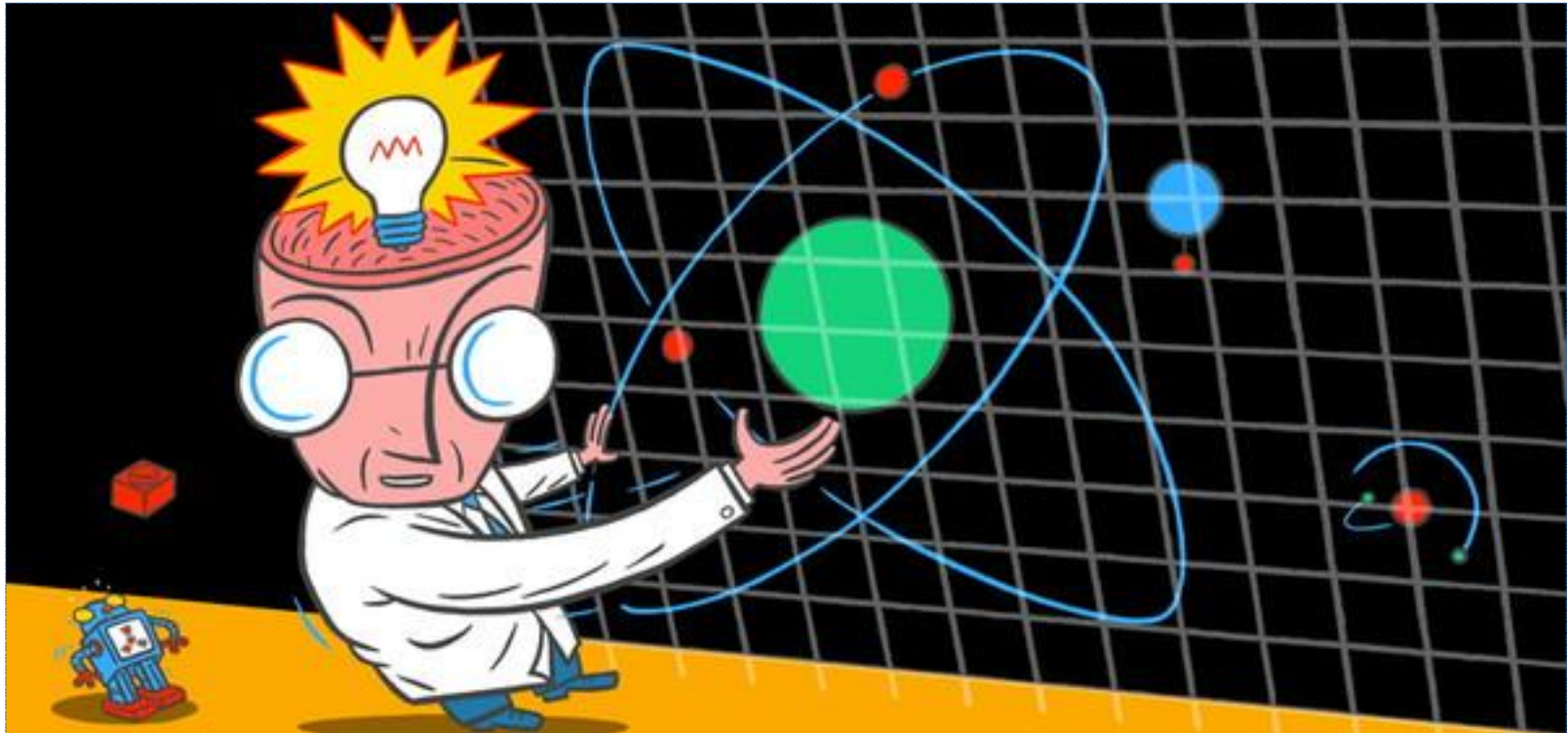


Institut
"Jožef Stefan"
Ljubljana, Slovenija

EKSPERIMENTALNA FIZIKA OSNOVNIH DELCEV - F9



NAJMANJŠI gradniki snovi



VSA SNOV je sestavljena iz njih

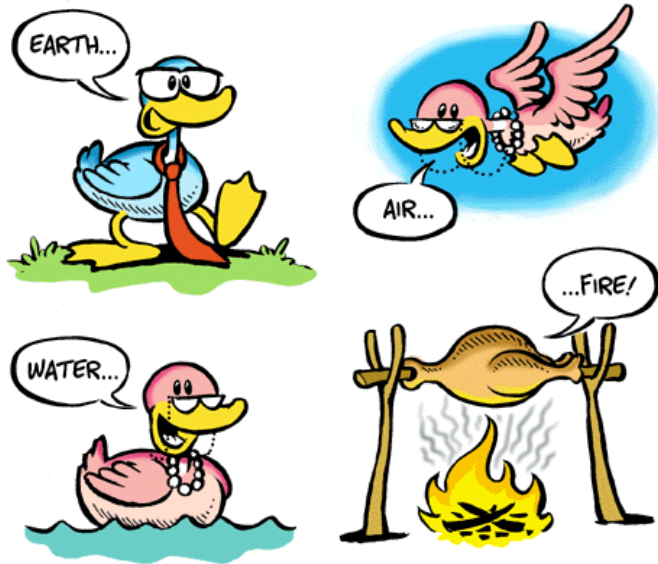


OSNOVNI DELICI

Osnovni delci so odgovorni
tudi za **SILE** v naravi



GRADNIKI NARAVE

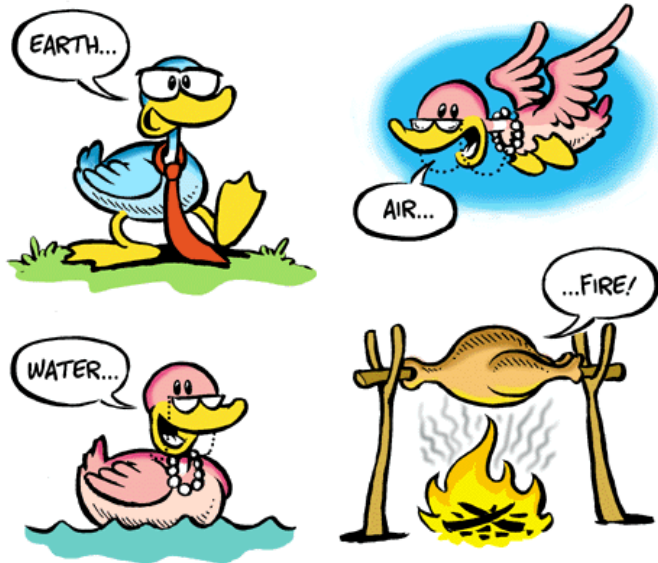


Kaj je najmanjši gradnik
v naravi?

=

Do katerega nivoja lahko
snov še razbijemo?

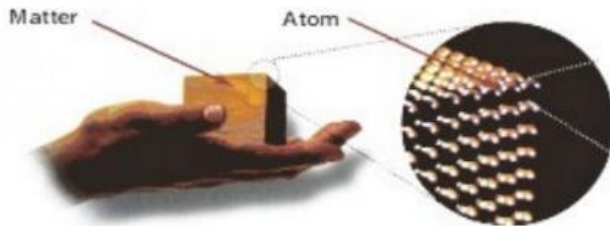
GRADNIKI NARAVE



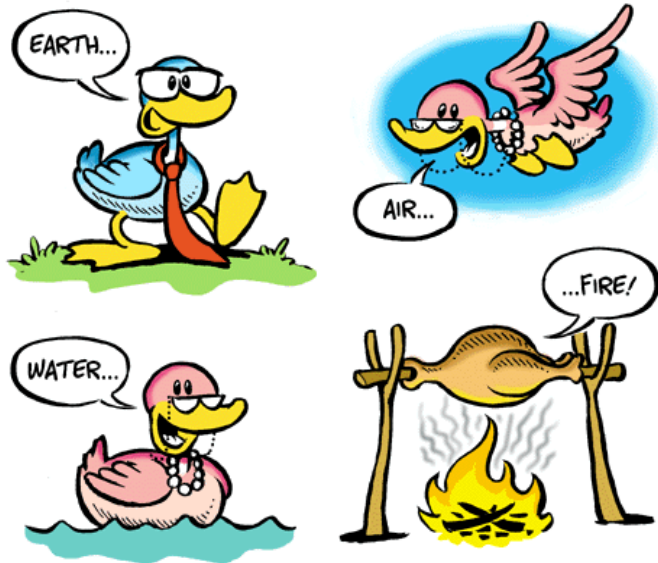
Kaj je najmanjši gradnik
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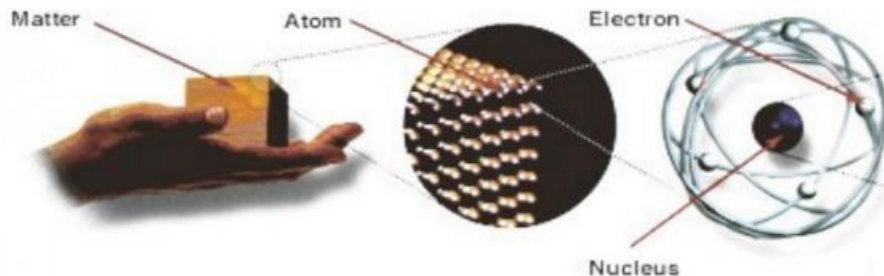
GRADNIKI NARAVE



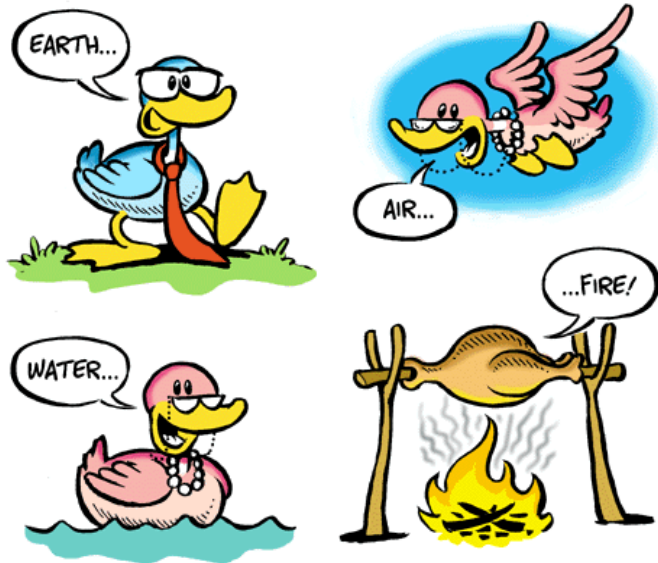
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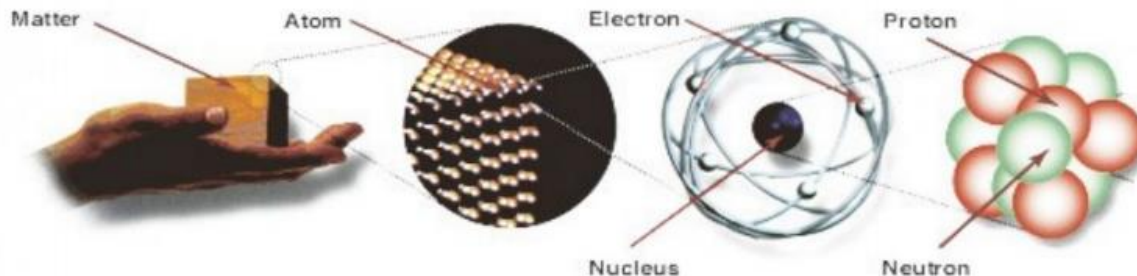
GRADNIKI NARAVE



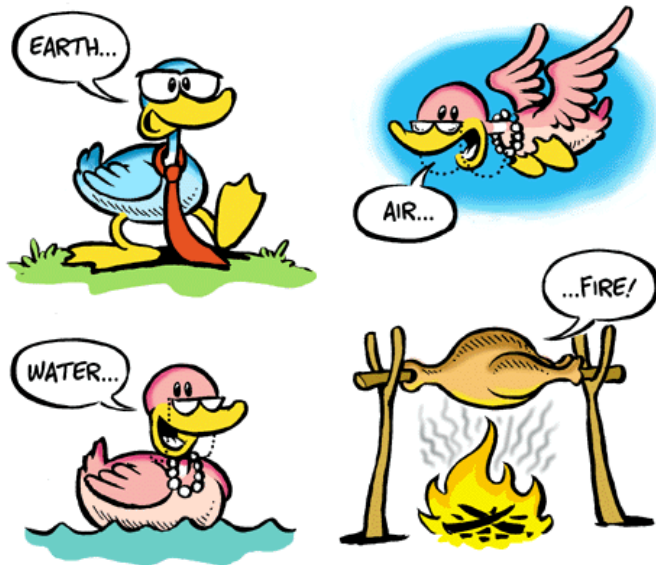
Kaj je najmanjši gradnik v naravi?

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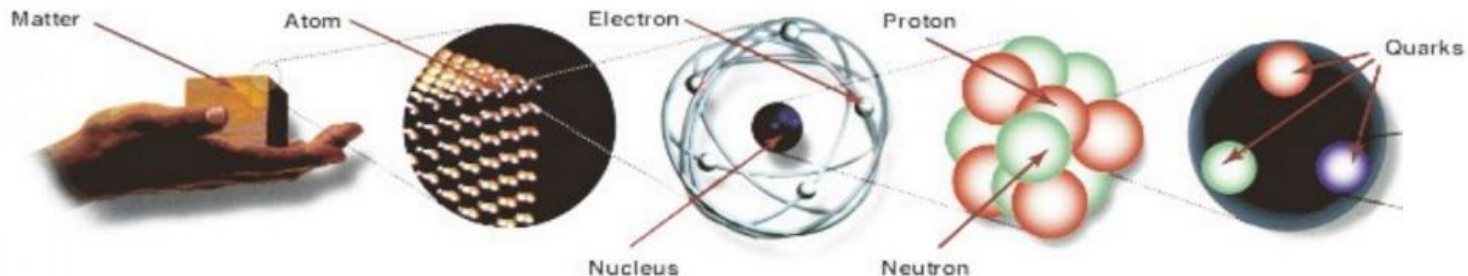
GRADNIKI NARAVE



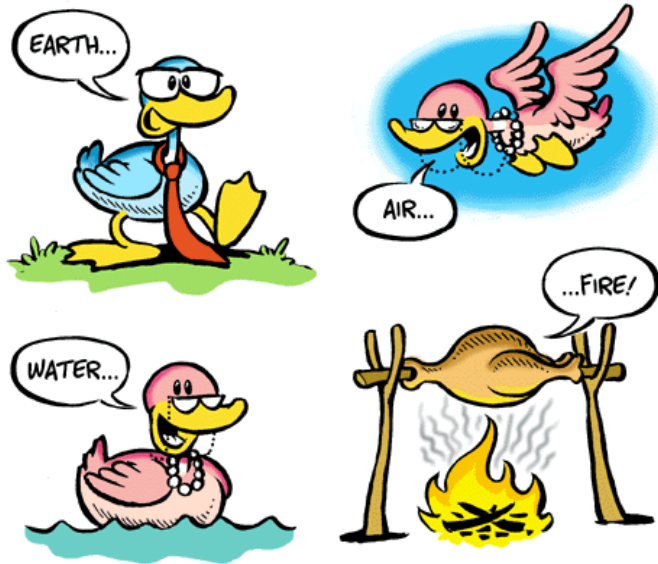
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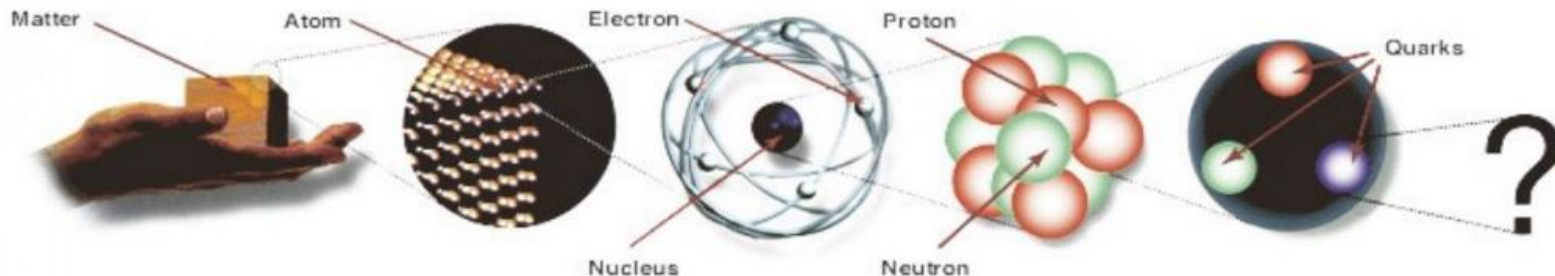
GRADNIKI NARAVE



Kaj je najmanjši gradnik
v naravi?

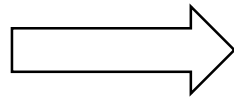
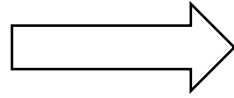
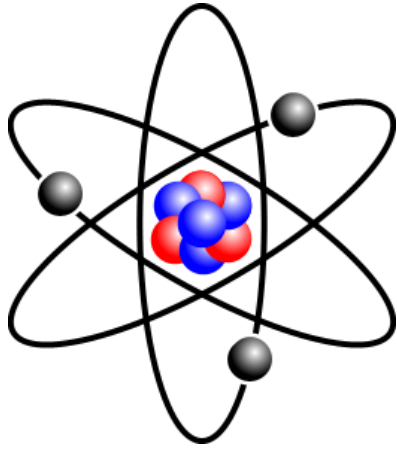
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Do katerega nivoja lahko
snov še razbijemo?



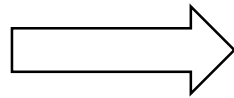
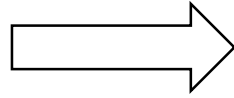
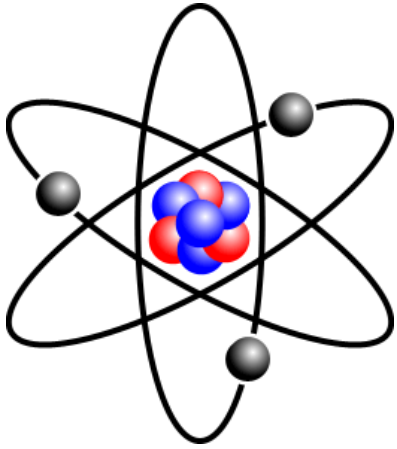
Kako velik je atom?

Če bi **atom** povečali na velikost **frnikule**, kako velika bi bila potem **frnikula**?



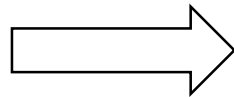
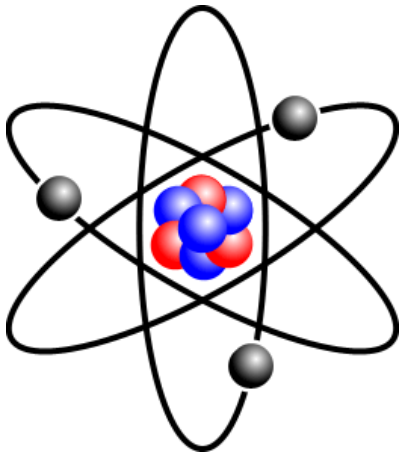
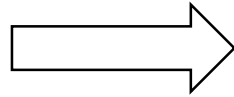
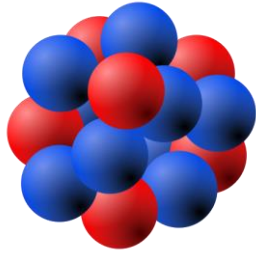
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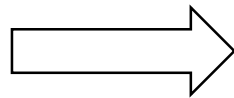
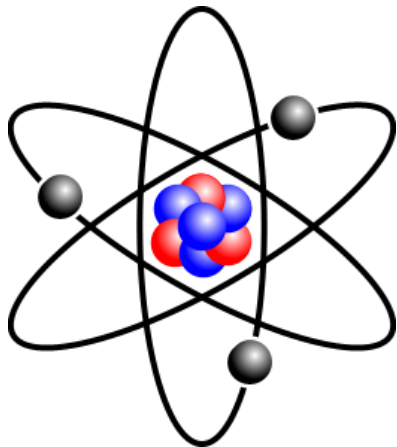
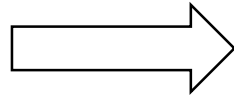
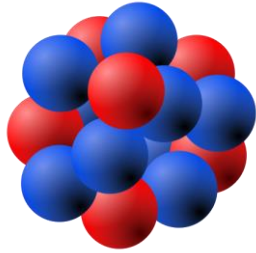
Vprašanje: Atomsko jedro je 10.000-krat manjše od atoma.

Če bi **atomsko jedro** povečali na velikost **čebele**, kako velik bi bil potem **atom**?

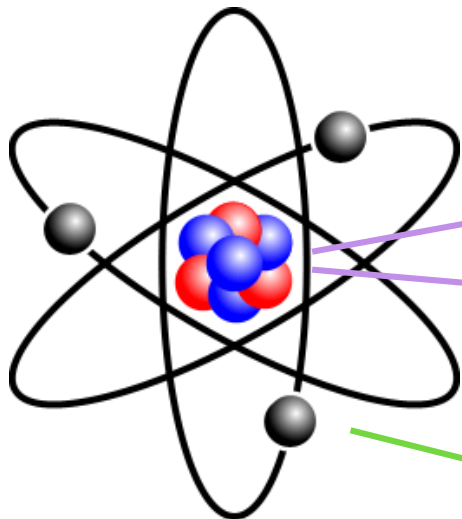


Vprašanje: Atomsko jedro je 10.000-krat manjše od atoma.

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OSNOVNI DELCI



mass →	$\approx 2.3 \text{ MeV}/c^2$	$\approx 1.275 \text{ GeV}/c^2$	$\approx 173.07 \text{ GeV}/c^2$	0	$\approx 126 \text{ GeV}/c^2$
charge	2/3	2/3	2/3	0	0
spin	1/2	1/2	1/2	1	0
	u up	c charm	t top	g gluon	H Higgs boson
	d down	s strange	b bottom	γ photon	
	e electron	μ muon	τ tau	Z Z boson	
	ν_e electron neutrino	ν_μ muon neutrino	ν_τ tau neutrino	W W boson	

QUARKS

LEPTONS

GAUGE BOSONS

Atomsko jedro sestavljajo protoni in nevtroni, ki so zgrajeni iz **kvarkov u in d** (ter gluonov).

Okrog jedra krožijo **elektroni**.

Vsi ostali delci so kratkoživi – obstajajo samo delček sekunde.

Fizika osnovnih delcev:

mass →	$\approx 2.3 \text{ MeV}/c^2$	$\approx 1.275 \text{ GeV}/c^2$	$\approx 173.07 \text{ GeV}/c^2$	0	$\approx 126 \text{ GeV}/c^2$
charge →	2/3	2/3	2/3	0	0
spin →	1/2	1/2	1/2	1	0
	u up	c charm	t top	g gluon	H Higgs boson
QUARKS	$\approx 4.8 \text{ MeV}/c^2$	$\approx 95 \text{ MeV}/c^2$	$\approx 4.18 \text{ GeV}/c^2$	0	
	d down	s strange	b bottom	γ photon	
	$0.511 \text{ MeV}/c^2$	$105.7 \text{ MeV}/c^2$	$1.777 \text{ GeV}/c^2$	$91.2 \text{ GeV}/c^2$	
	e electron	μ muon	τ tau	Z Z boson	
LEPTONS	$< 2.2 \text{ eV}/c^2$	$< 0.17 \text{ MeV}/c^2$	$< 15.5 \text{ MeV}/c^2$	$80.4 \text{ GeV}/c^2$	
	ν_e electron neutrino	ν_μ muon neutrino	ν_τ tau neutrino	W W boson	GAUGE BOSONS

Vsi poznani osnovni delci skupaj tvorijo zapletenejše delce

T.i. živalski vrt delcev ("Particle ZOO")
→ Standardni model

Kemija:

The periodic table shows elements color-coded by groups: Alkali Metals (purple), Alkaline Earth (pink), Transition Metal (blue), Basic Metal (orange), Semimetals (green), Nonmetals (light blue), Halogens (yellow), Noble Gas (light green), Lanthanides (light yellow), and Actinides (red). Elements B, C, N, and O are circled in red. The table includes atomic numbers, symbols, and names for all elements from Hydrogen (1) to Oganesson (118).

Kemijski elementi tvorijo zapletenejše spojine

Kako vidimo osnovne delce?



Kako vidimo osnovne delce?



Rabimo res močan mikroskop!



UISSE
FRANCE

CMS

LHCb

ATLAS

CERN Meyrin

CERN Prévessin

SPS 7 km

ALICE

LHC 27 km



Veliki Hadronski trkalnik LHC
CERN, Ženeva, Švica/Francija
Obseg 27 km, 100 m pod površjem

Trki proton – proton
Masa protonov v žarku:
0,000000000001 kg
Energija žarkov:
360 MJ (velik potniški vlak pri 150 km/h)

LHC 27 km

SPS 7 km

ALICE

ATLAS

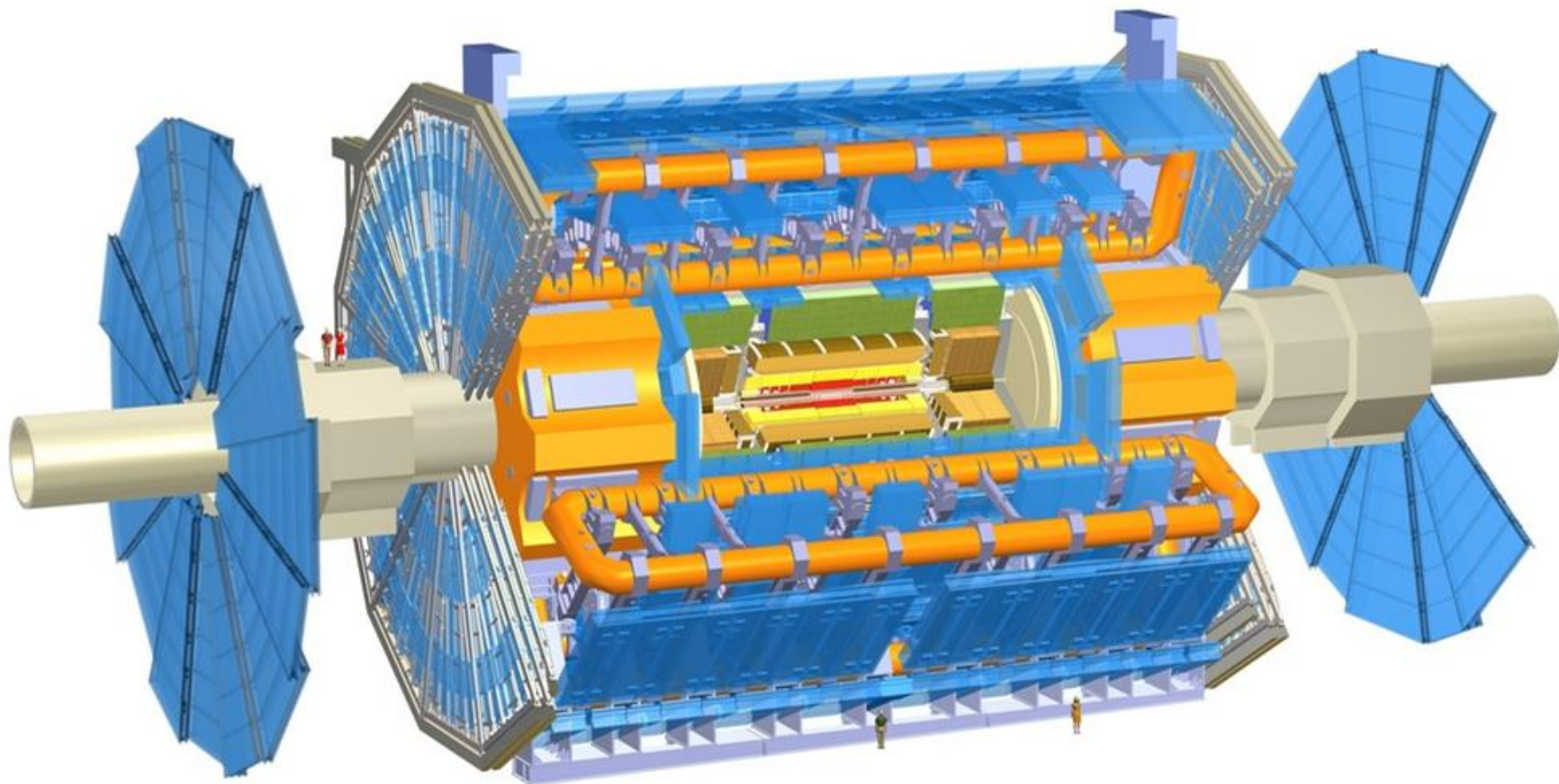
LHCb

CERN Prévessin

CERN Meyrin

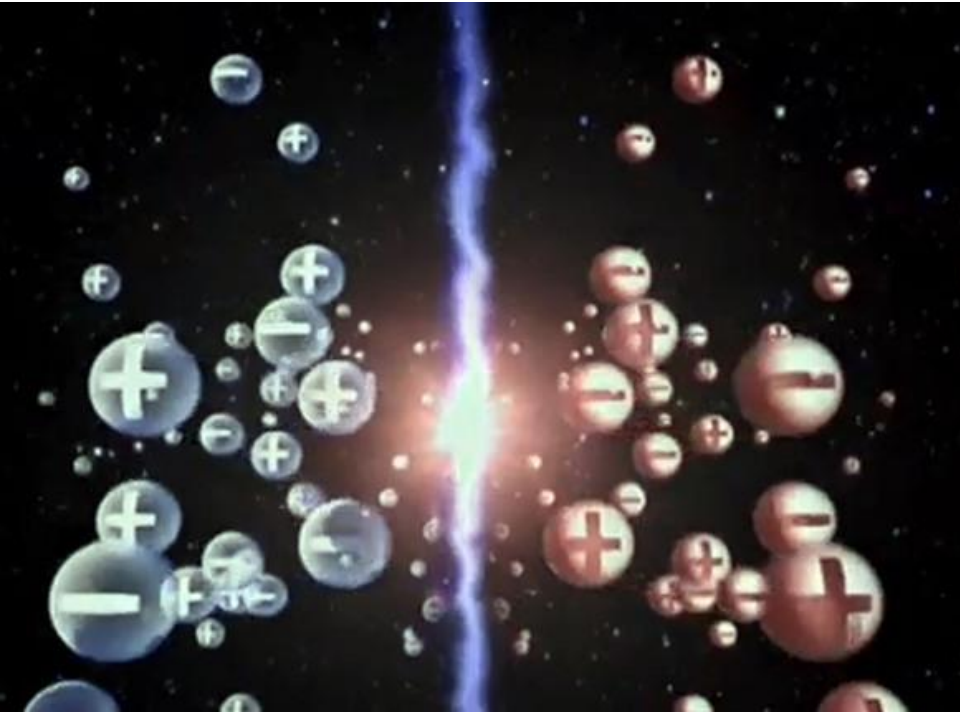
SUISSE
FRANCE

Detektor ATLAS, CERN, Švica

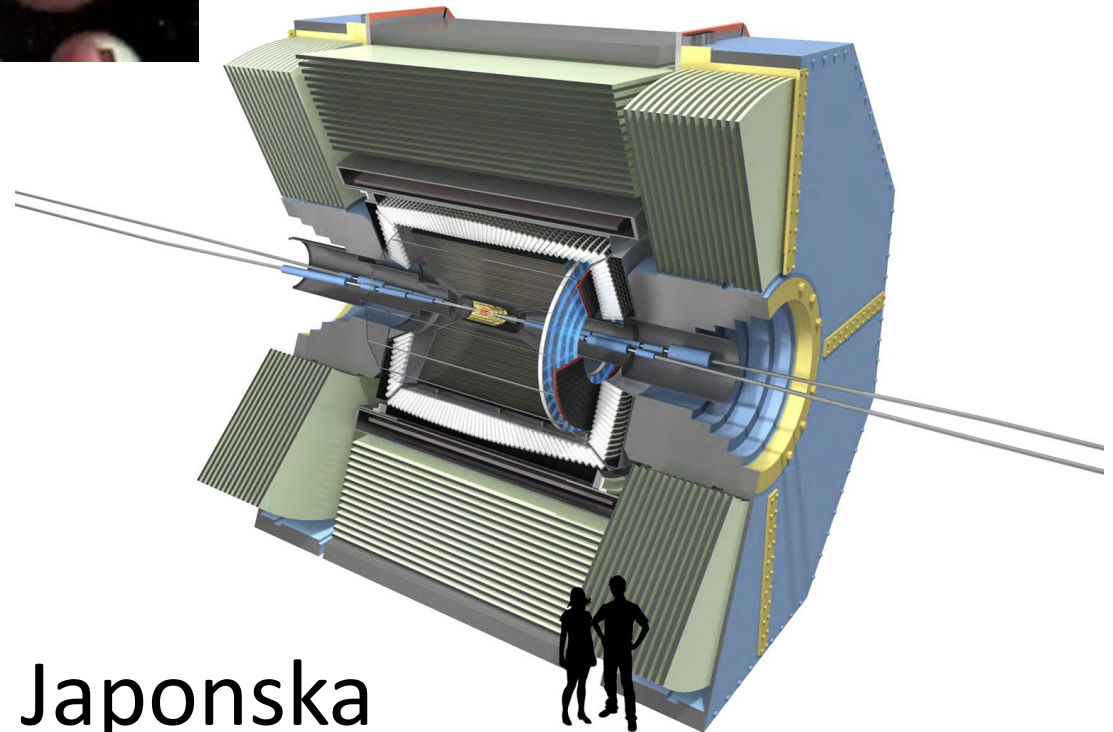




posnetek: trk dveh delcev (LHC)



Od kje prihaja
asimetrija med snovjo
in antisnovjo?



Belle II, KEK, Japonska



NOBELOVE NAGRADE



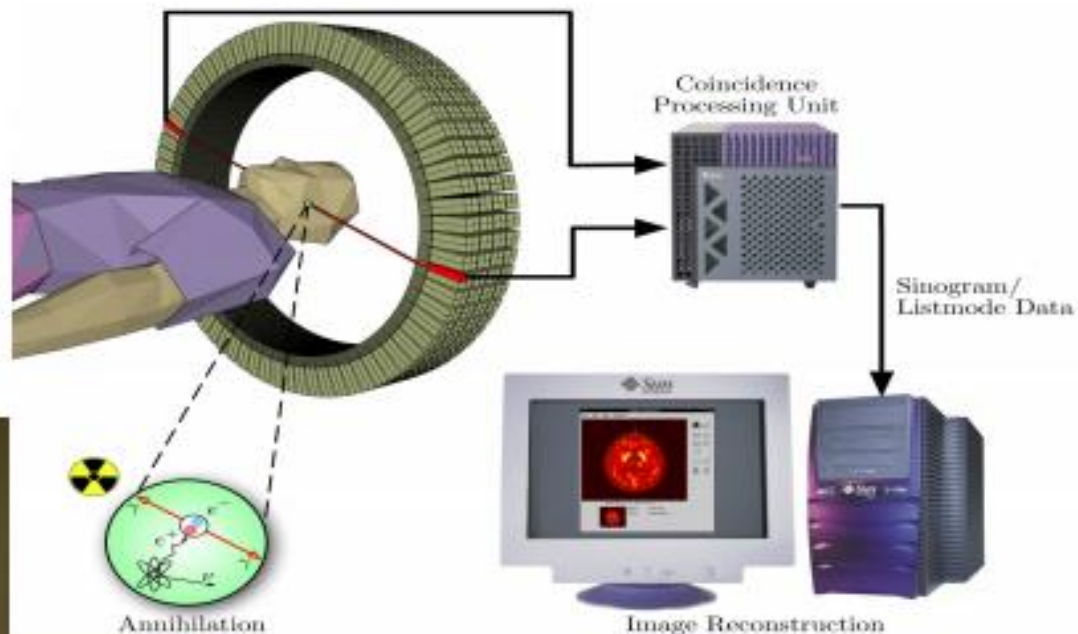
Belle: Kobayashi in Maskawa,
kršitev simetrije CP (2008)



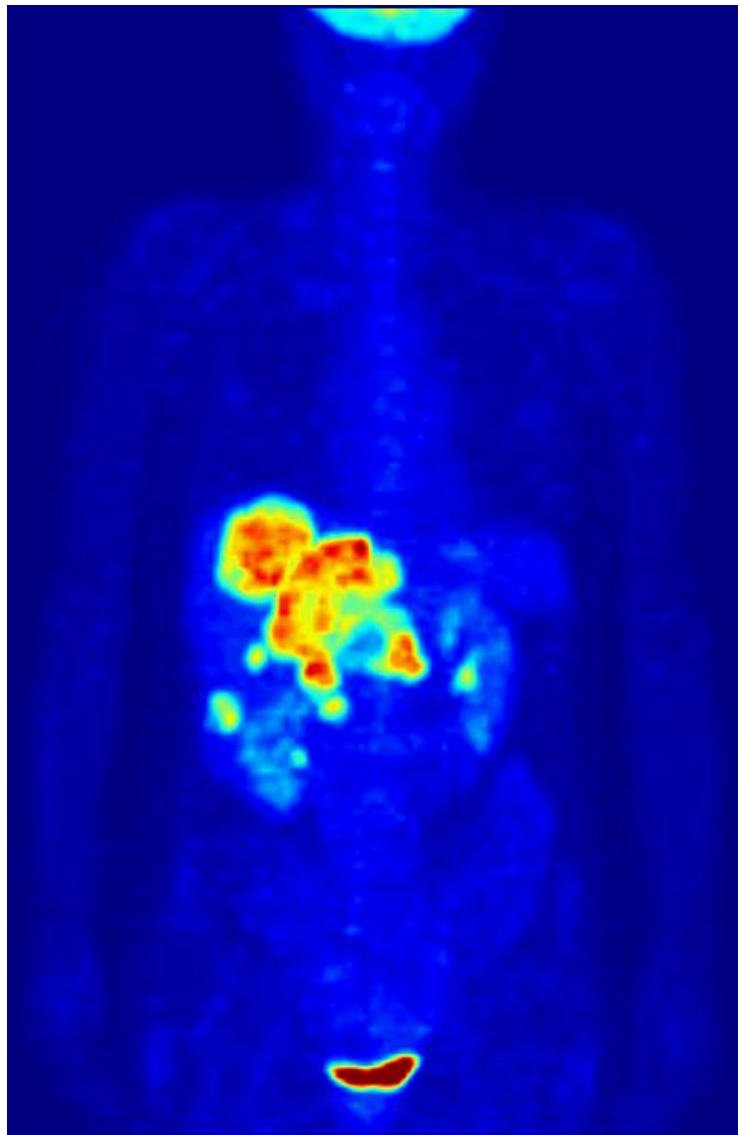
ATLAS: Higgs in Englert,
Higgsov bozon (2013)

UPORABA V MEDICINI

Pozitronska emisijska tomografija (PET)



PET Slikanje



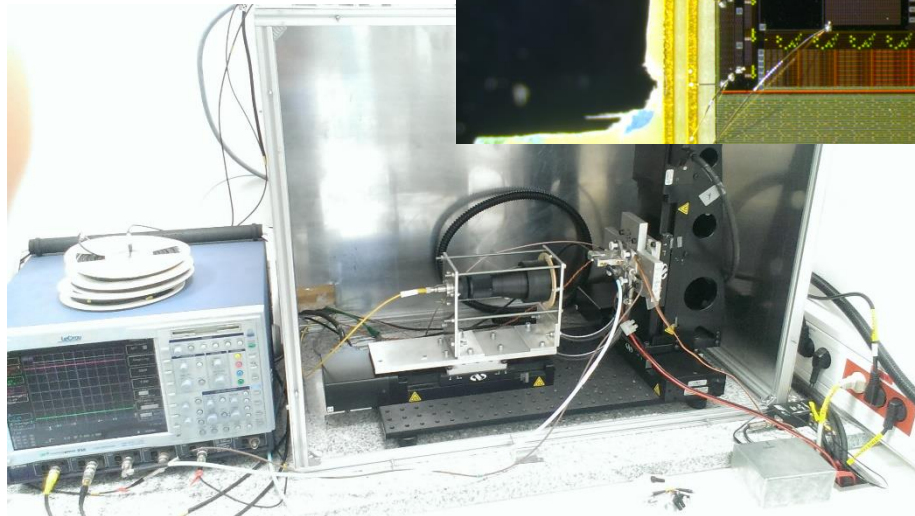
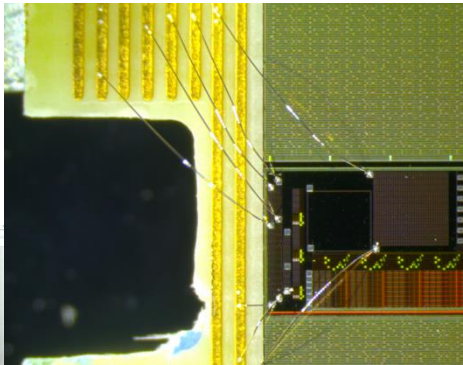
Kaj delamo na F9?

Razvoj novih detektorjev za trkalnike

- Silicijevi detektorji
- Diamantni detektorji
- Detektorji Čerenkova

Razvoj novih detektorjev za medicino

- LGAD



Analiza trkov na detektorjih ATLAS in Belle

