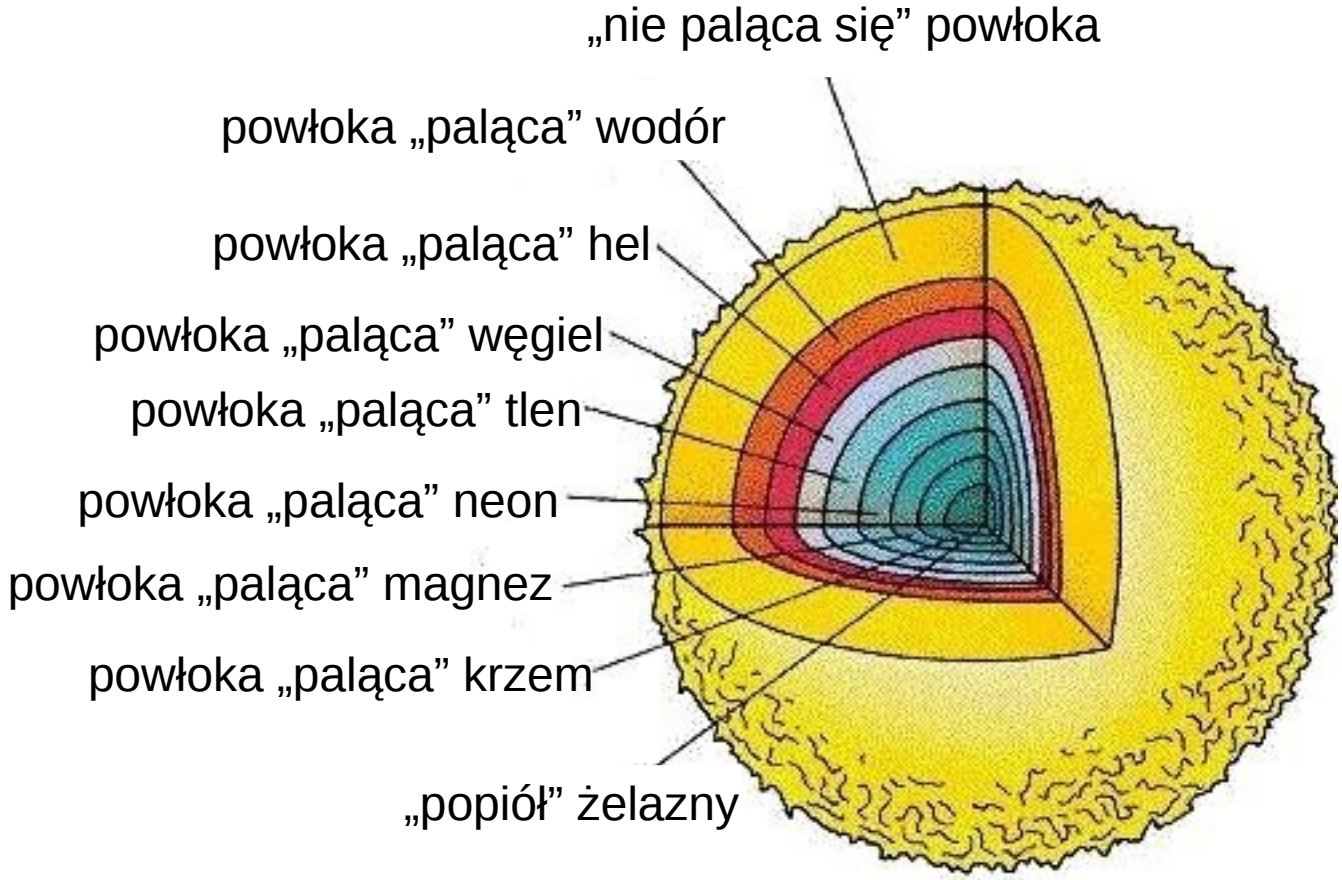
wiek gromady ~ 11,7 mld. lat



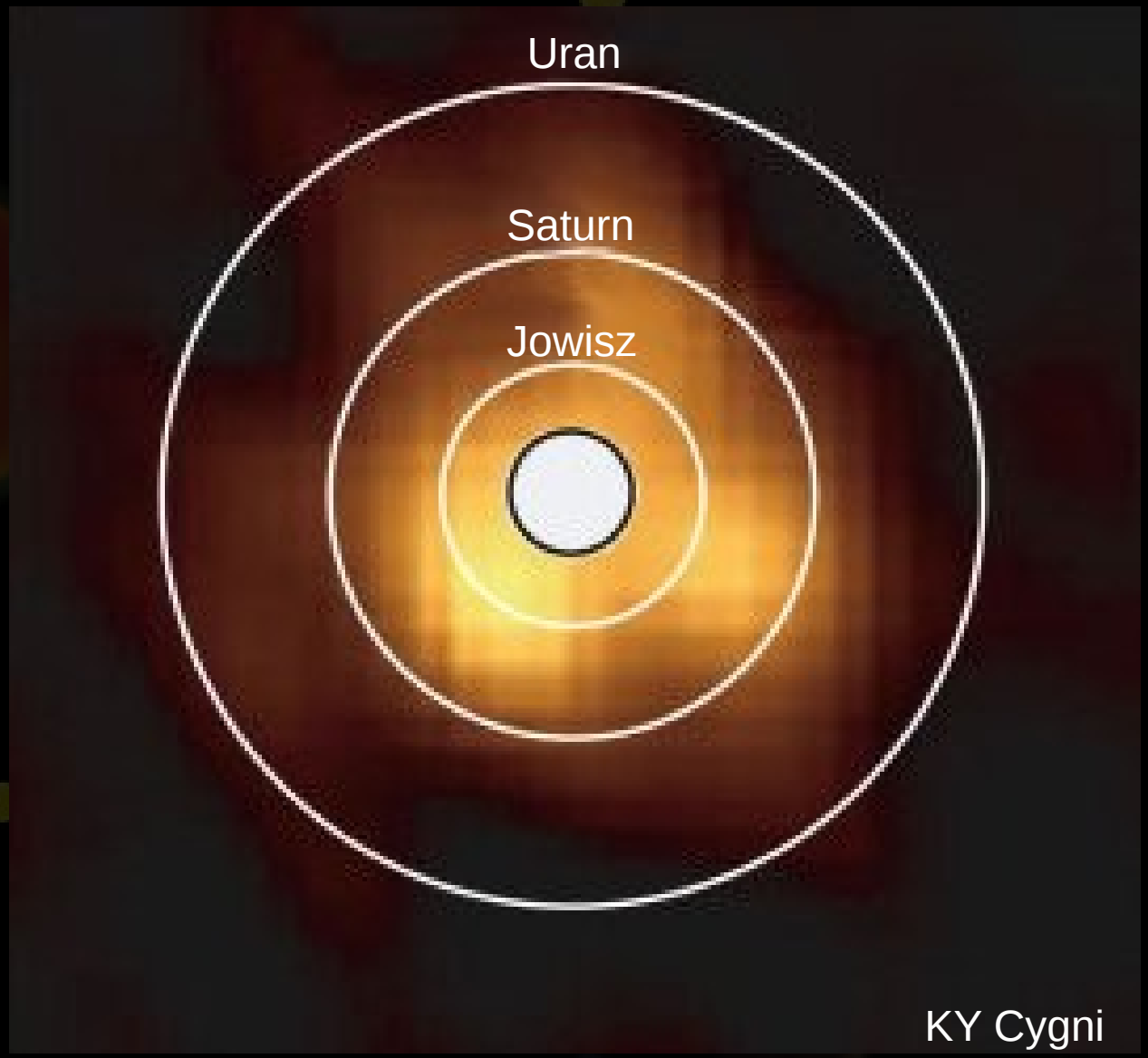
Ewolucja masywnych gwiazd



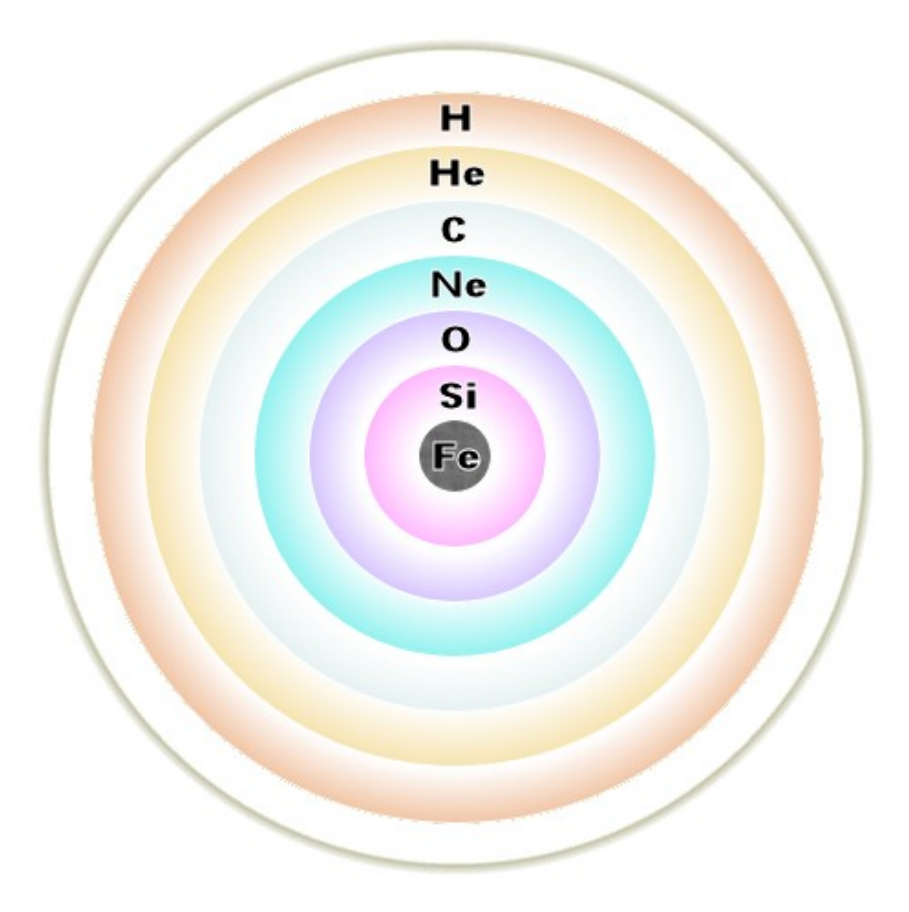
Ewolucja masywnych gwiazd



Czerwone nadolbrzymy

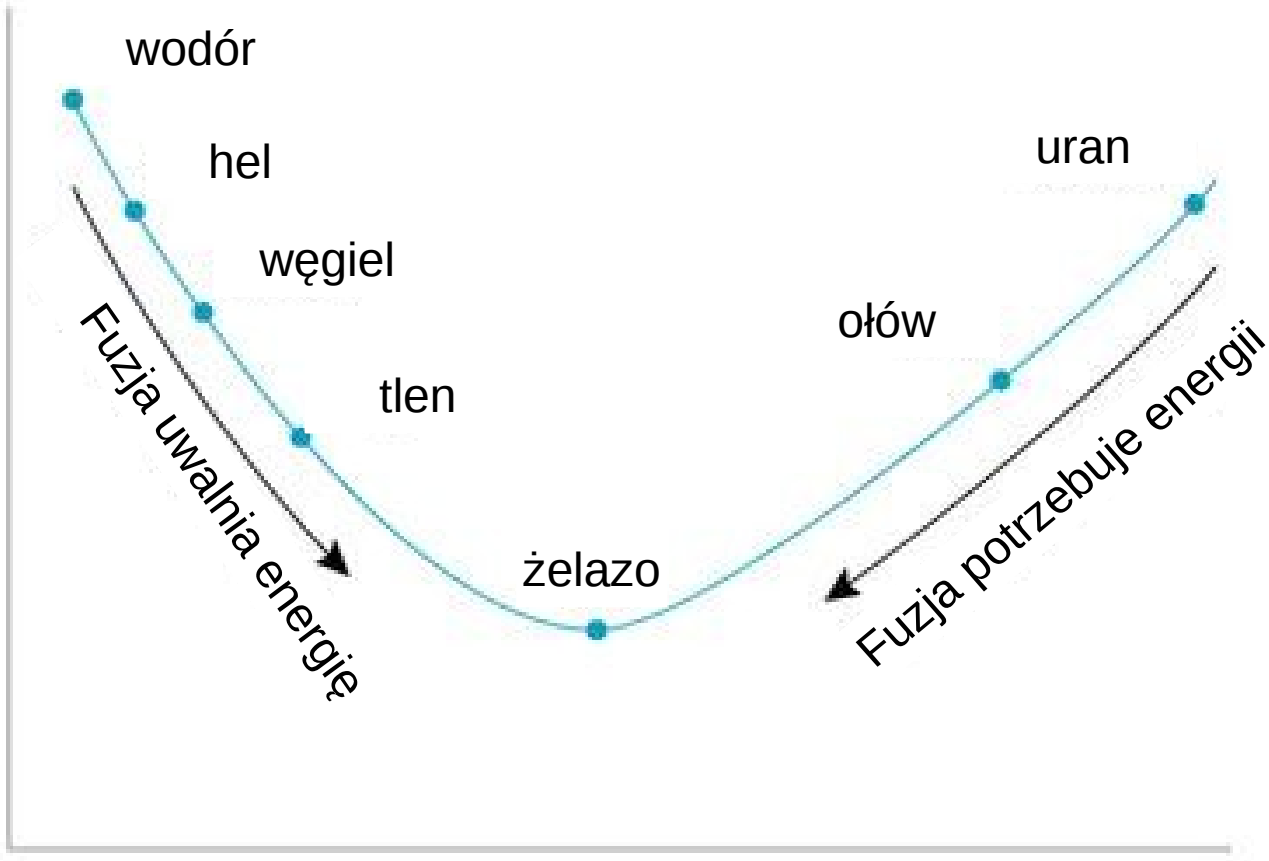


Ewolucja masywnych gwiazd

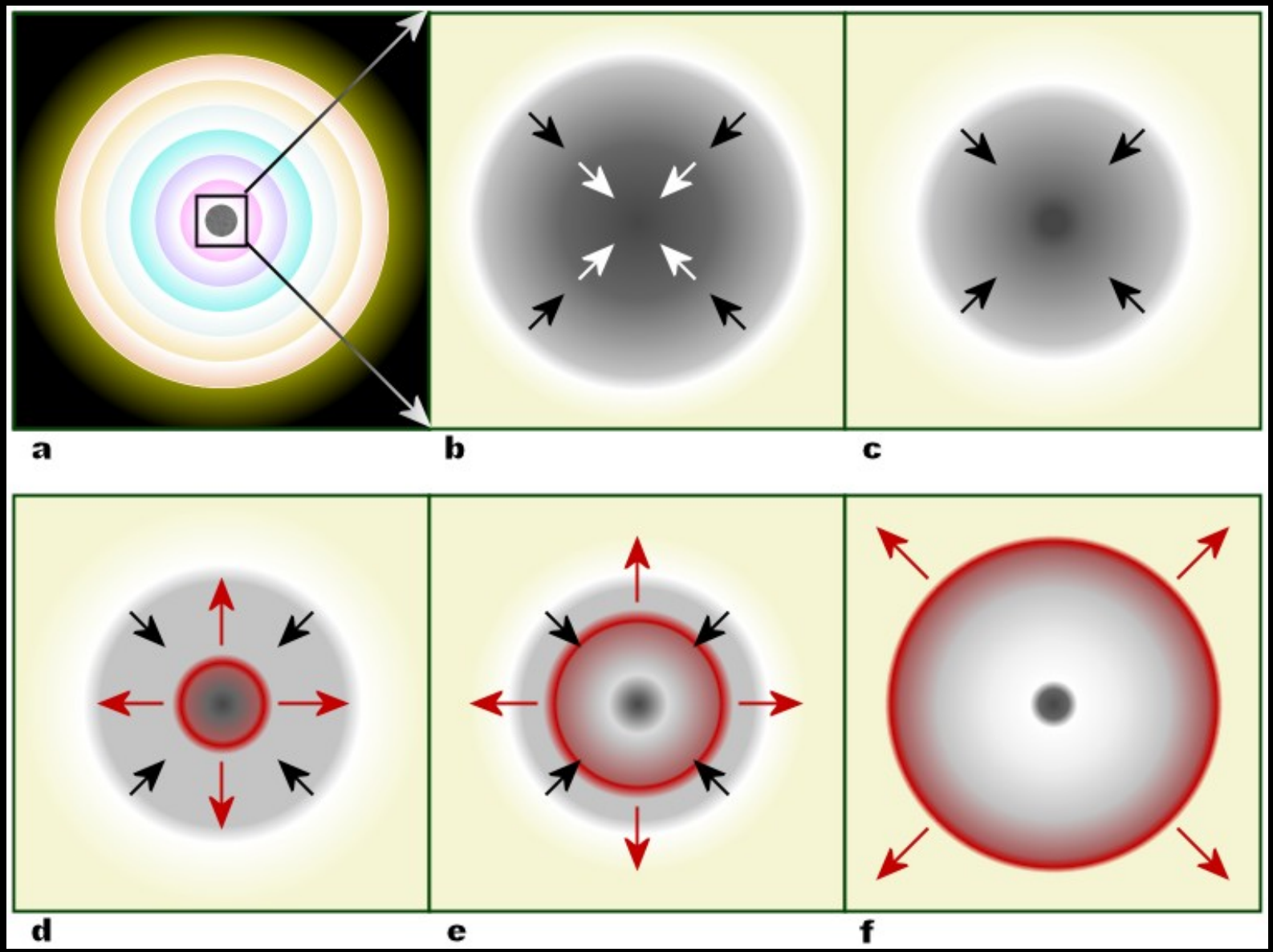


Faza	*Temperatura*	*Czas trwania*
wodorowa	$6{,}10^7$	10^7 lat
helowa	$2{,}10^8$	10^5 lat
węglowe	10^9	600 lat
neonowa	$1{,}7 \cdot 10^9$	1 rok
tlenowa	$2{,}5 \cdot 10^9$	6 miesięcy
krzemowa	$4 \cdot 10^9$	1 dzień

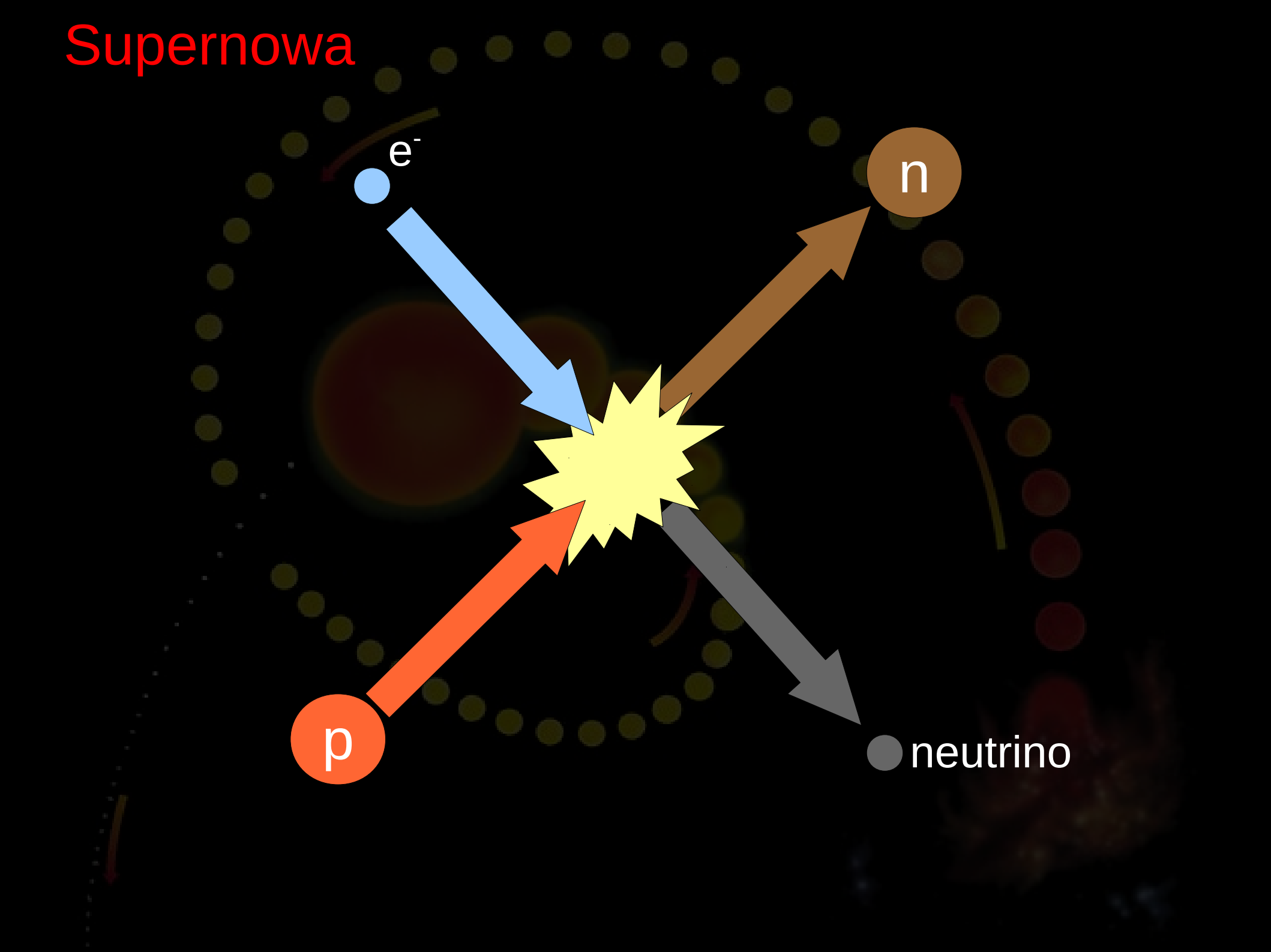
Żelazo – graniczny pierwiastek



Supernowa



Supernowa

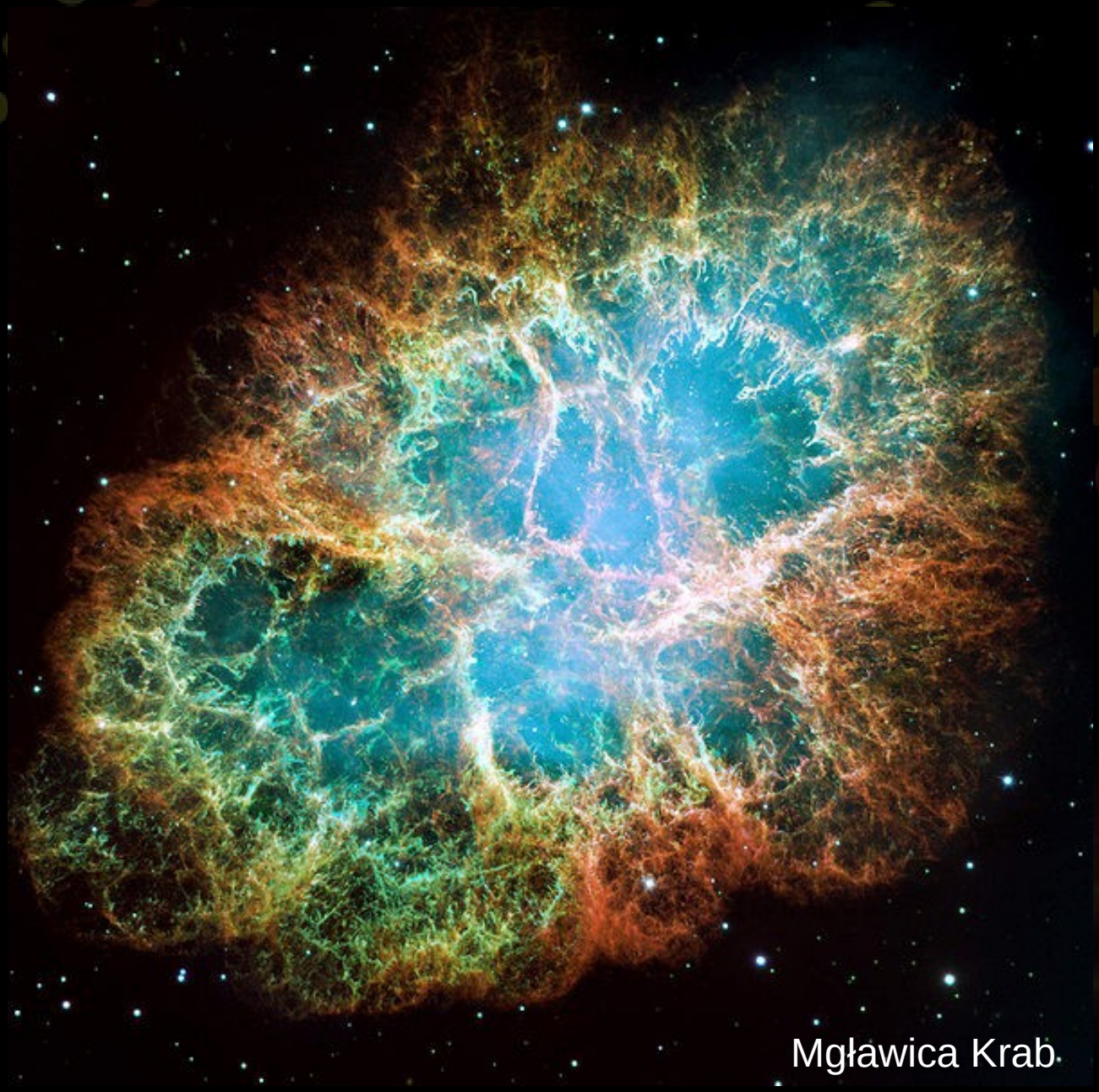


Supernowa

Supernowa

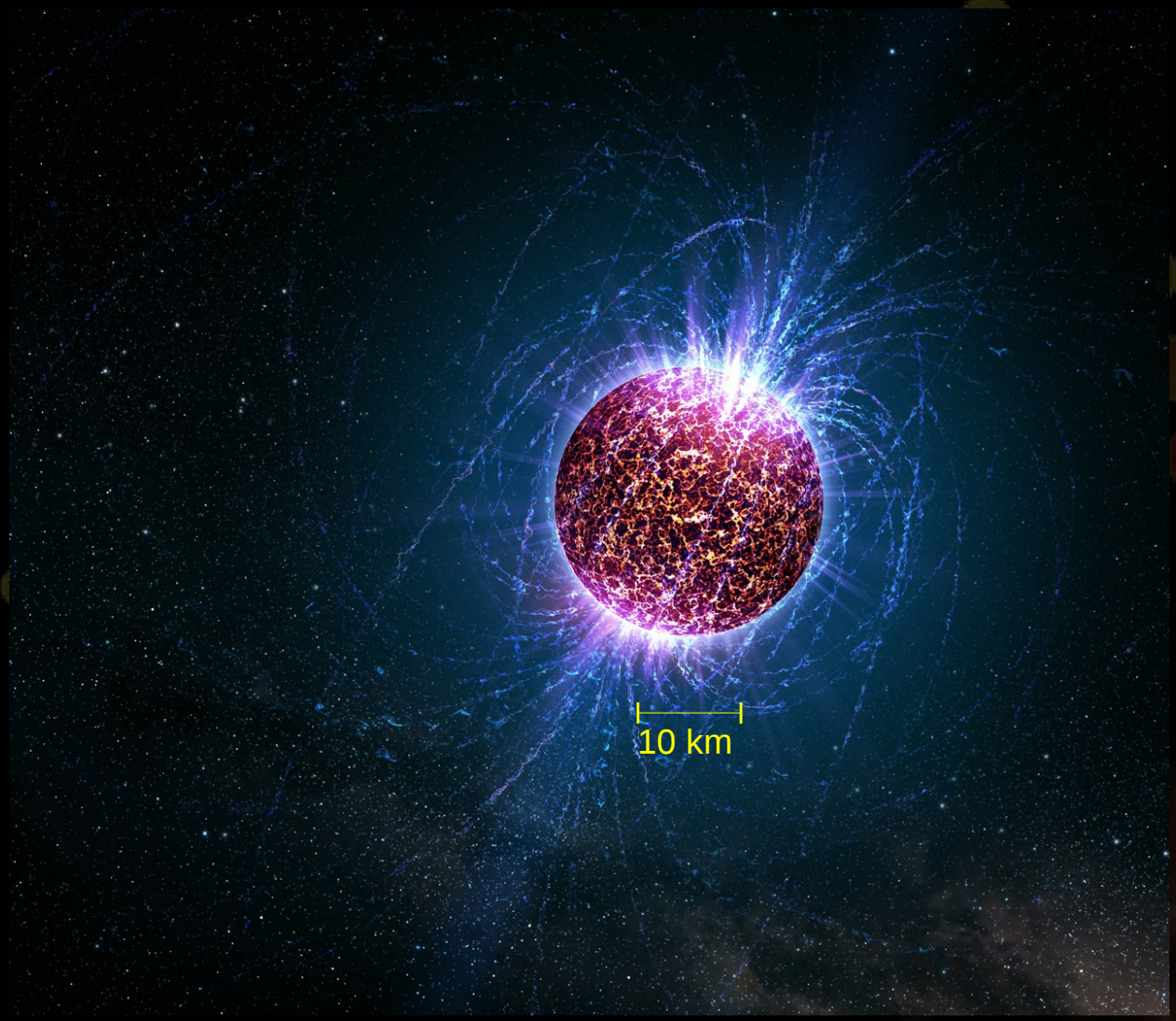
SN 1994D w galaktyce NGC 4526

Pozostałości po supernowych



Mgławica Krab

Gwiazda neutronowa



$\rho \approx 1$ mld t/cm^3

Pulsar

$f \leq 700$

Czarna dziura