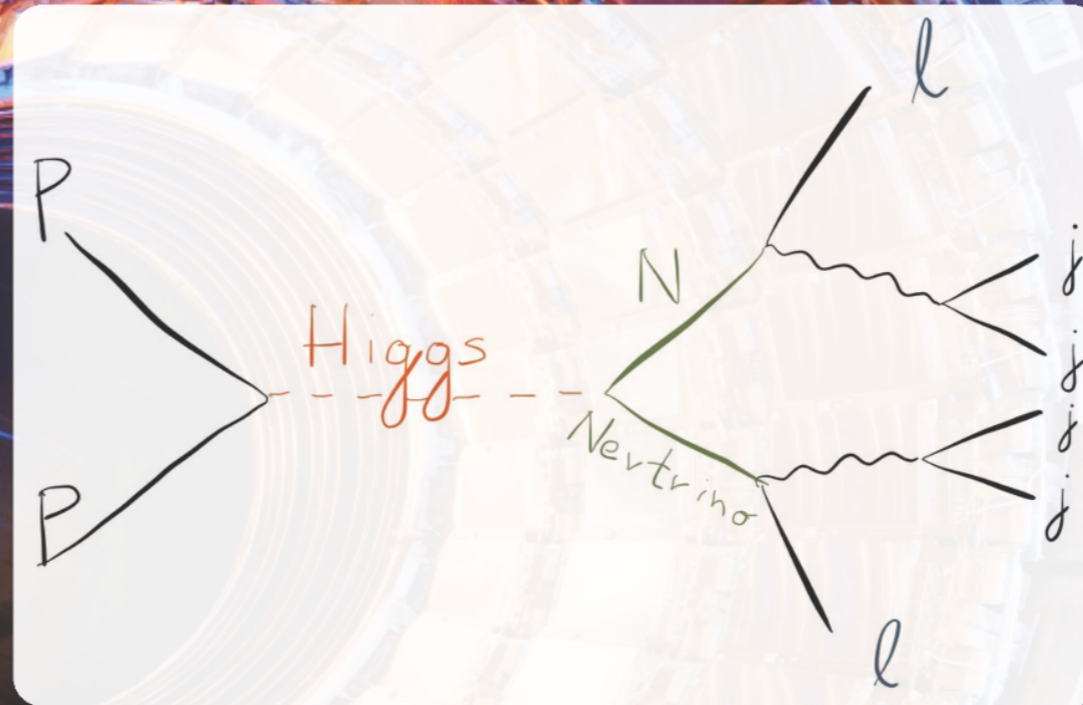


Znanost
na cesti



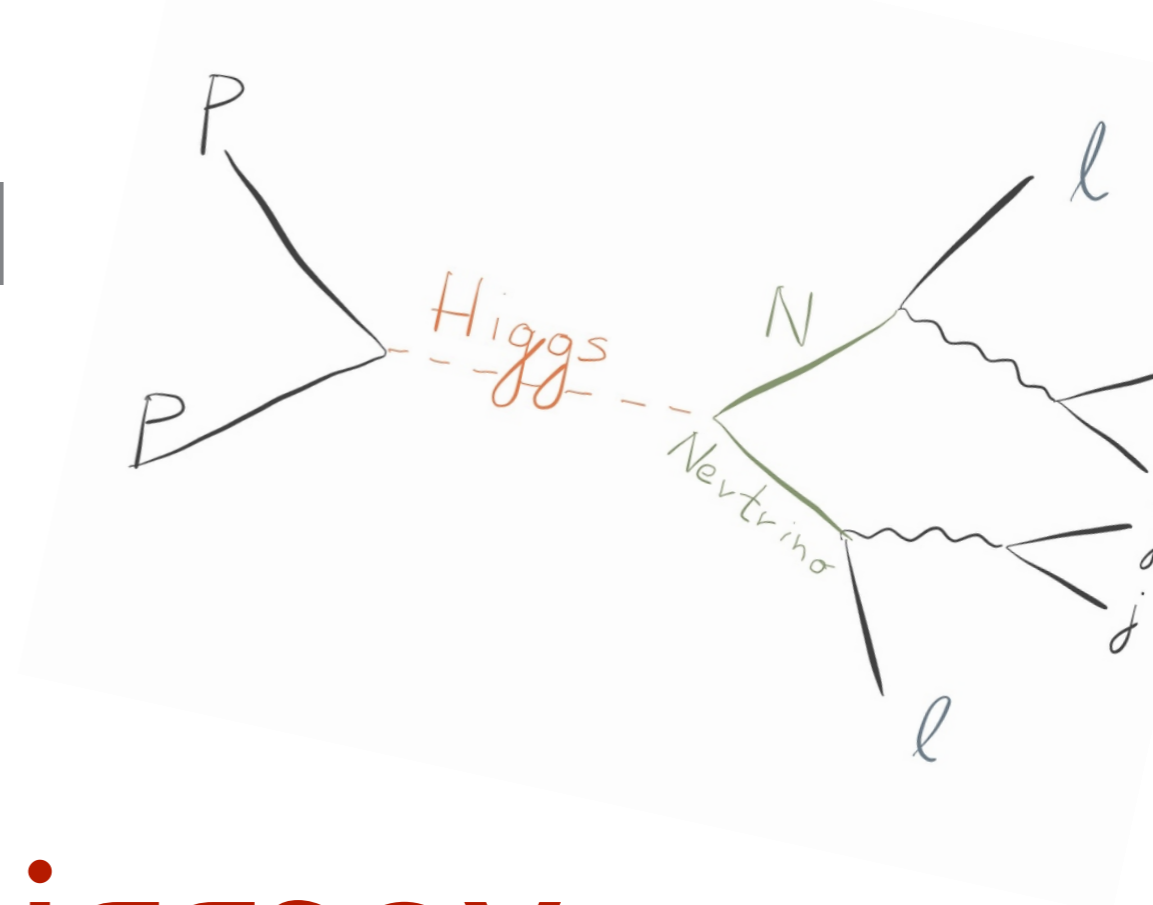
21. oktober 2015 ob 19h

Nevtrini, Higgsov mehanizem in LHC

dr. Miha Nemevšek, Institut „Jožef Stefan“

Maja Ratej, Val 202

Znanost na
cesti



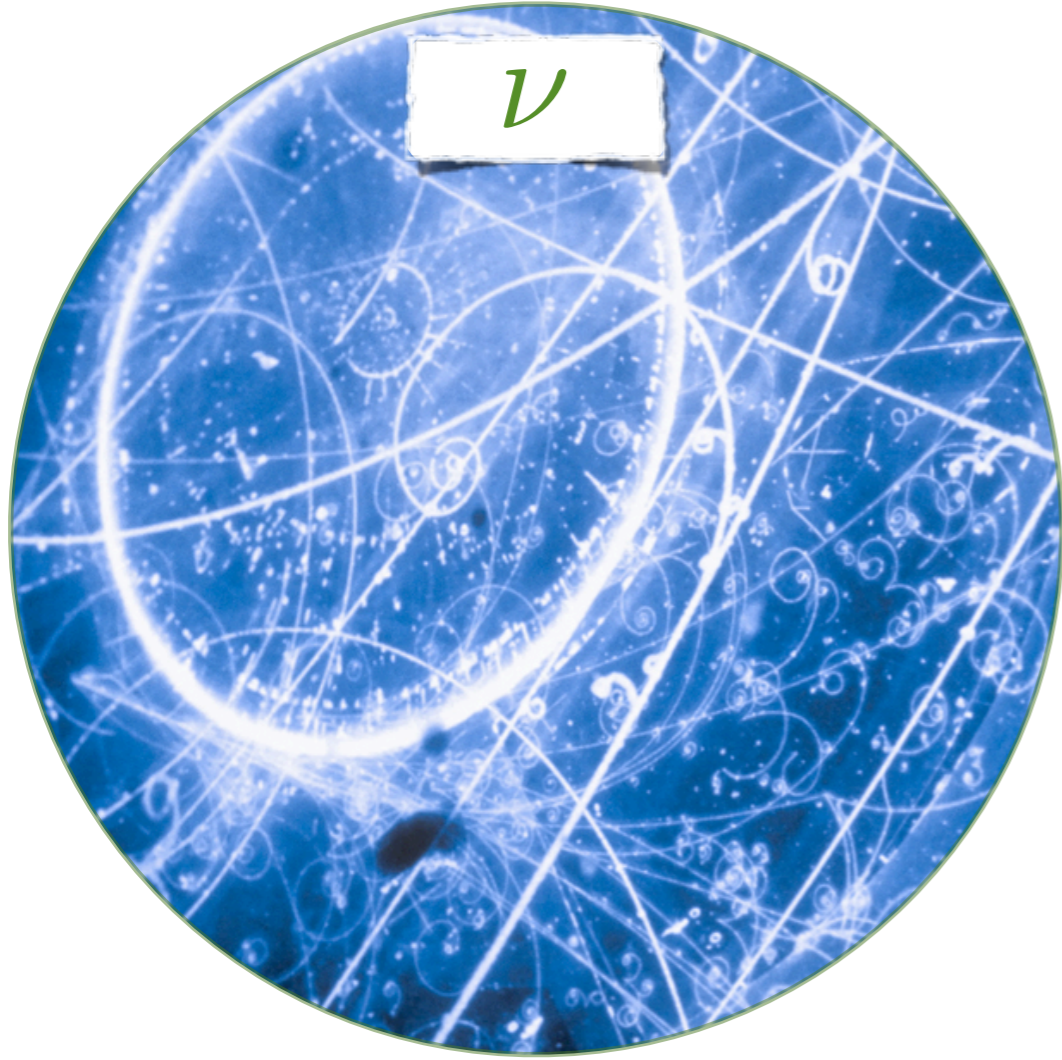
Nevtrini, Higgsov mehanizem in LHC

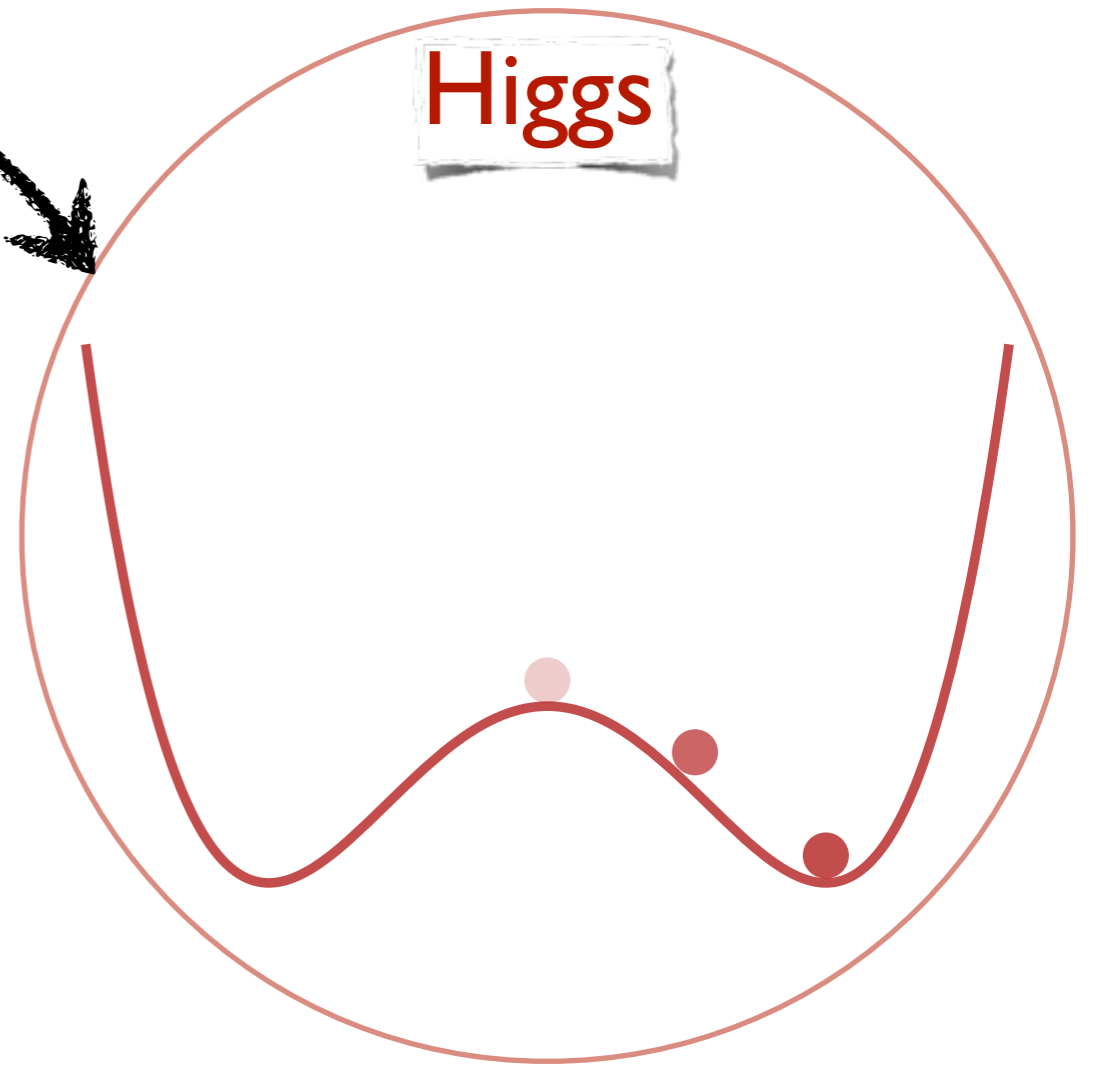
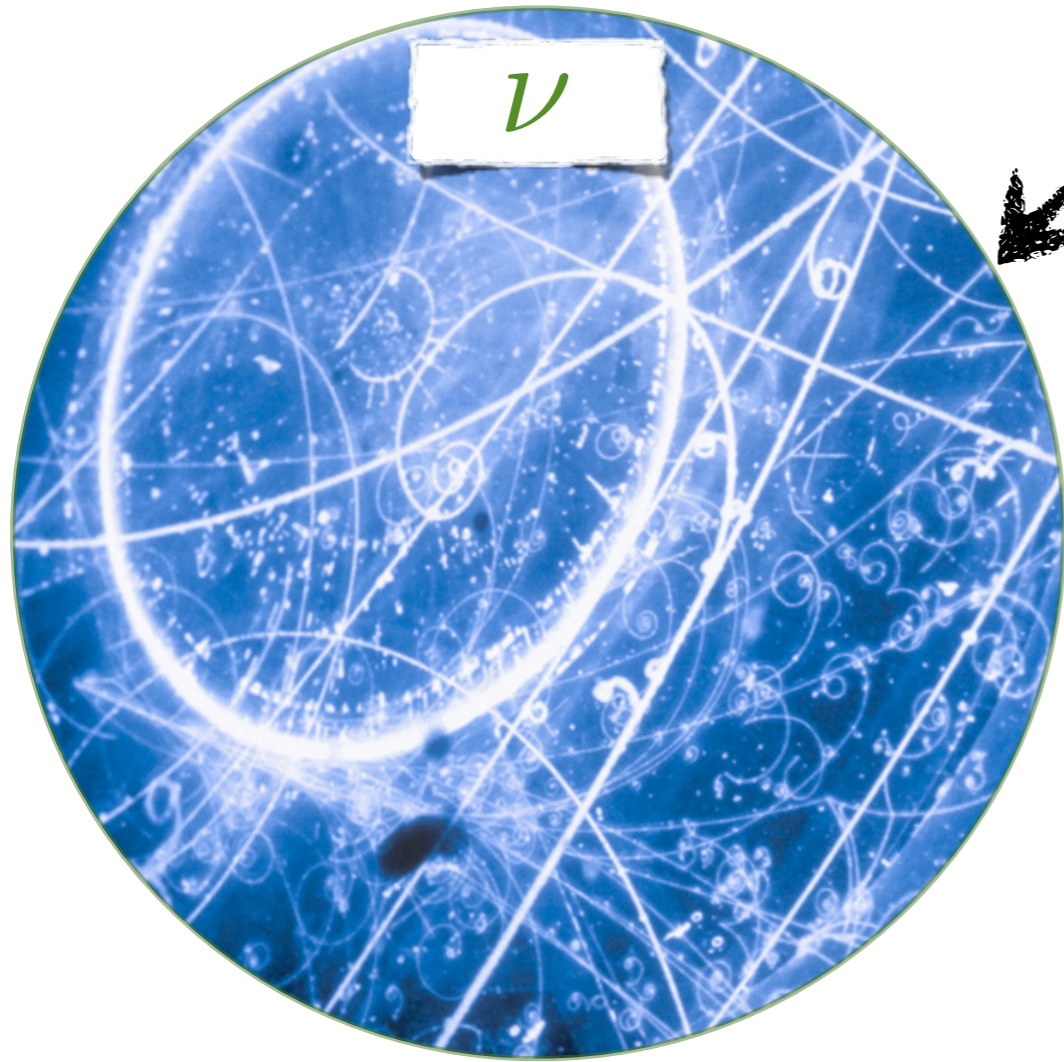
Miha Nemevšek

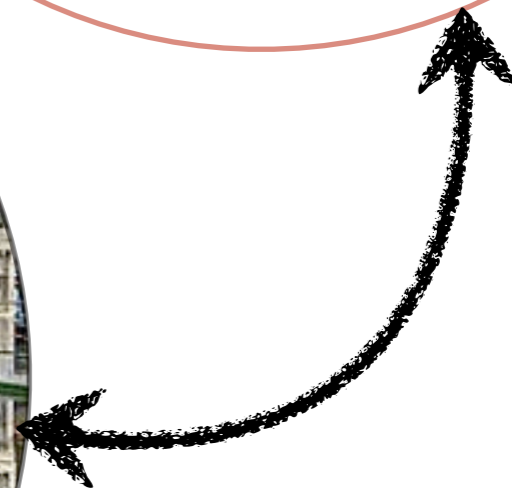
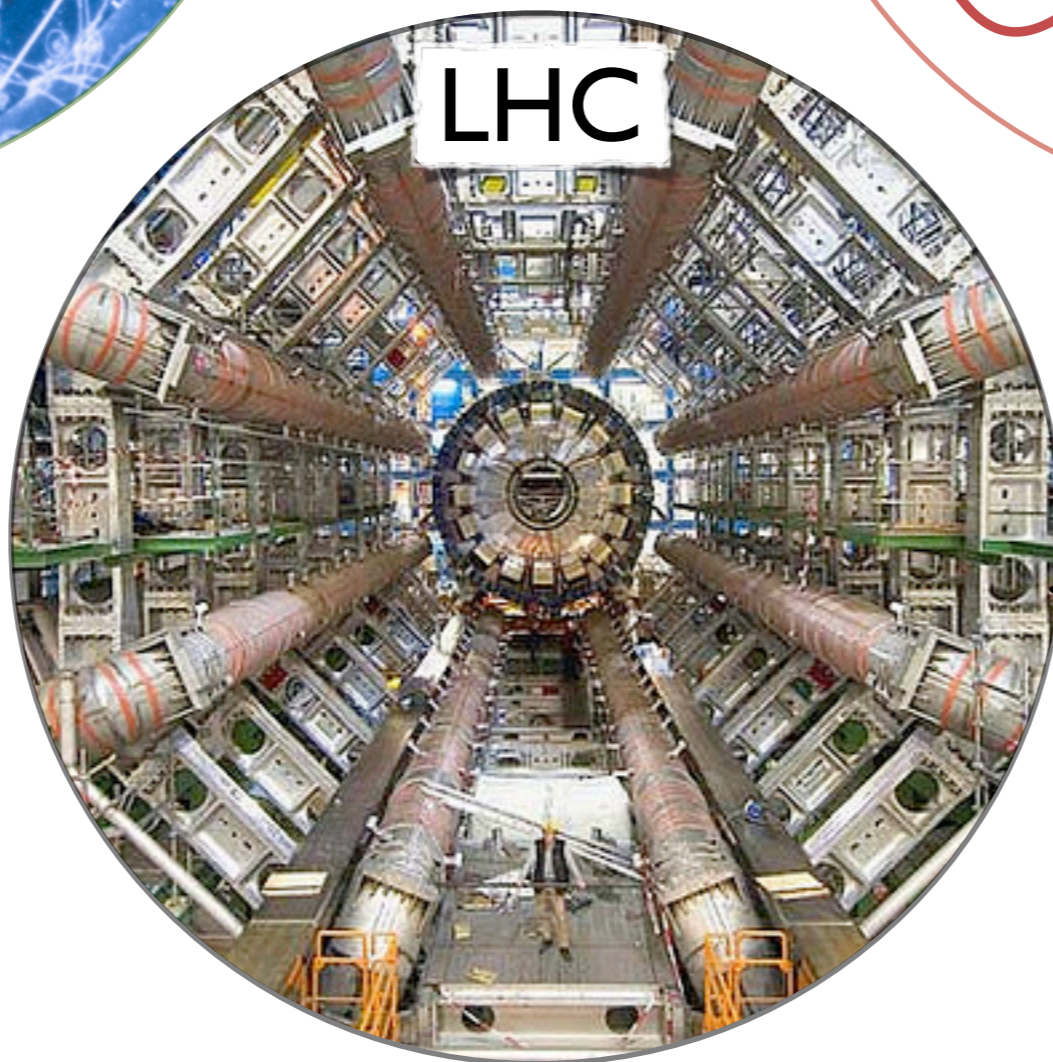
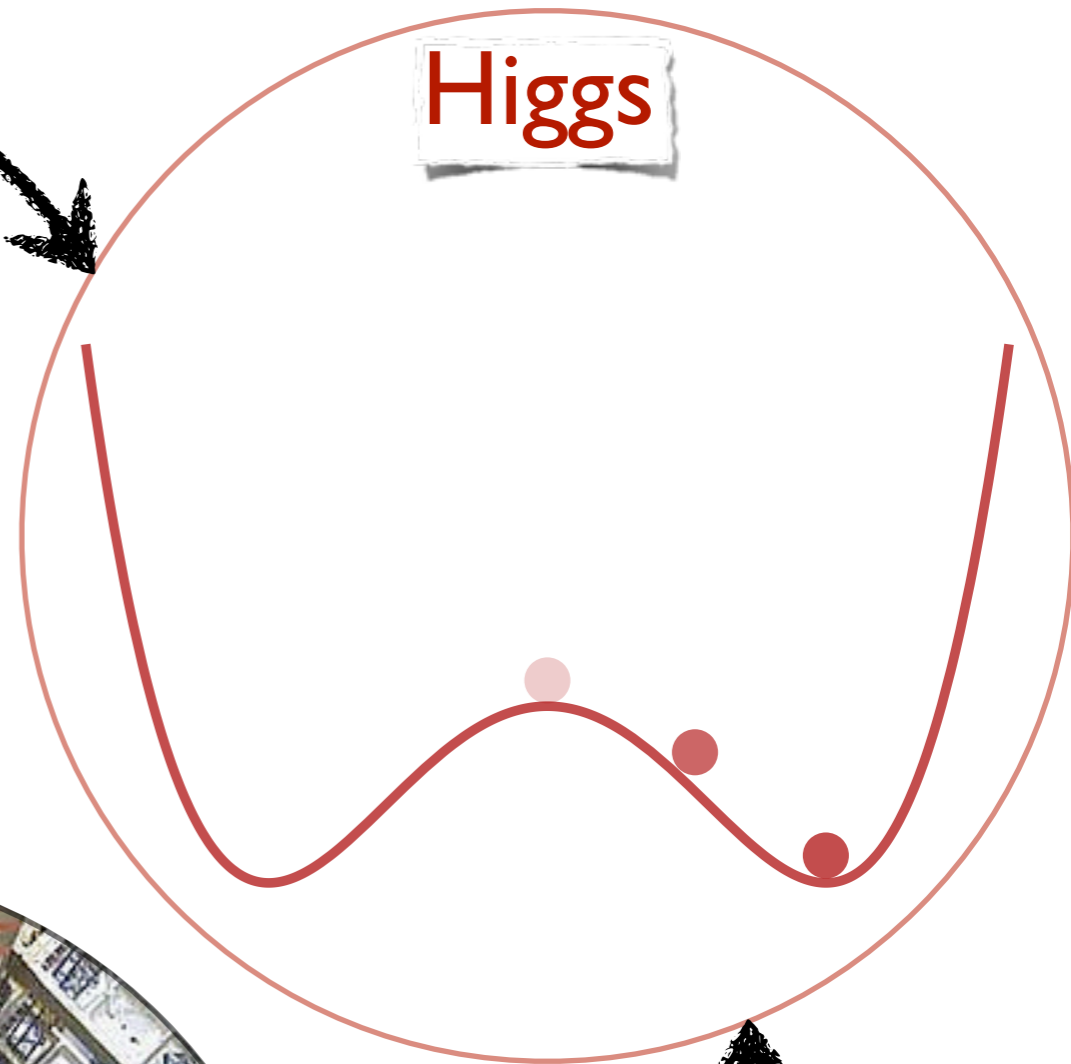
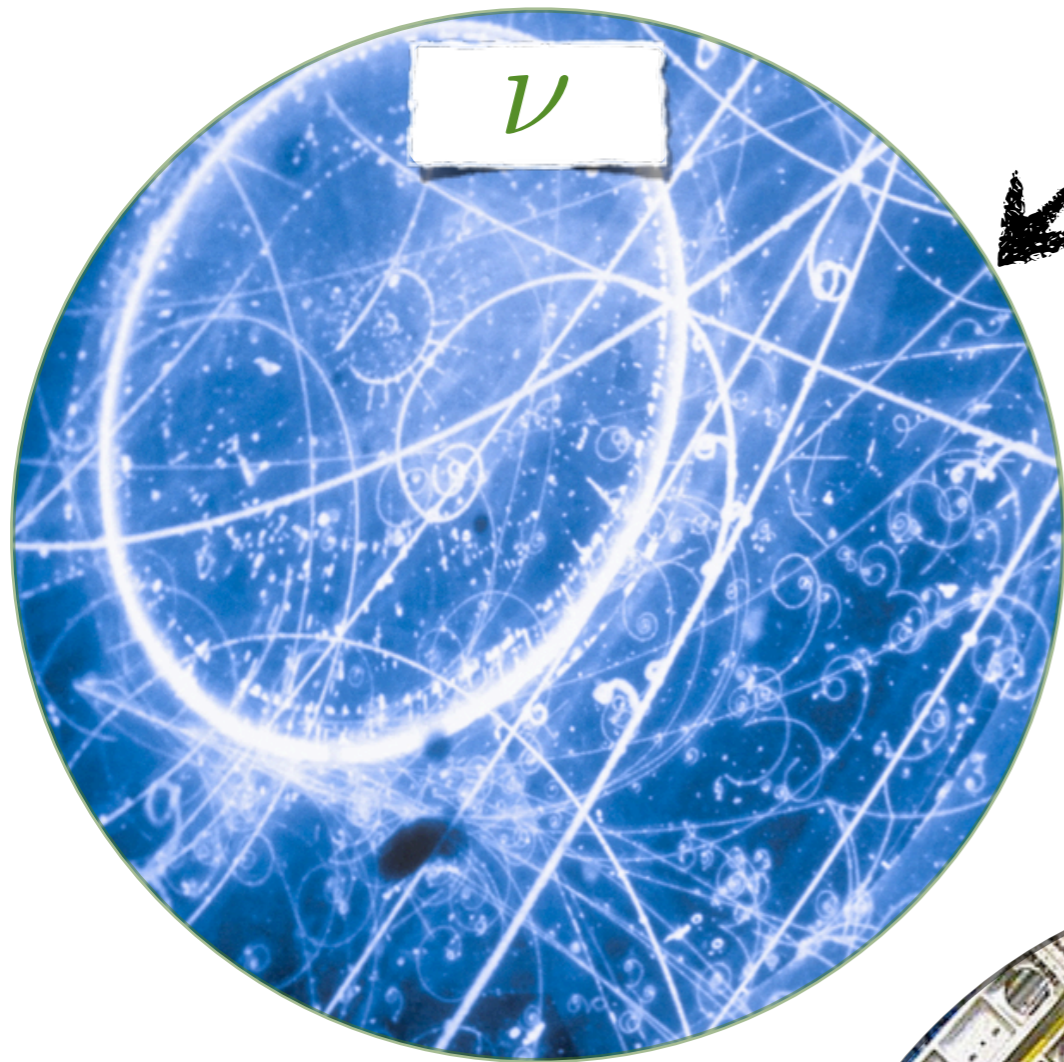
in Bajc, Nesti, Maiezza, Senjanović, Tello, Vissani, Zhang

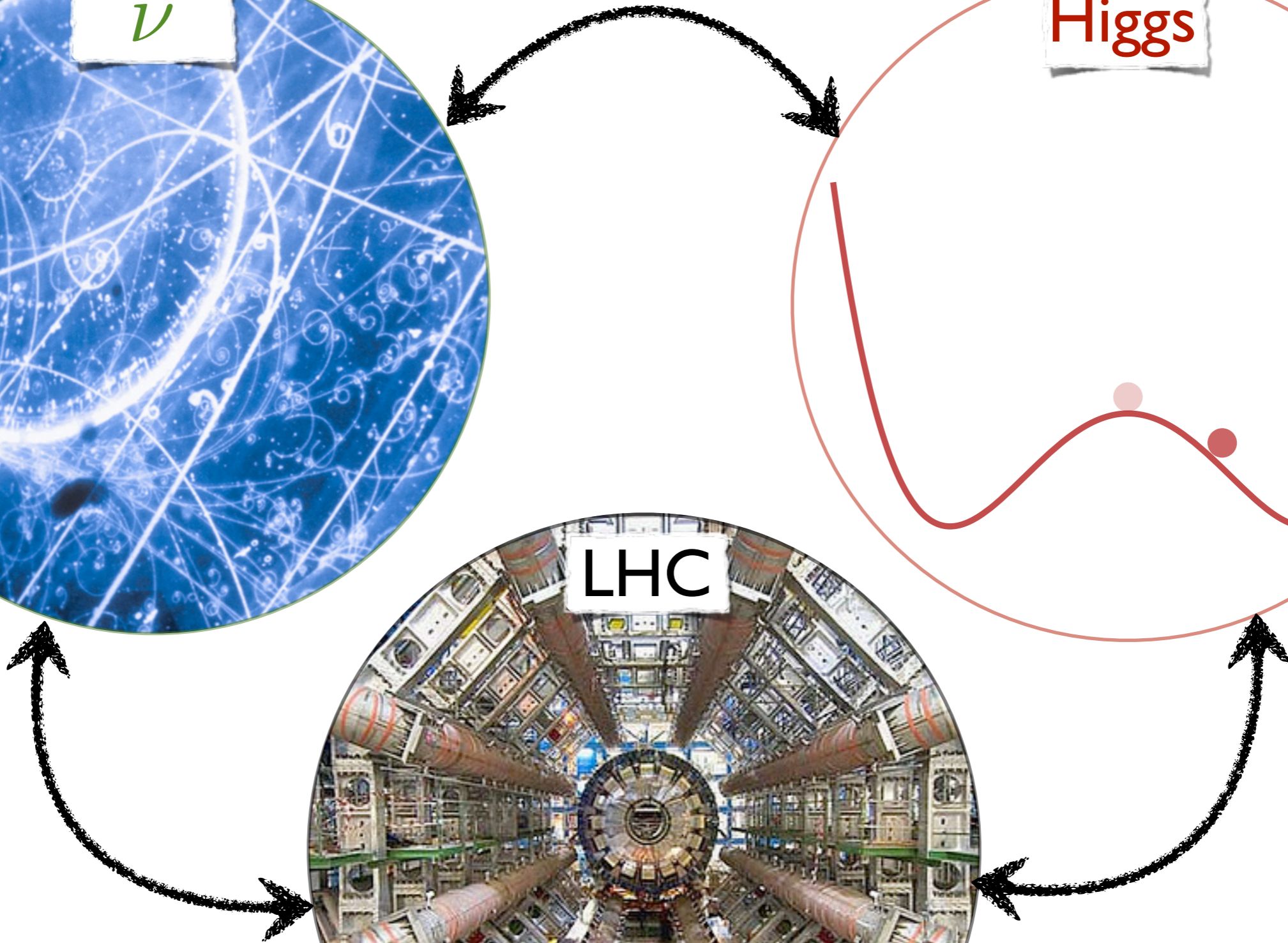
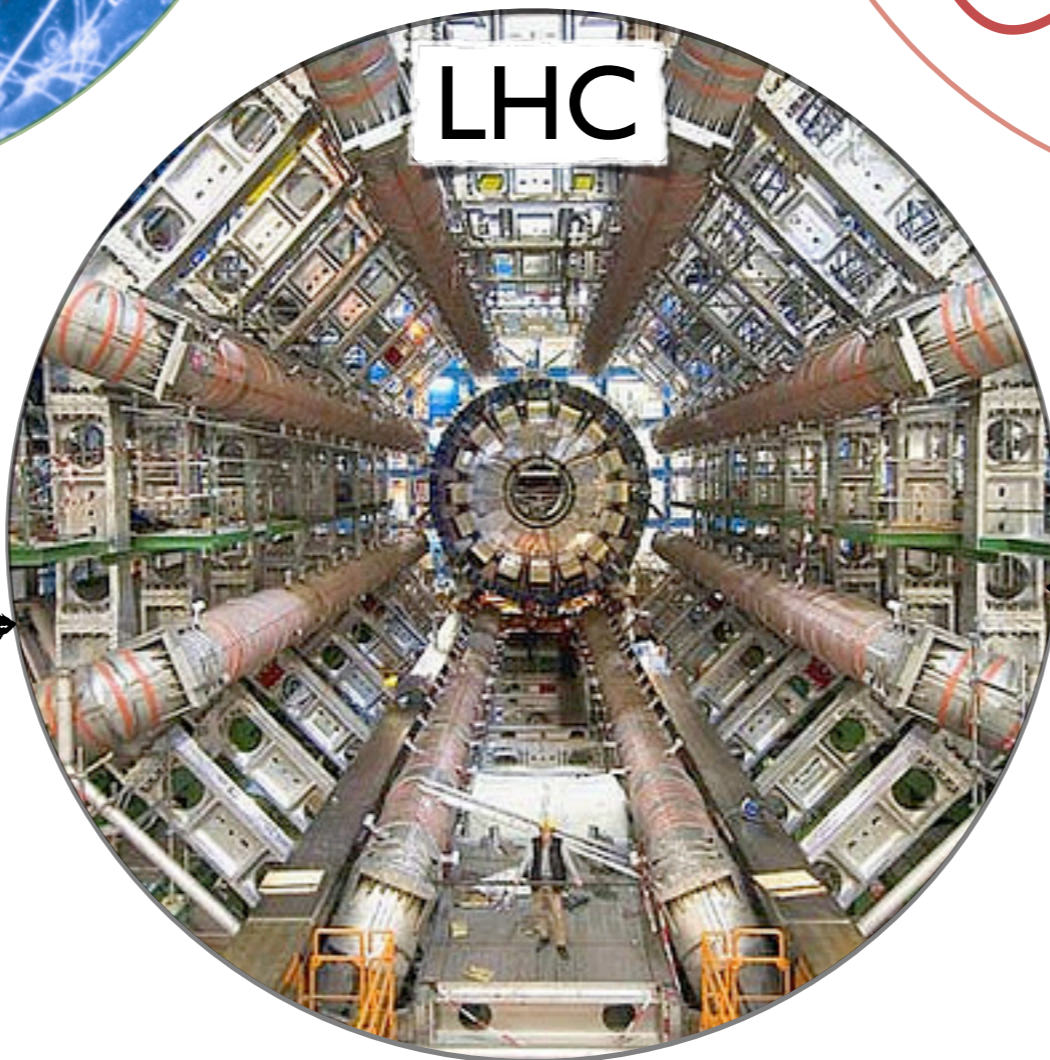
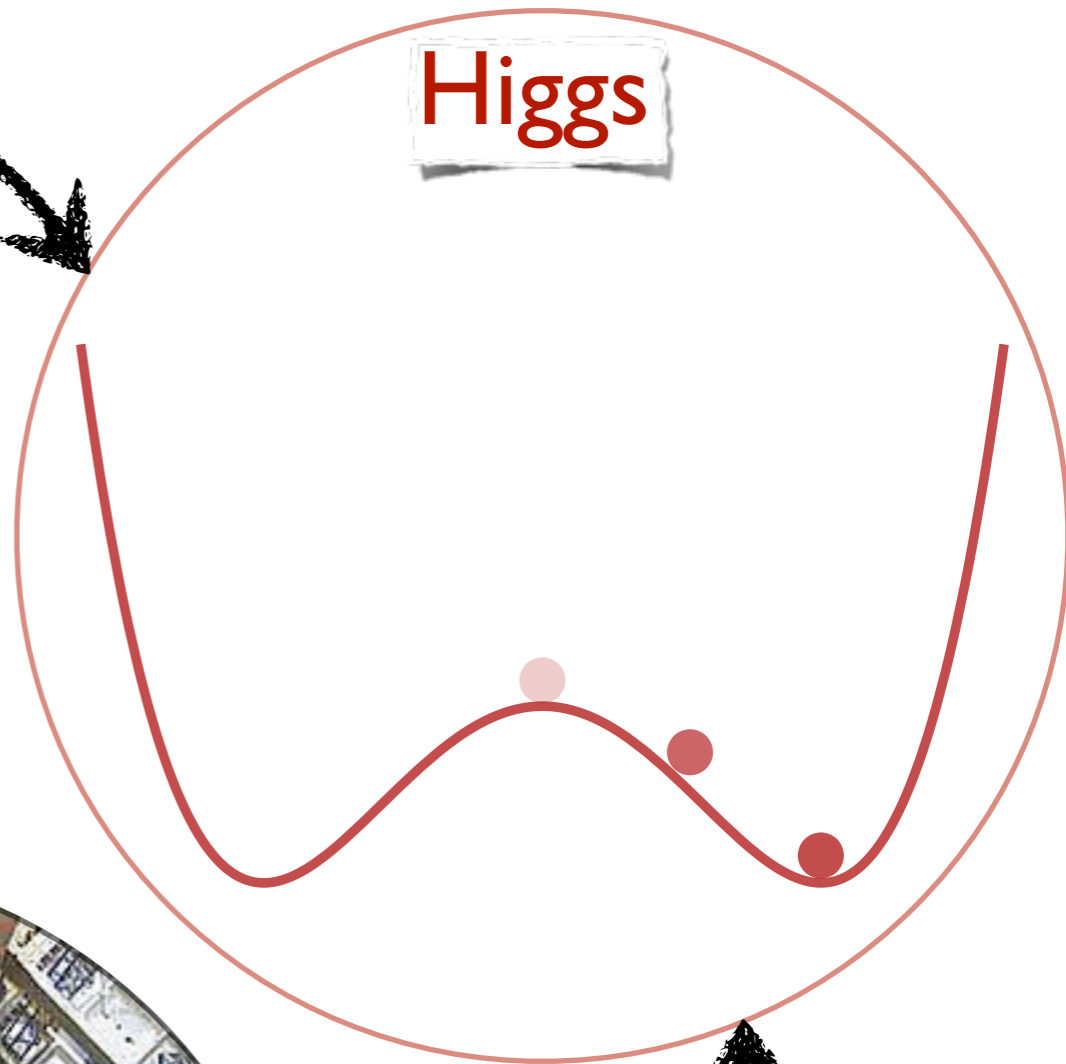
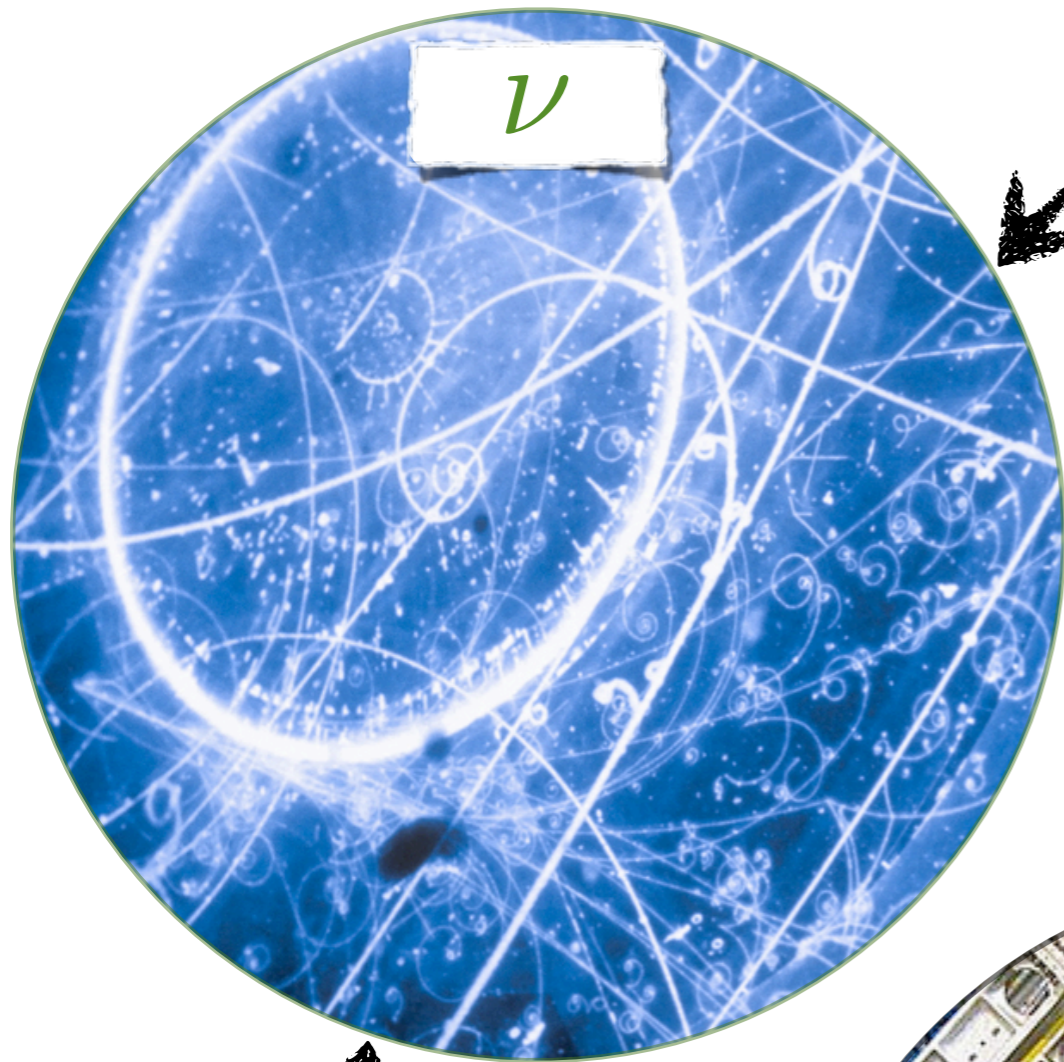
Ljubljana
Oktober 2015

ν







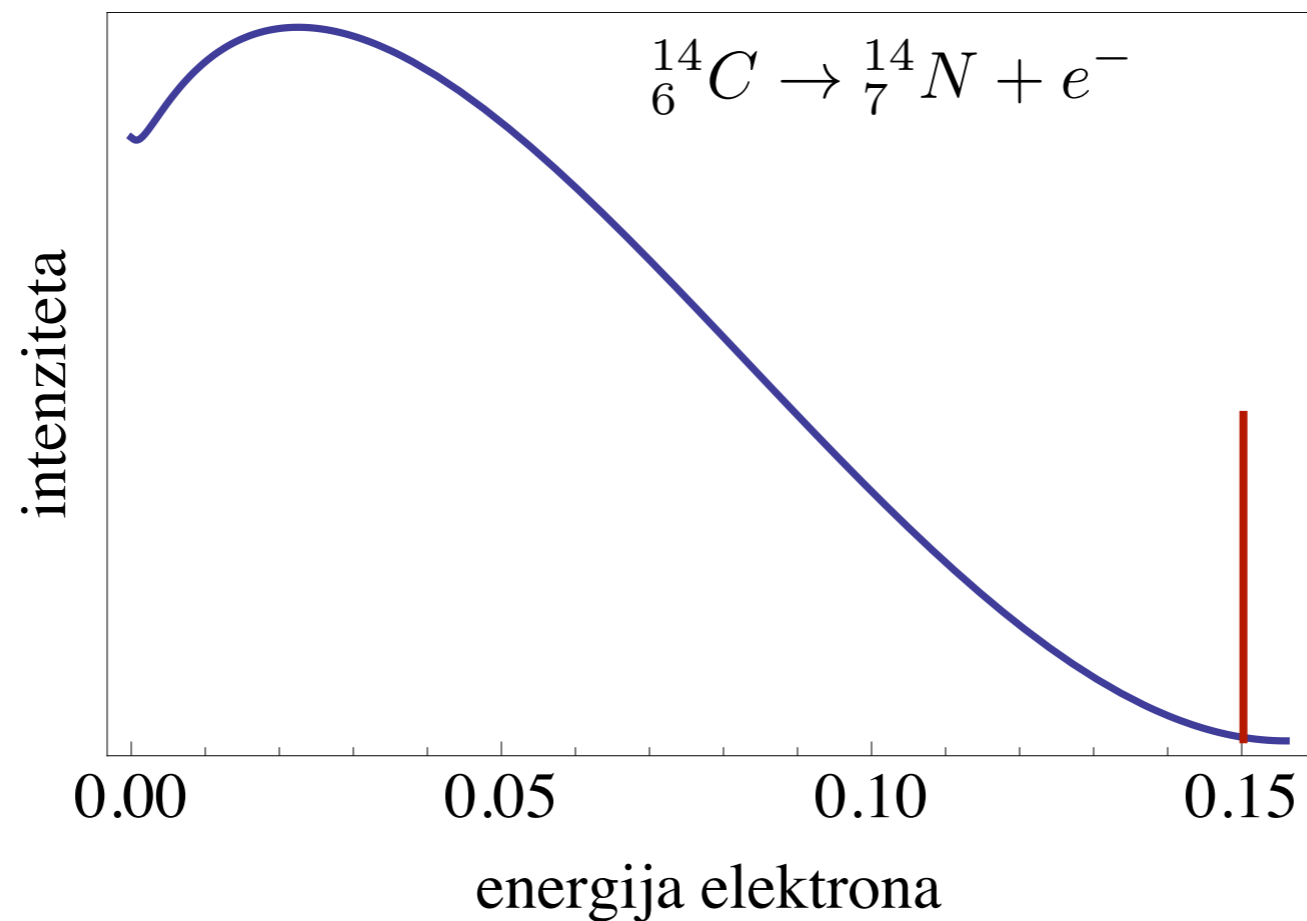


Nevtrino kratka zgodovina eksperimenta

1930 v zmedi glede beta razpada

1914 Chadwick, ...

se energija
ne ohranja?



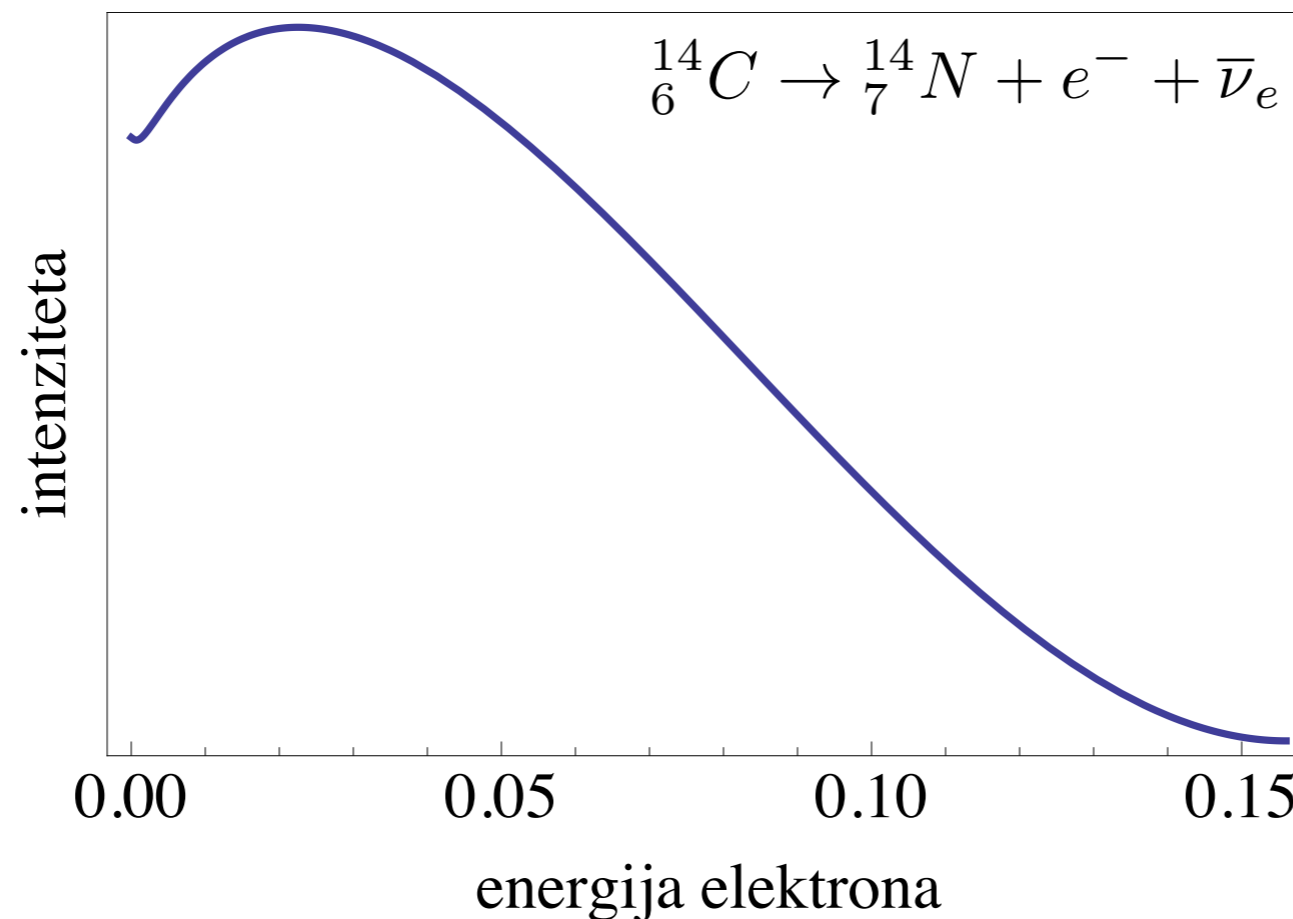
Nevtrino kratka zgodovina eksperimenta

1930 v zmedi glede beta razpada Pauli predlaga obstoj *nevtrona*

Physikalisches Institut
der Eidg. Technischen Hochschule
Zürich

Zürich, 4. Dez. 1930
Gloriastrasse

Liebe Radioaktive Damen und Herren,
Wie der Ueberbringer dieser Zeilen, den ich herzlichst



KATRIN
eksperiment

Nevtrino kratka zgodovina eksperimenta

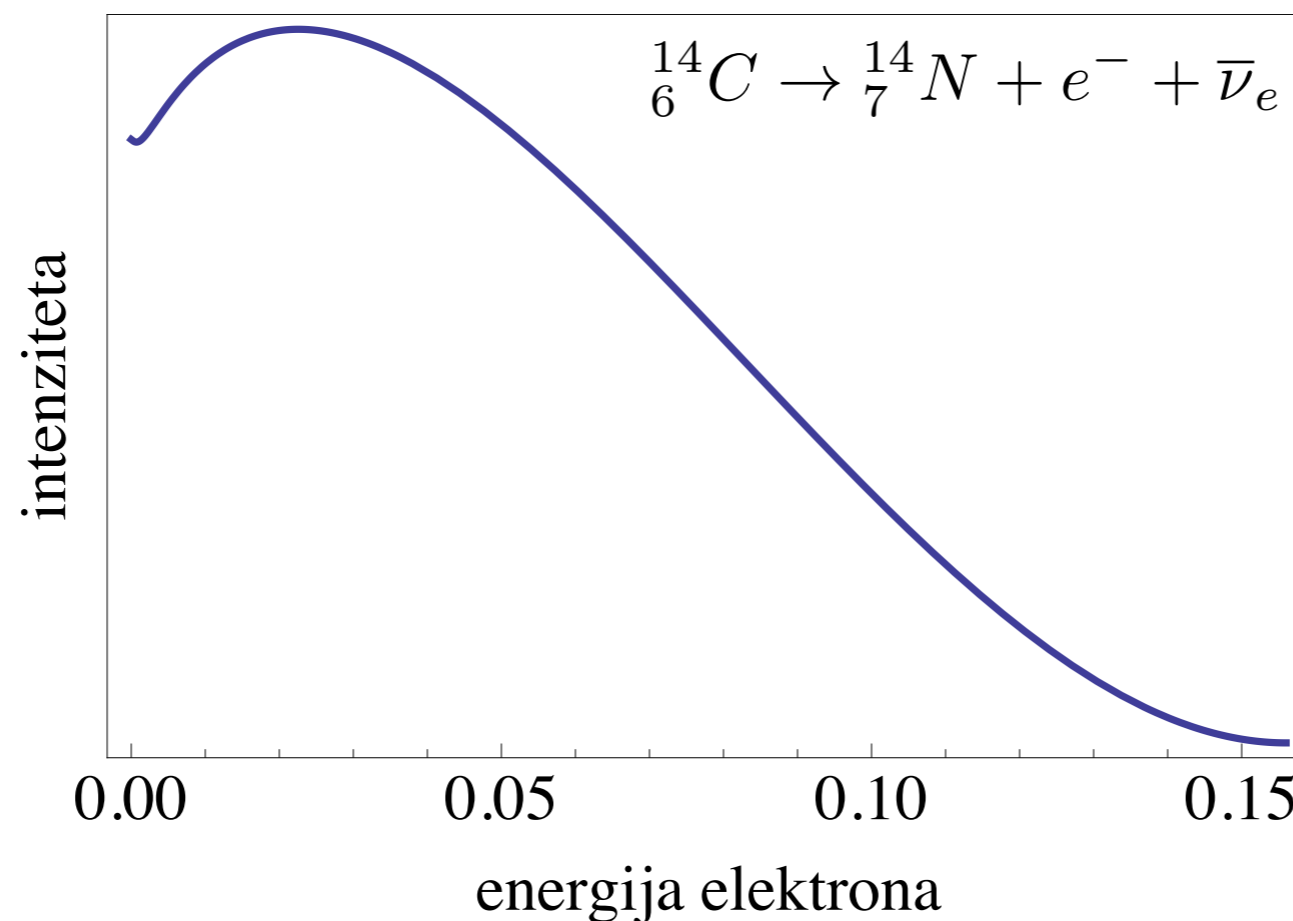
neutrino Fermi

1930 v zmedi glede beta razpada Pauli predlaga obstoj ~~neutrona~~

Physikalisches Institut
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Zürich, 4. Dez. 1930
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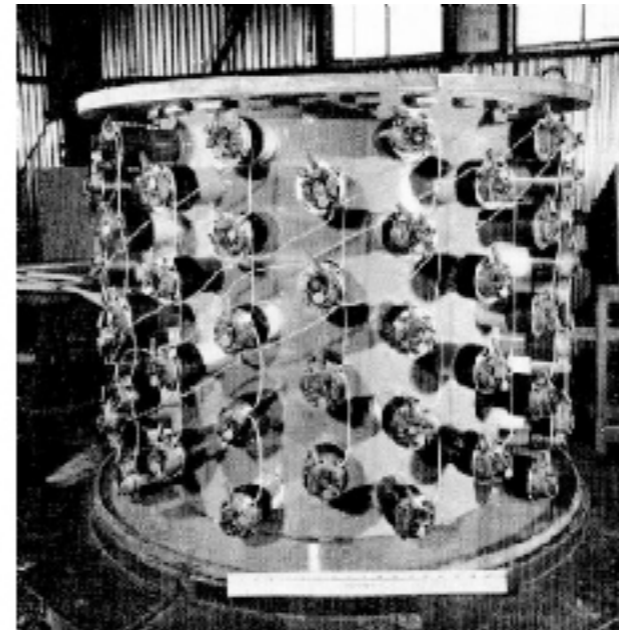
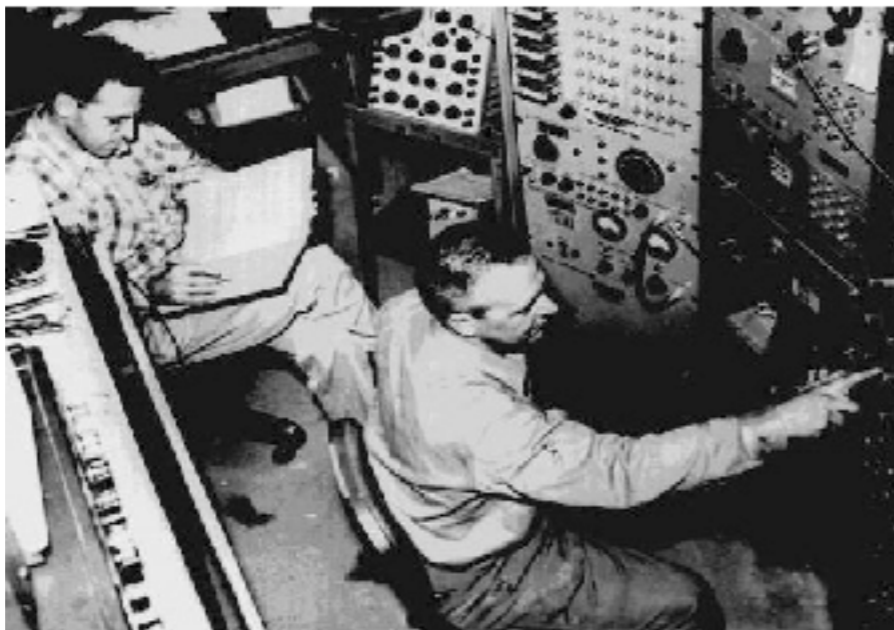
1930 v zmedi glede beta razpada Pauli predlaga obstoj *nevtrina*

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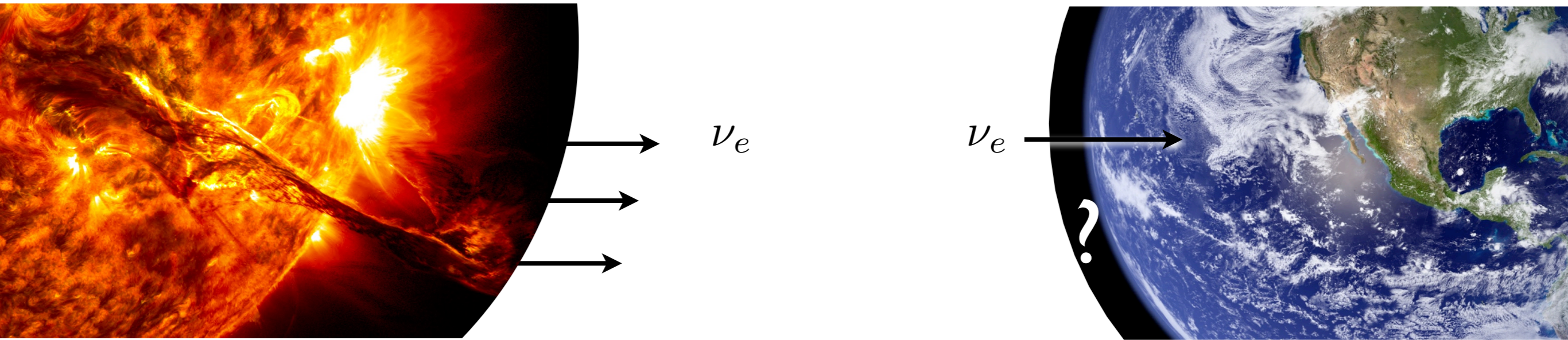
Liebe Radioaktive Damen und Herren,
Wie der Ueberbringer dieser Zeilen, den ich herzlichst

1956 Reines in Cowan izmerita reaktorske anti-nevtrine



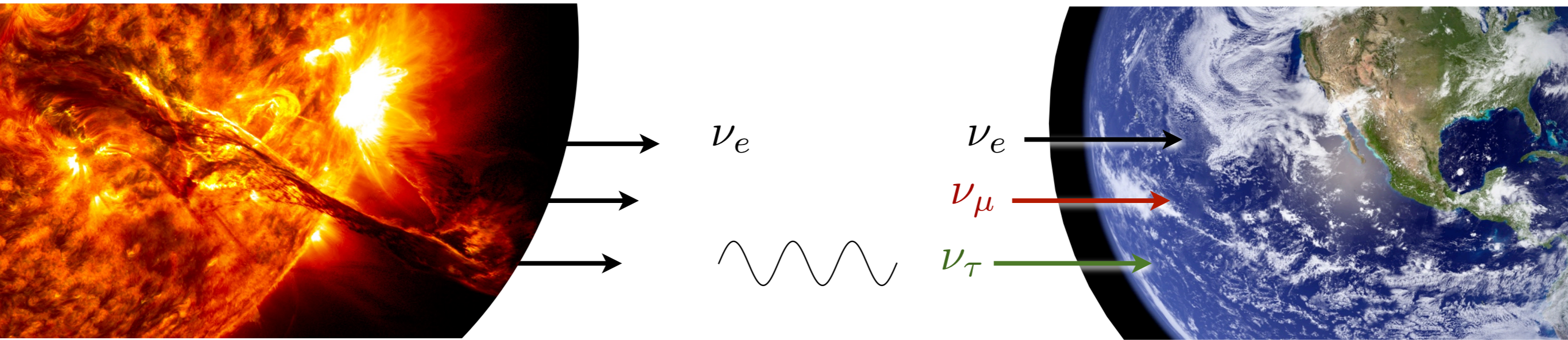
Nevtrino kratka zgodovina eksperimenta

1960-1990 Bahcall napove, Davis izmeri 1/3 nevtrinov iz sonca



Nevtrino kratka zgodovina eksperimenta

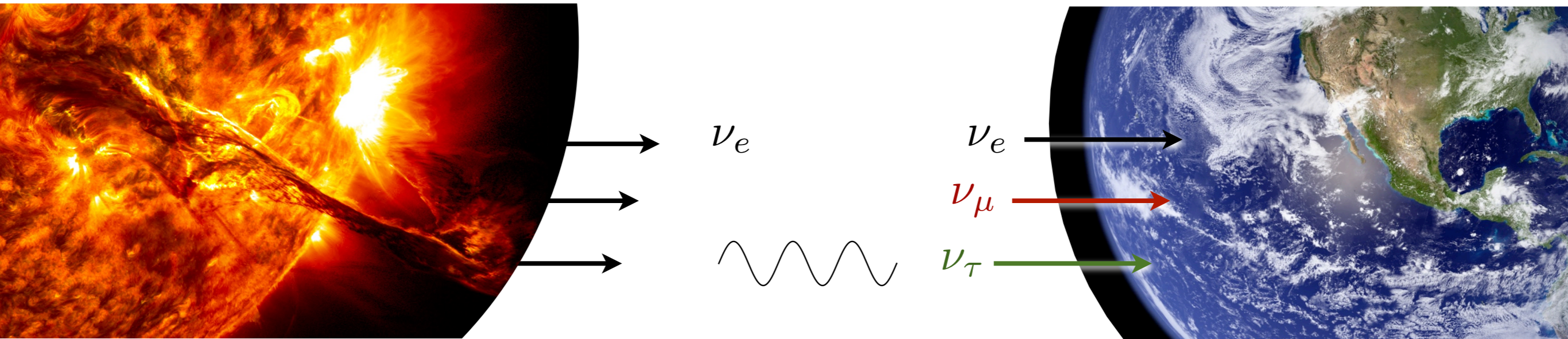
1960-1990 Bahcall napove, Davis izmeri 1/3 nevtrinov iz sonca



1957...- Pontecorvo predlaga
oscilacije nevtrinov z maso

Nevtrino kratka zgodovina eksperimenta

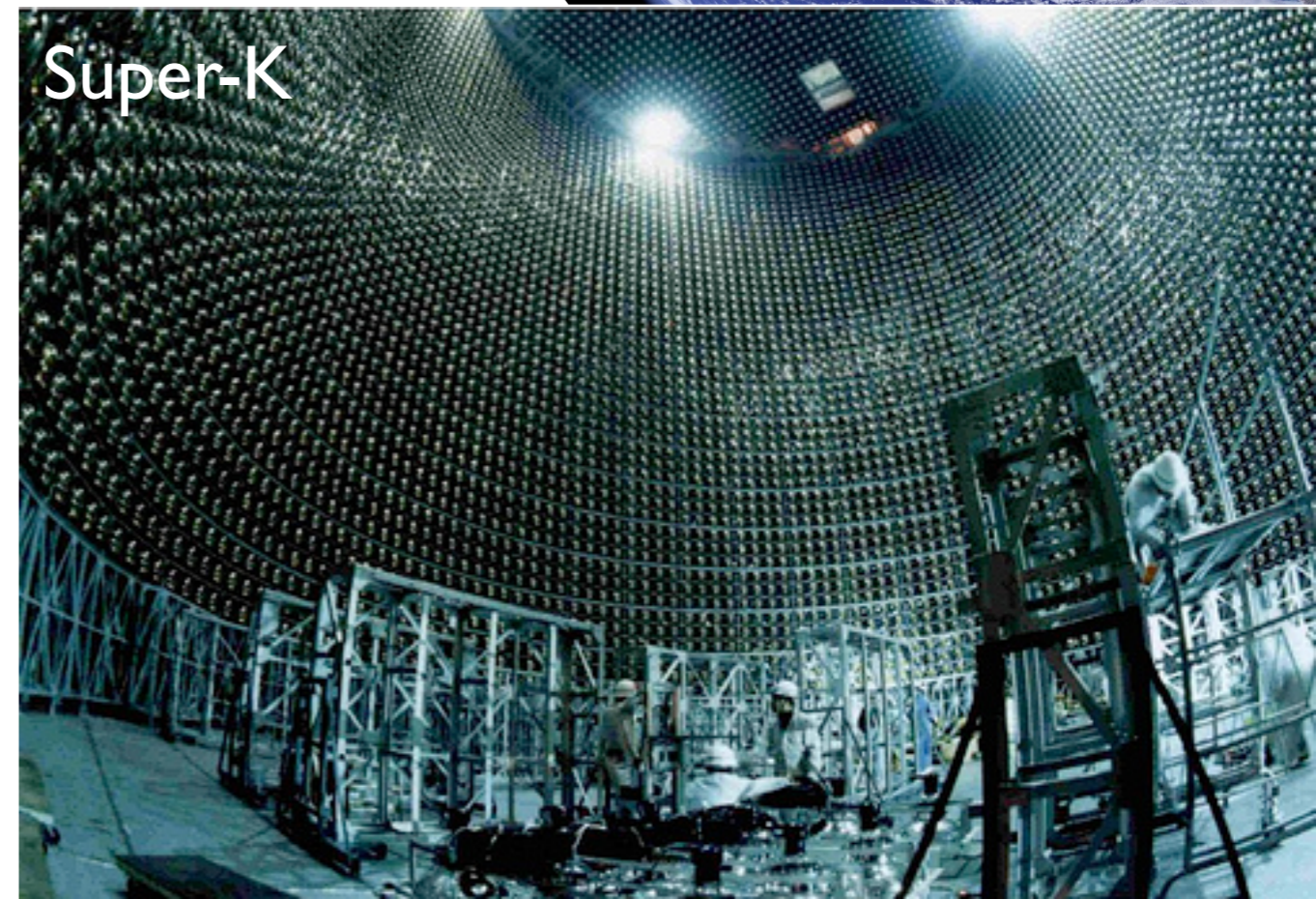
1960-1990 Bahcall napove, Davis izmeri 1/3 nevtrinov iz sonca



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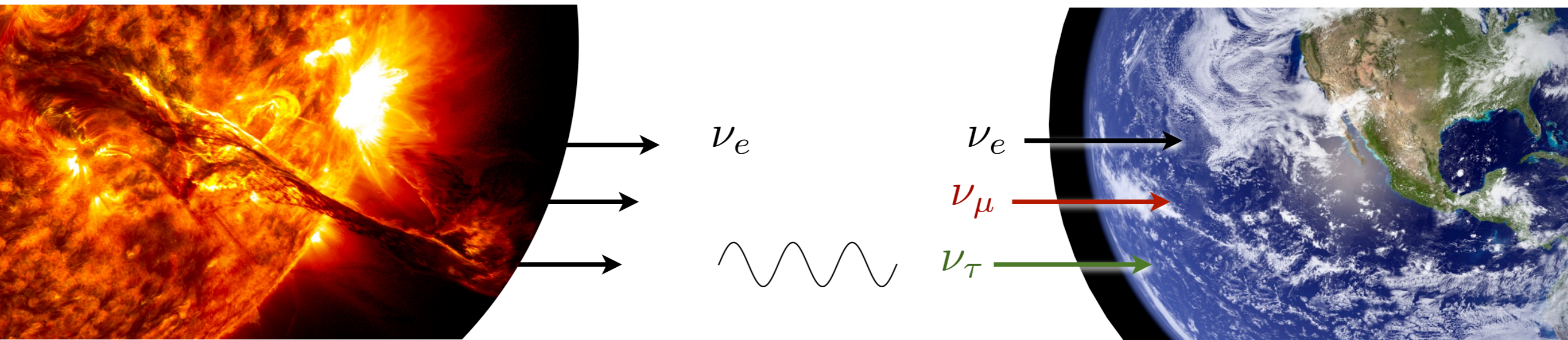
1998 Super-K izmeri atmosferske
oscilacije

2001 SNO potrди Davis-a



Nevtrino kratka zgodovina eksperimenta

1960-1990 Bahcall napove, Davis izmeri 1/3 nevtrinov iz sonca



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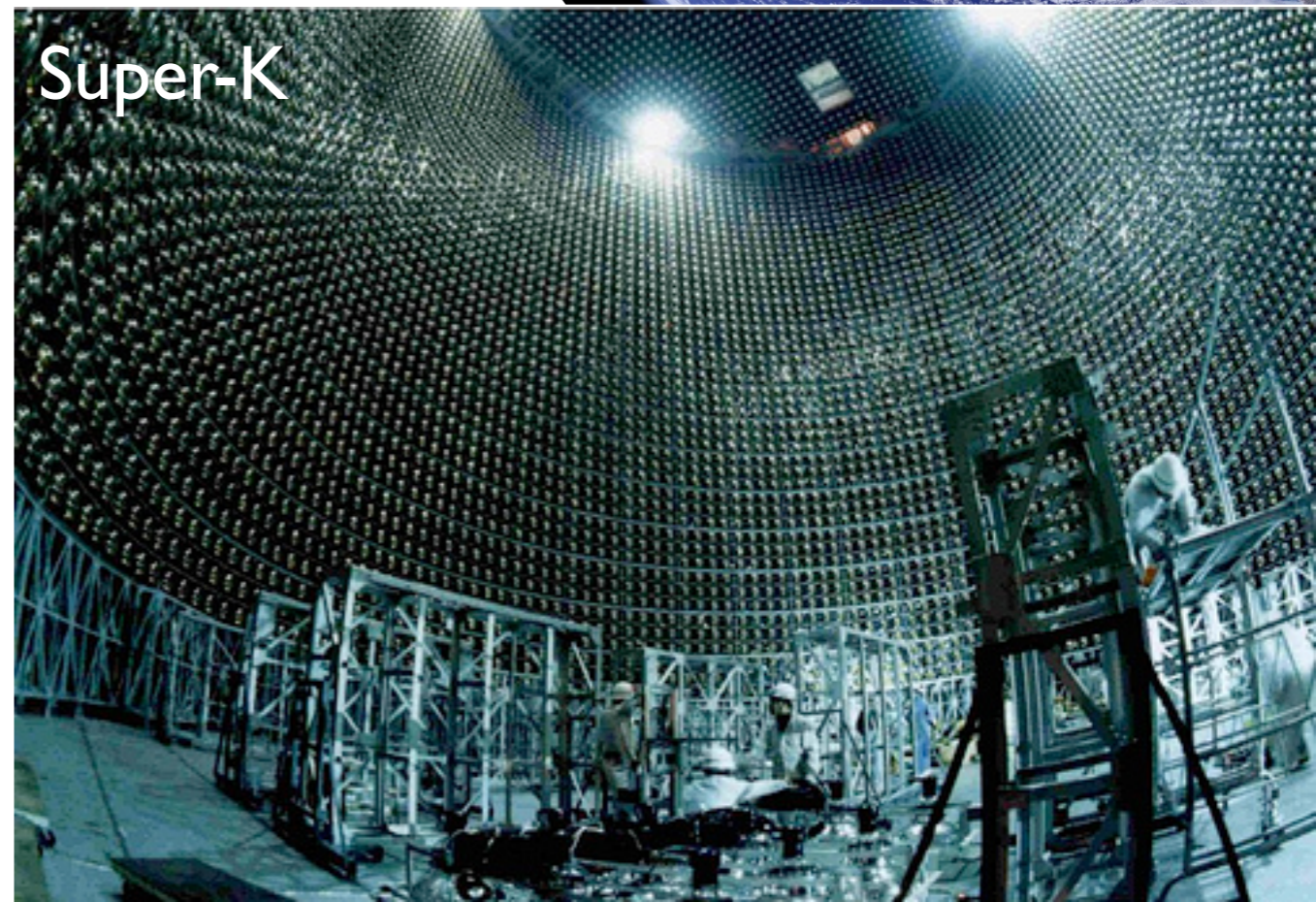
1998 Super-K izmeri atmosferske
oscilacije

2001 SNO potrди Davis-a

$$m_\nu \neq 0$$



2015



Nevtrino kratka zgodovina teorije

1933 Fermiju revija Nature *ne objavi* teorije beta razpada

Špekulativno!

Nevtrino kratka zgodovina teorije

Špekulativno!

1933 Fermiju revija Nature *ne objavi* teorije beta razpada

1937 Majorana za habilitacijo objavi teorijo 'realnih' fermionov



in izgine.

Nevtrino kratka zgodovina teorije

Špekulativno!

1933 Fermiju revija Nature *ne objavi* teorije beta razpada

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$$\nu = \bar{\nu}$$

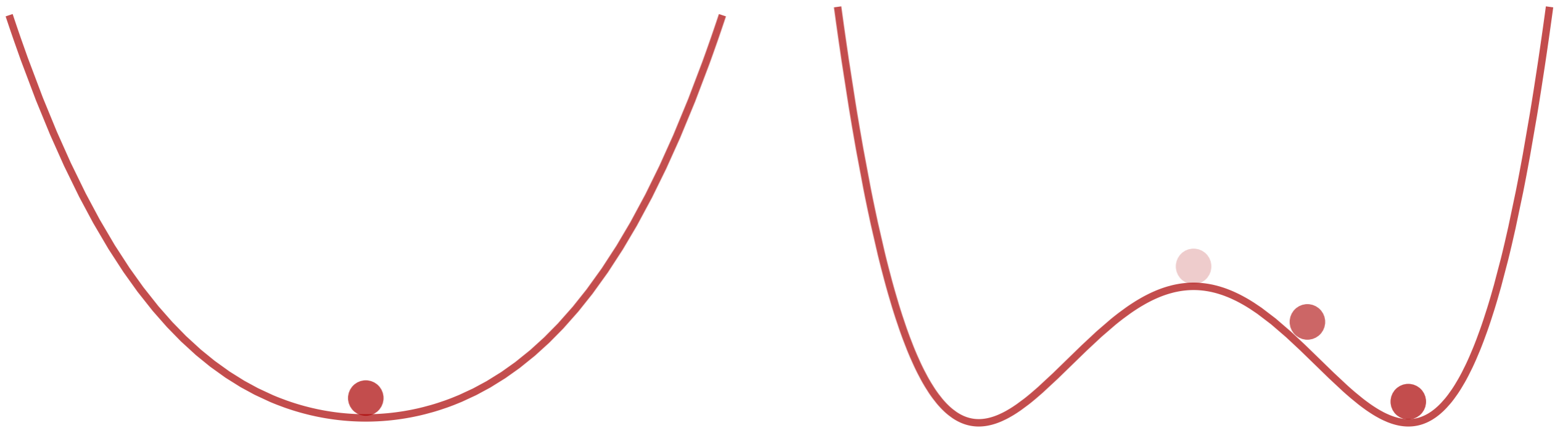
in izgine.

1937 Racah & Furry: iskanje Majorana nevtrina...

...se nadaljuje še danes.

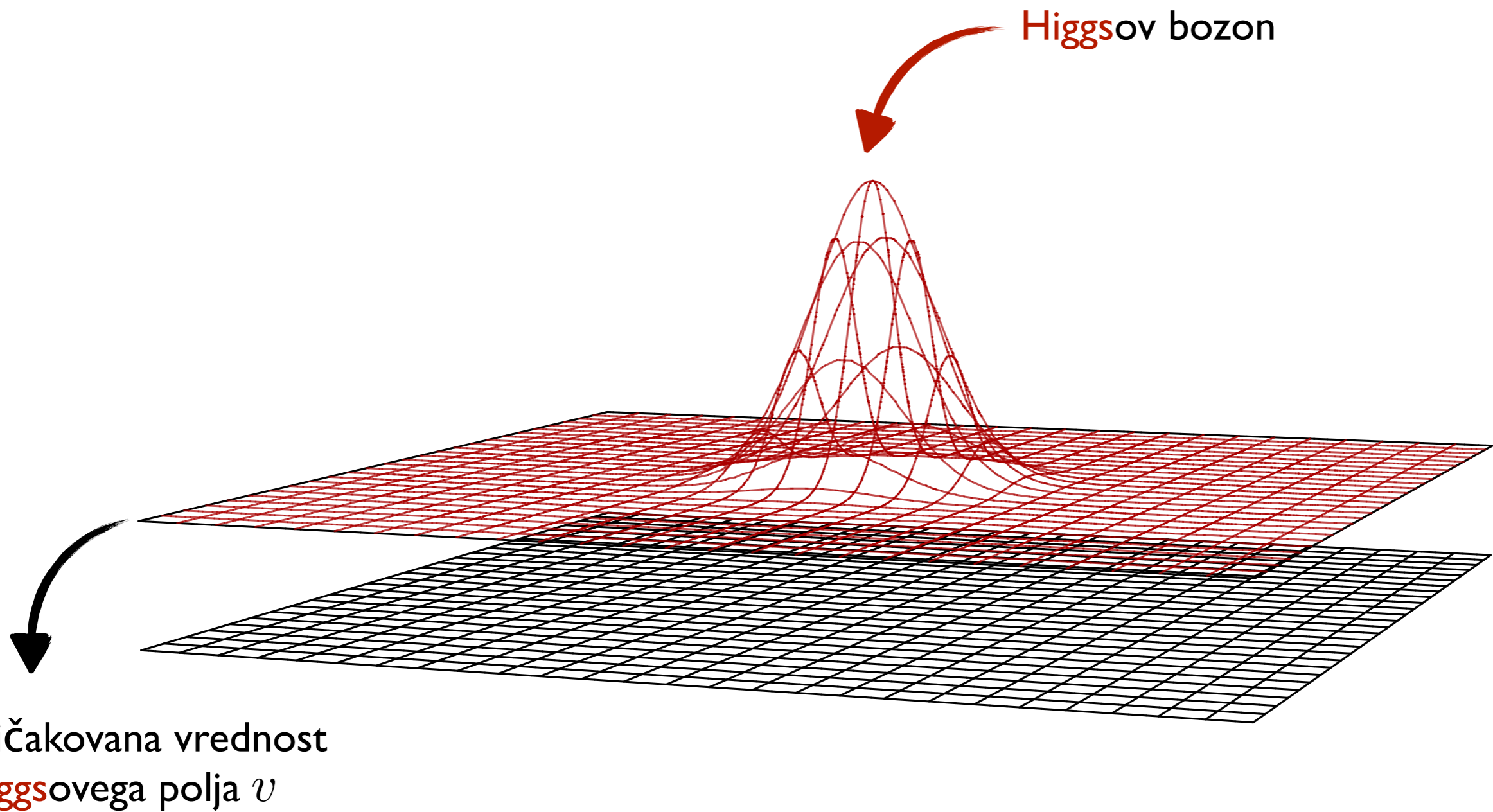
Higgsov mehanizem

1960 Nambu, '61 Goldstone: spontani zlom simetrije



Higgsov mehanizem

1964 Higgs uporabi mehanizem za interakcije delcev



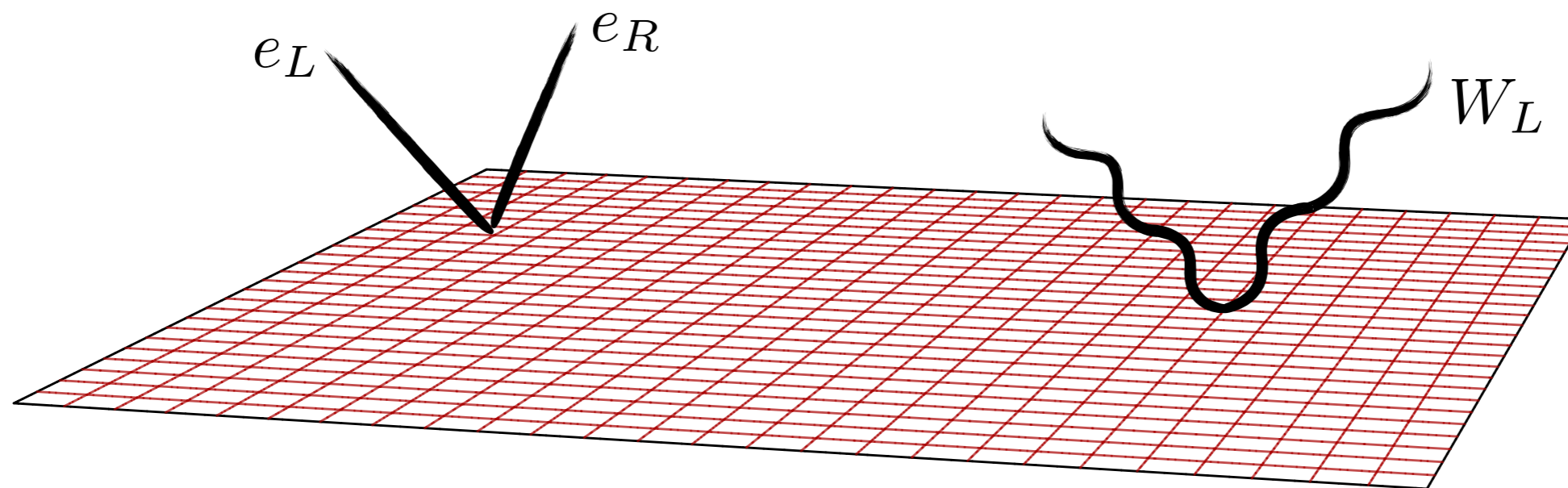
Higgsov mehanizem in izvor mase

Masa delca sorazmerna sklopitvi s Higgs poljem

Higgsov mehanizem in izvor mase

Masa delca sorazmerna sklopitvi s Higgs poljem

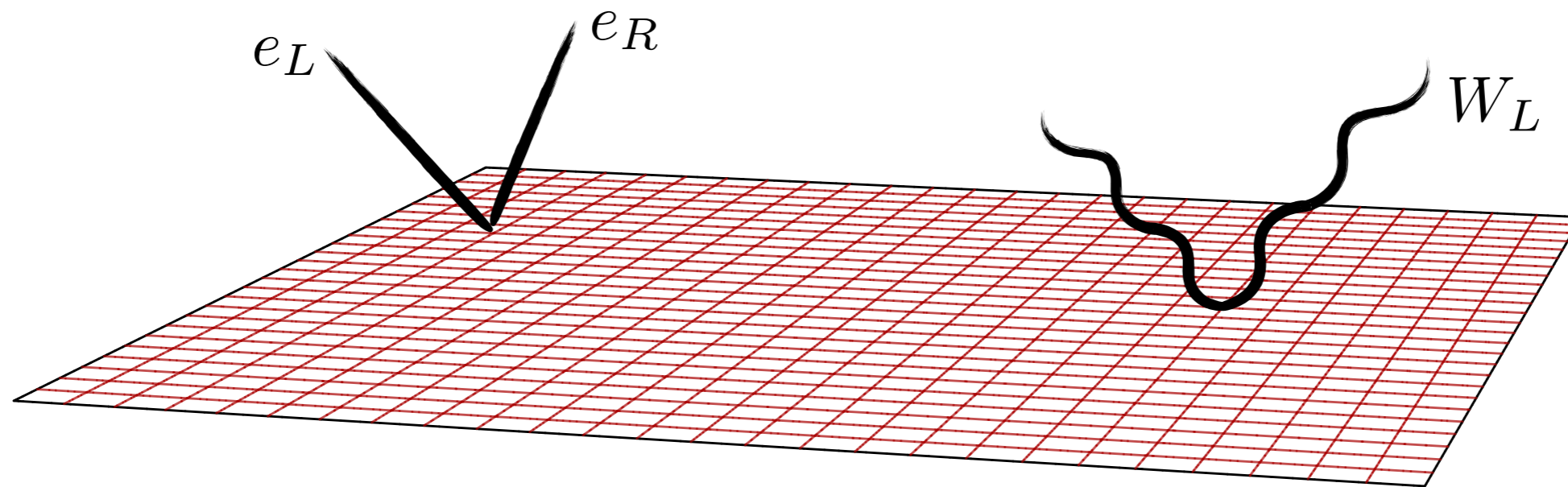
1967 Weinberg uporabi Higgsov bozon za šibko interakcijo



Higgsov mehanizem in izvor mase

Masa delca sorazmerna sklopitvi s Higgs poljem

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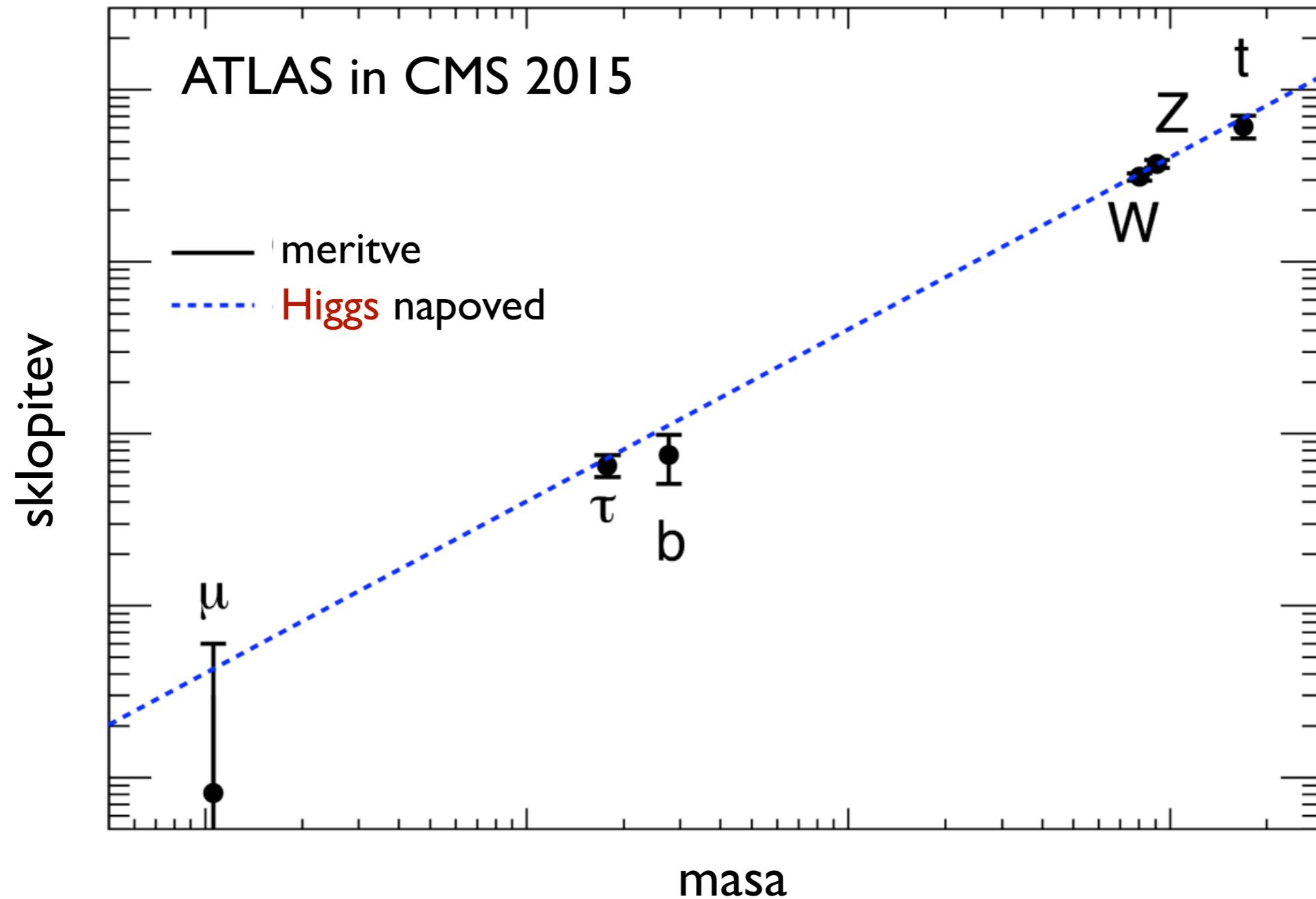


Mehanizem nedavno preverjen na LHC!

- 1) napravimo Higgsov bozon
- 2) napovemo in izmerimo sklopitve

Higgs in izvor mase

Masa delca sorazmerna sklopitvi s Higgs poljem

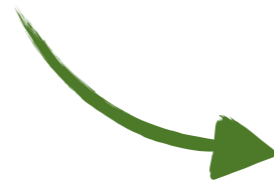


Nevtrino kratko nadaljevanje zgodovine teorije

1967 Weinbergov asimetrični model napove **Higgs** sklopitve in

$$m_\nu = 0$$

V skladu z (nekaterimi) teorijami poenotenja

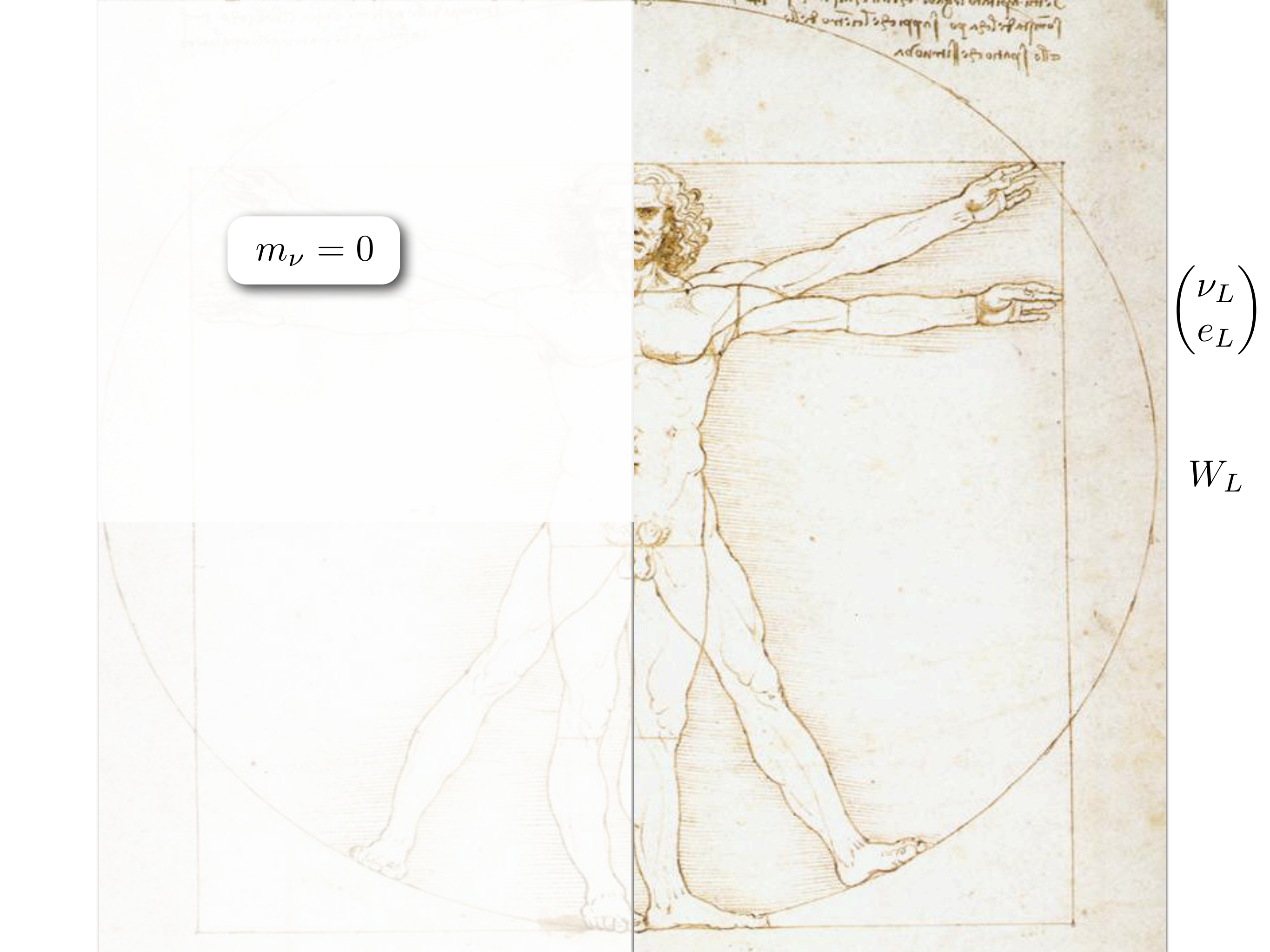


pedsodek proti Davis & Bahcall



$$\begin{pmatrix} \nu_L \\ e_L \end{pmatrix}$$

W_L


$$m_\nu = 0$$

$$\begin{pmatrix} \nu_L \\ e_L \end{pmatrix}$$

 W_L

Nevtrino kratko nadaljevanje zgodovine teorije

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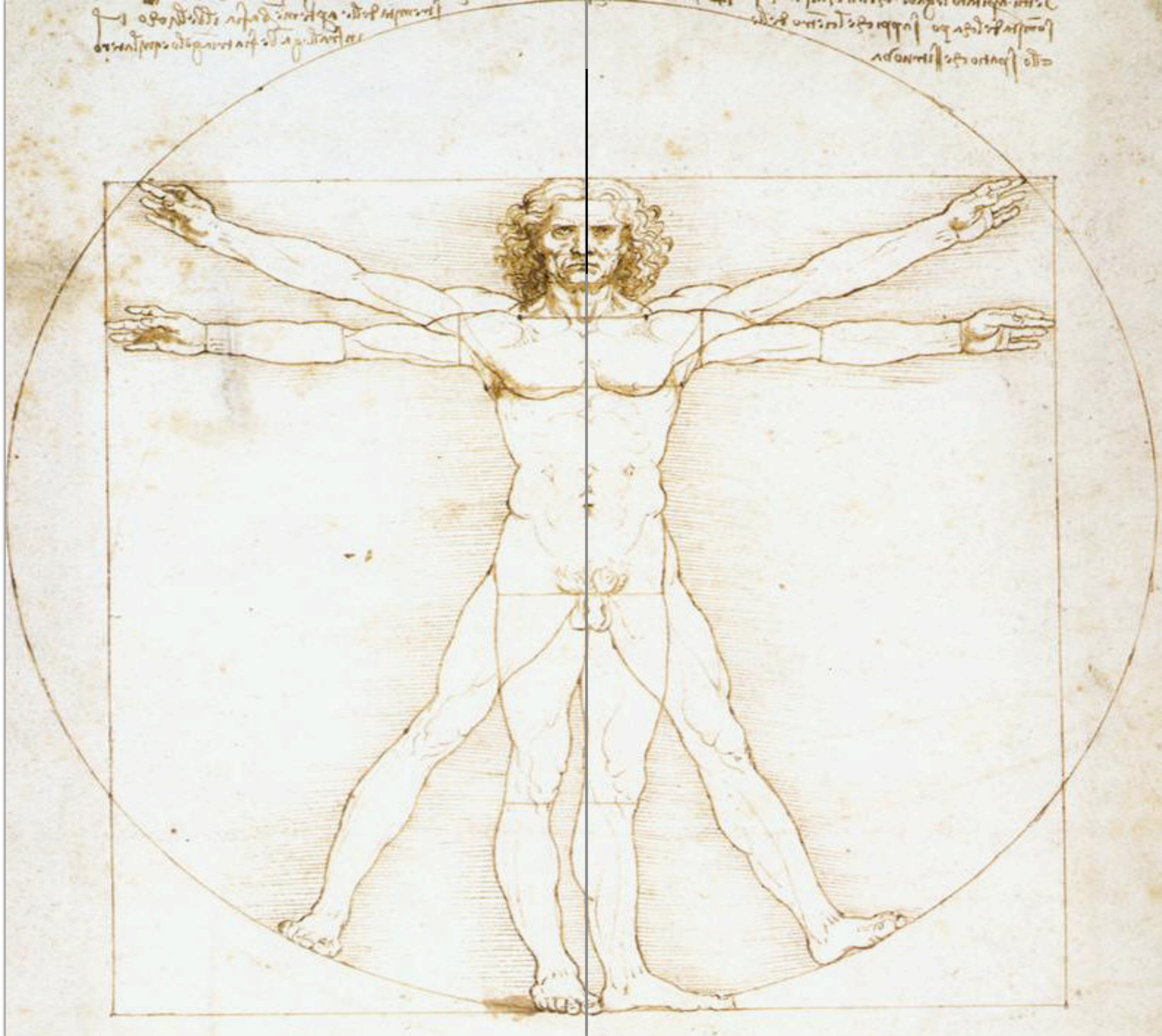
1974 Pati in Salam predlagata Levo-Desno simetrijo

1975 Senjanović in Mohapatra jo spontano zlomita

1979 Gugalnični mehanizem in majhne mase nevtrinov

$\begin{pmatrix} \nu_R \\ e_R \end{pmatrix}$

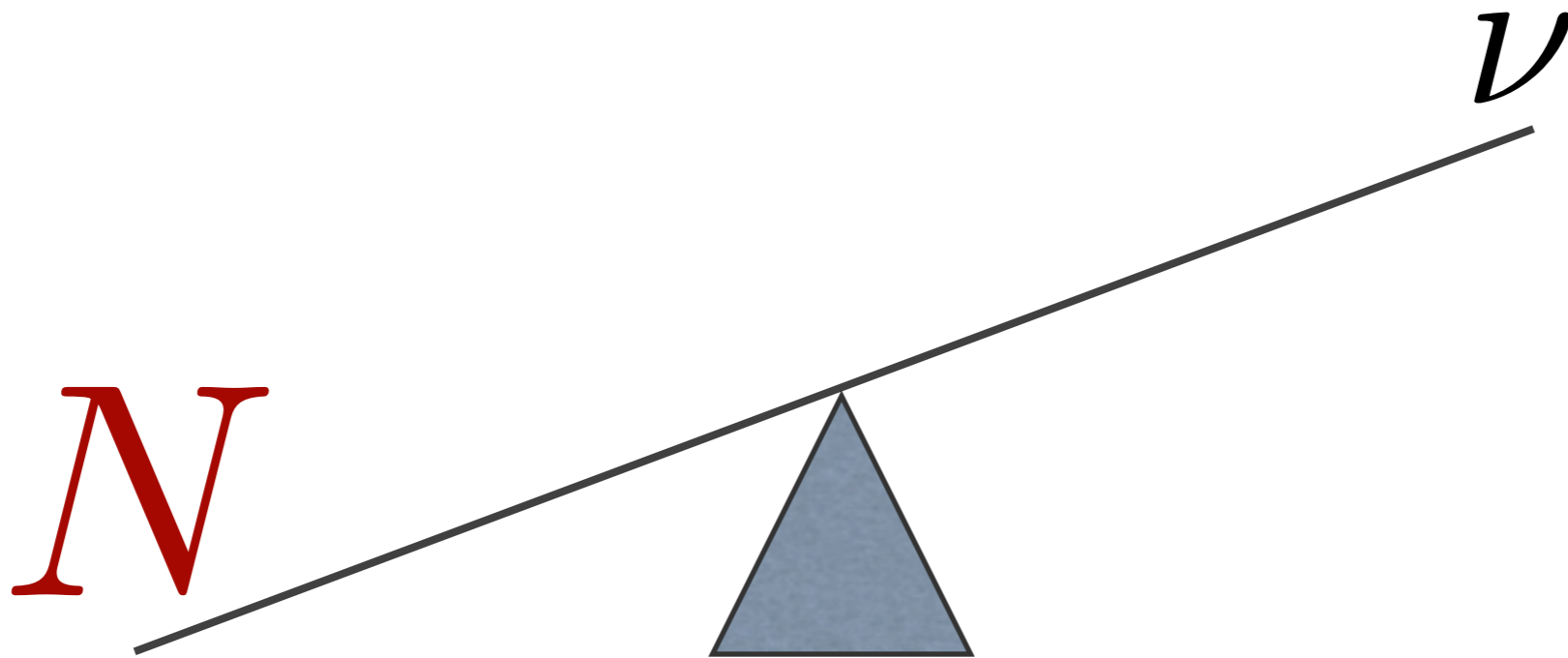
W_R



$\begin{pmatrix} \nu_L \\ e_L \end{pmatrix}$

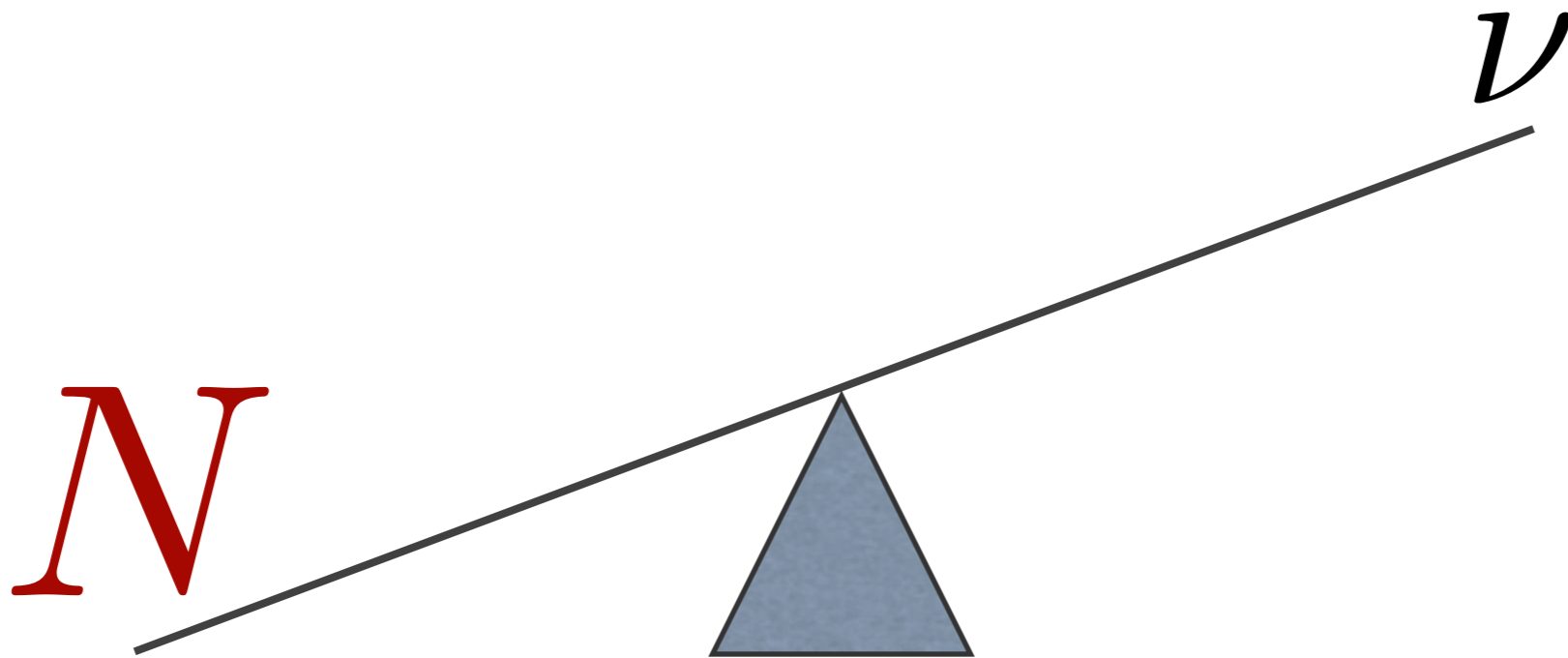
W_L

Majorana nevtrino in gugalnični mehanizem



$$m_\nu \propto \frac{v^2}{m_N}$$

Majorana nevtrino in gugalnični mehanizem



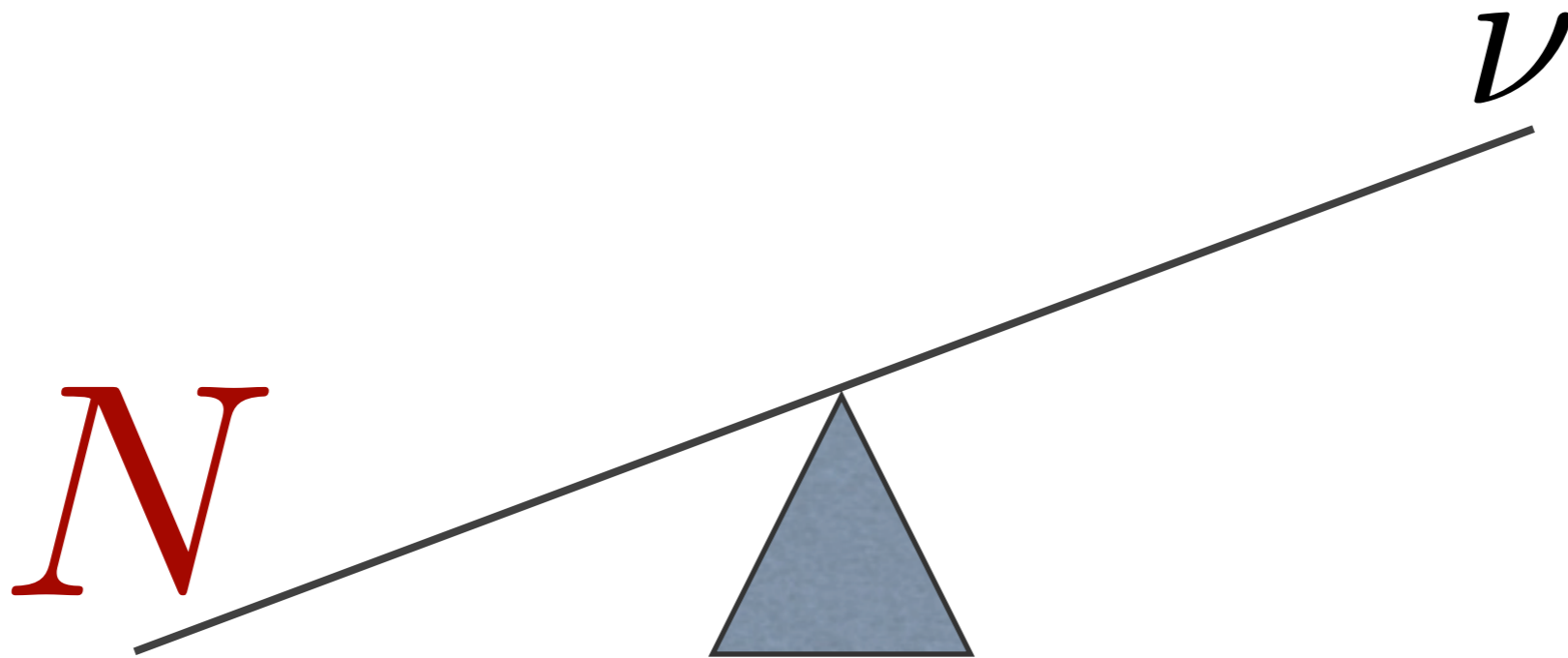
nevtrinske oscilacije

$0\nu 2\beta$

β spekter ?

kozmozologija

Majorana nevtrino in gugalnični mehanizem



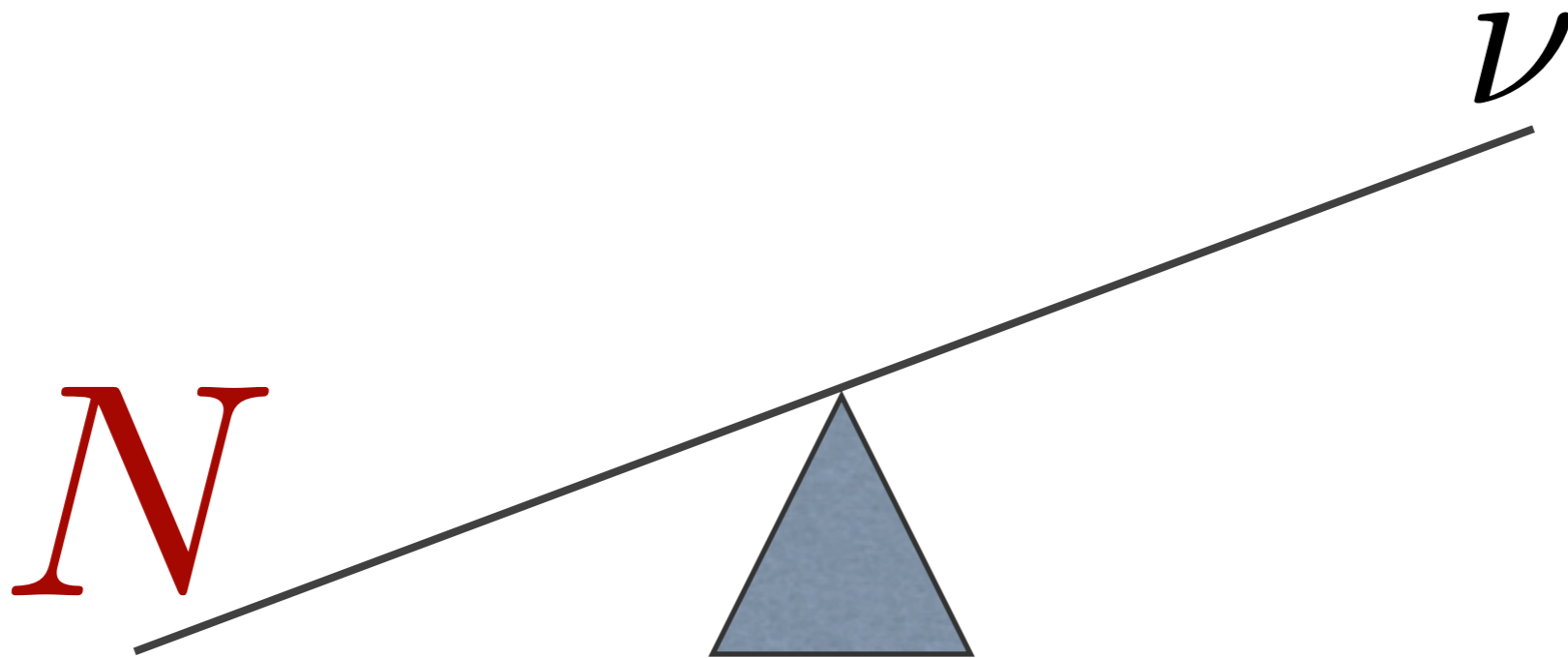
LHC in Higgs

redki razpadi

$0\nu 2\beta$?

temna snov

Majorana nevtrino in gugalnični mehanizem



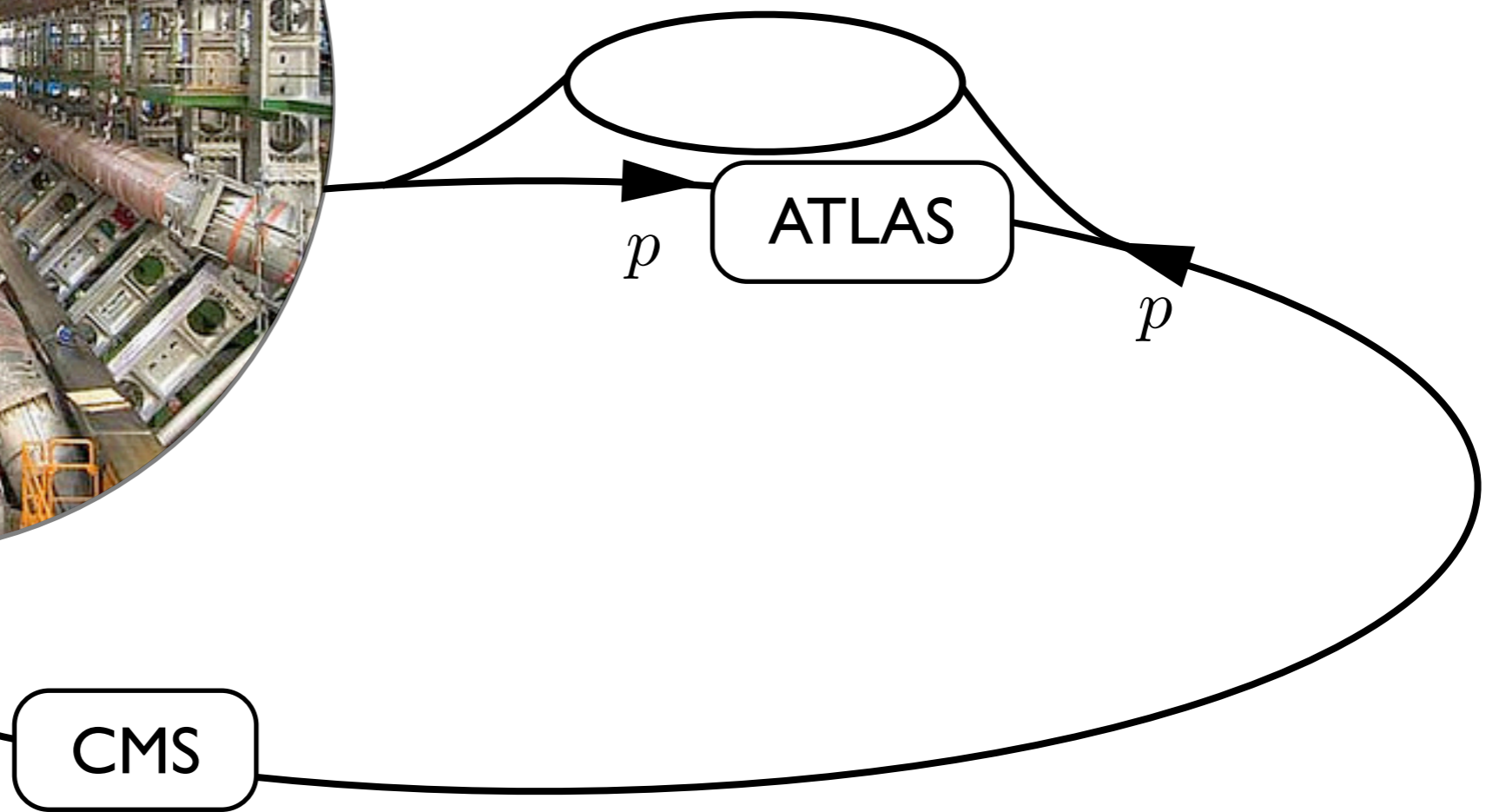
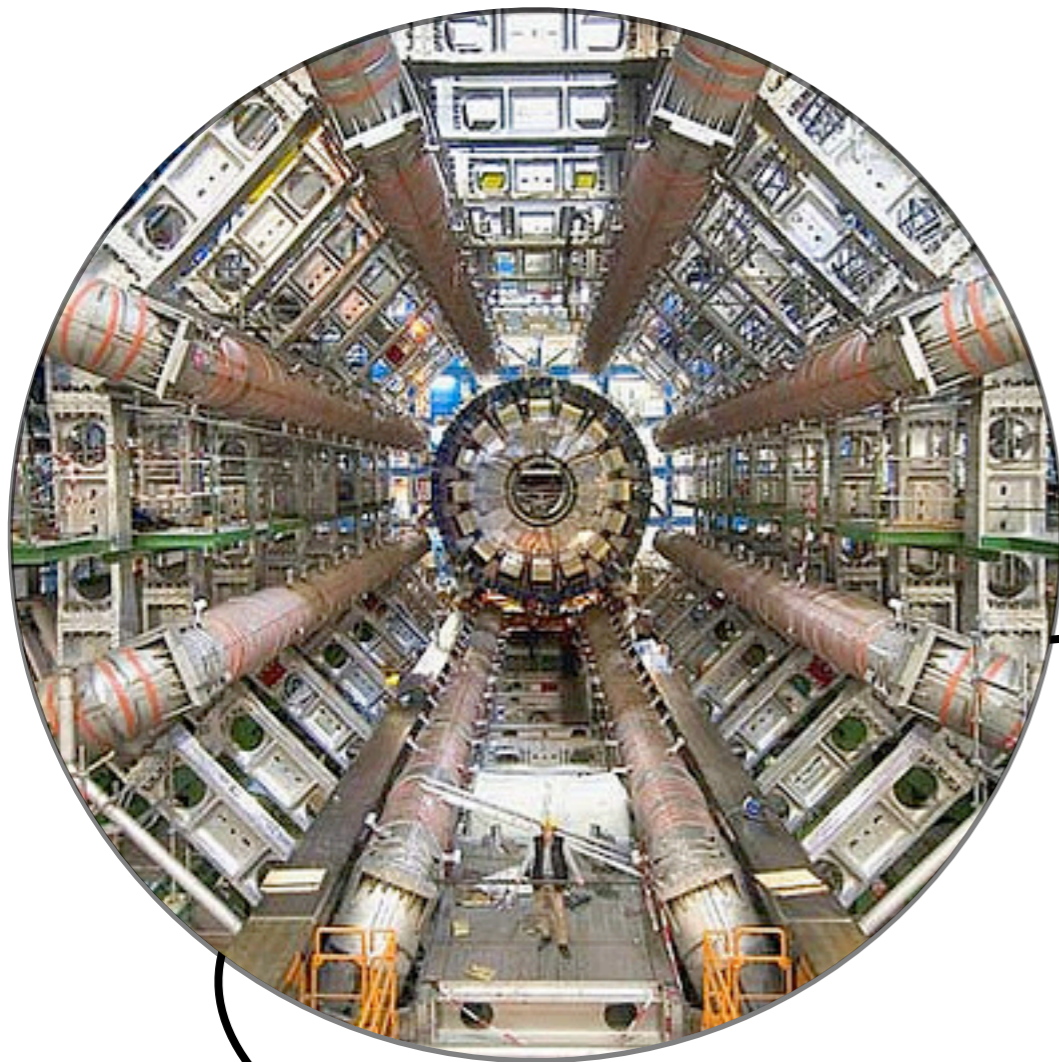
LHC in Higgs

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$0\nu 2\beta$?

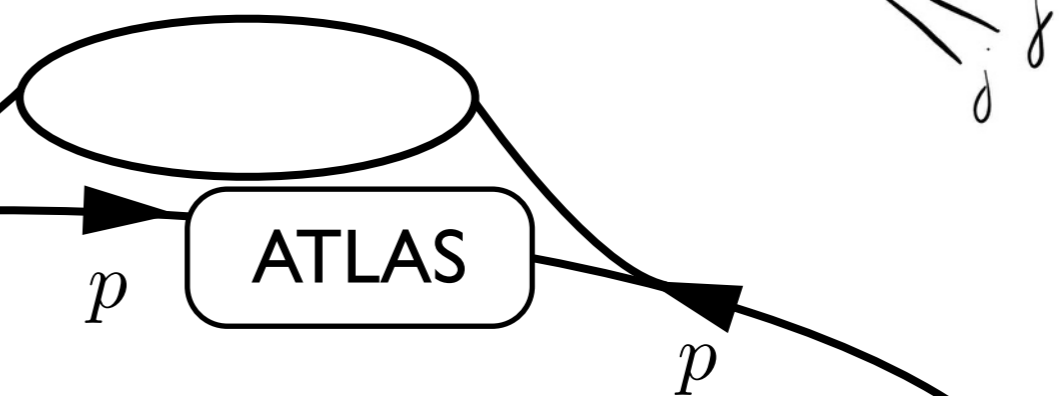
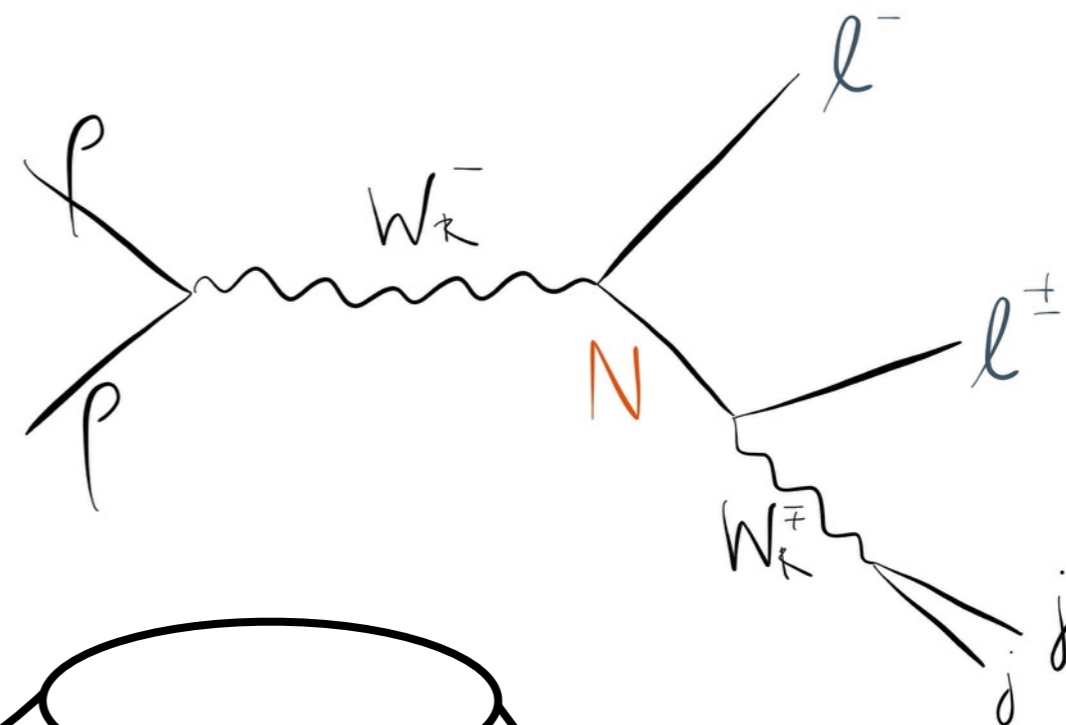
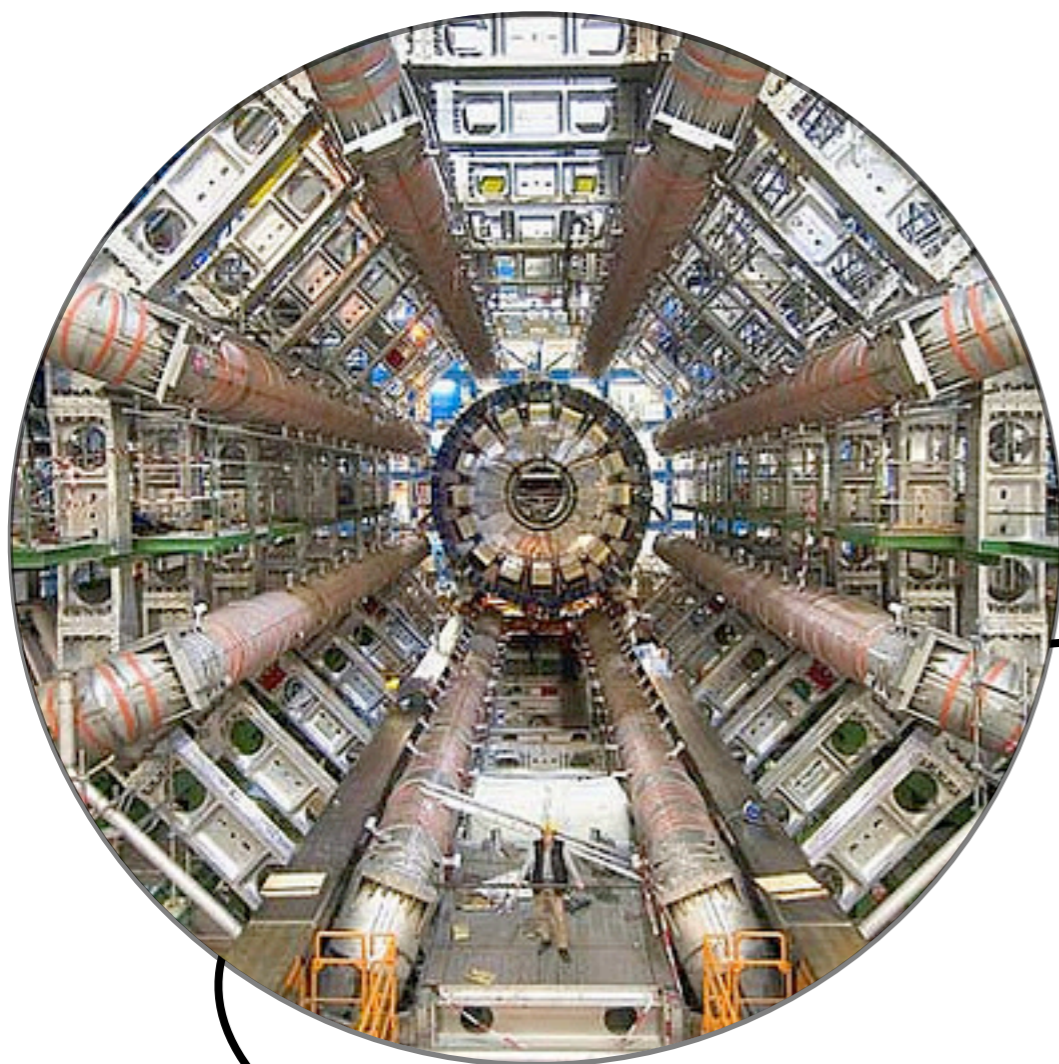
temna snov

Majorana neutrino in LHC



Majorana nevtrino in LHC

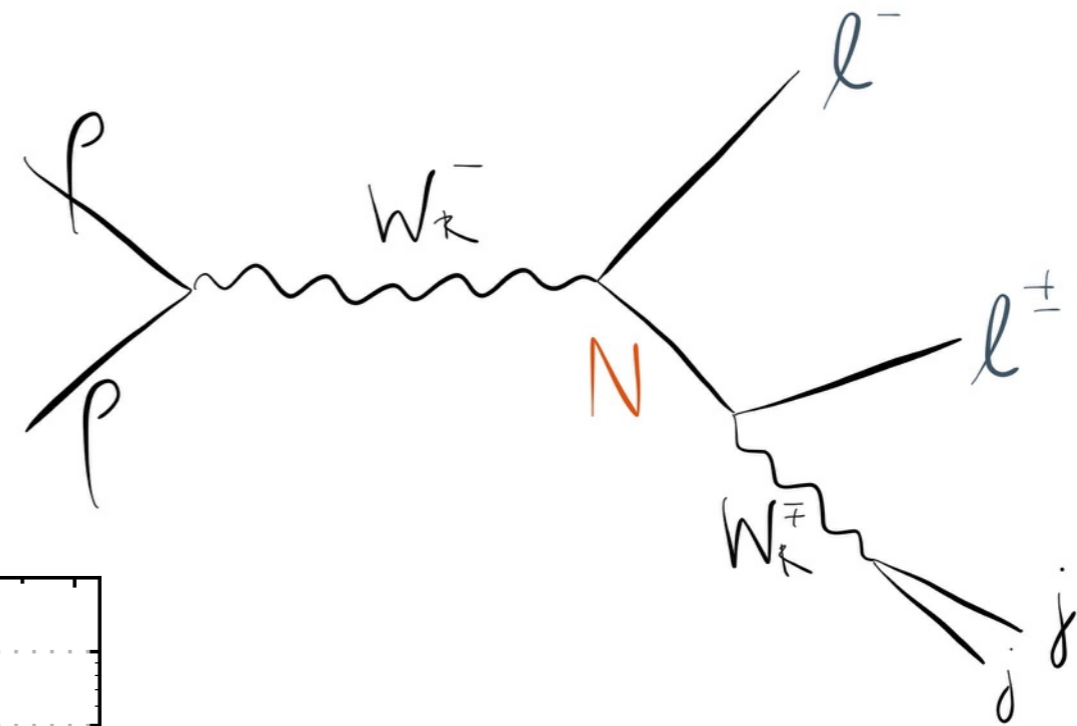
1983 Keung in Senjanović: N na trkalniku



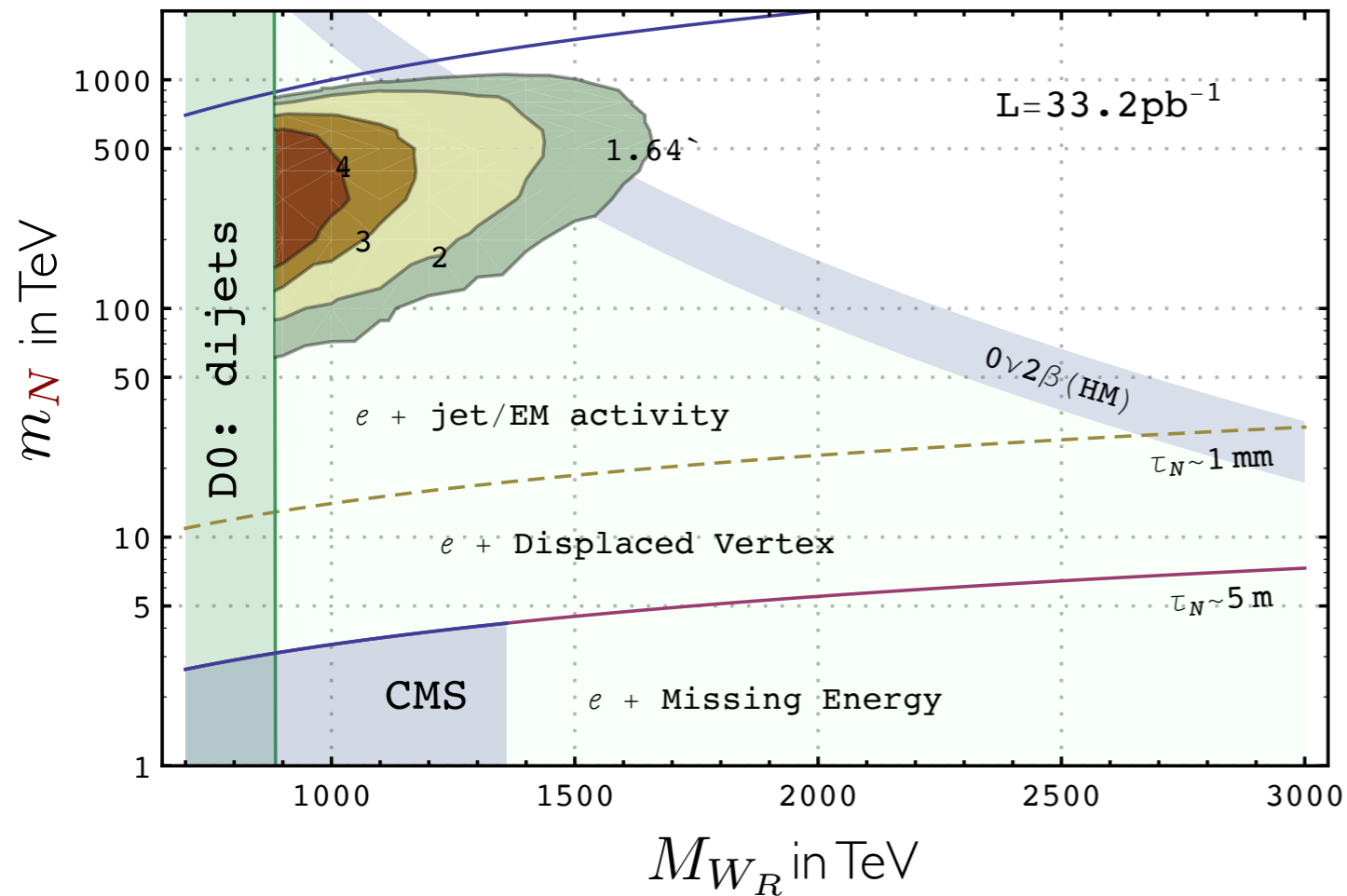
CMS

Majorana nevtrino in LHC

1983 Keung in Senjanović: N na trkalniku



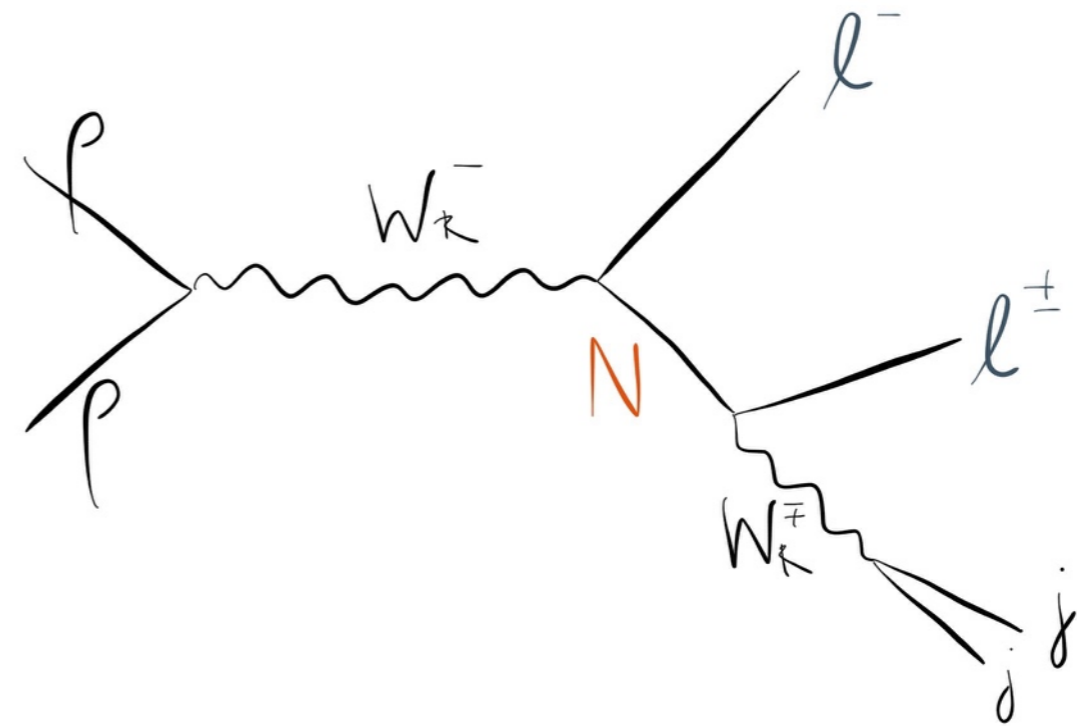
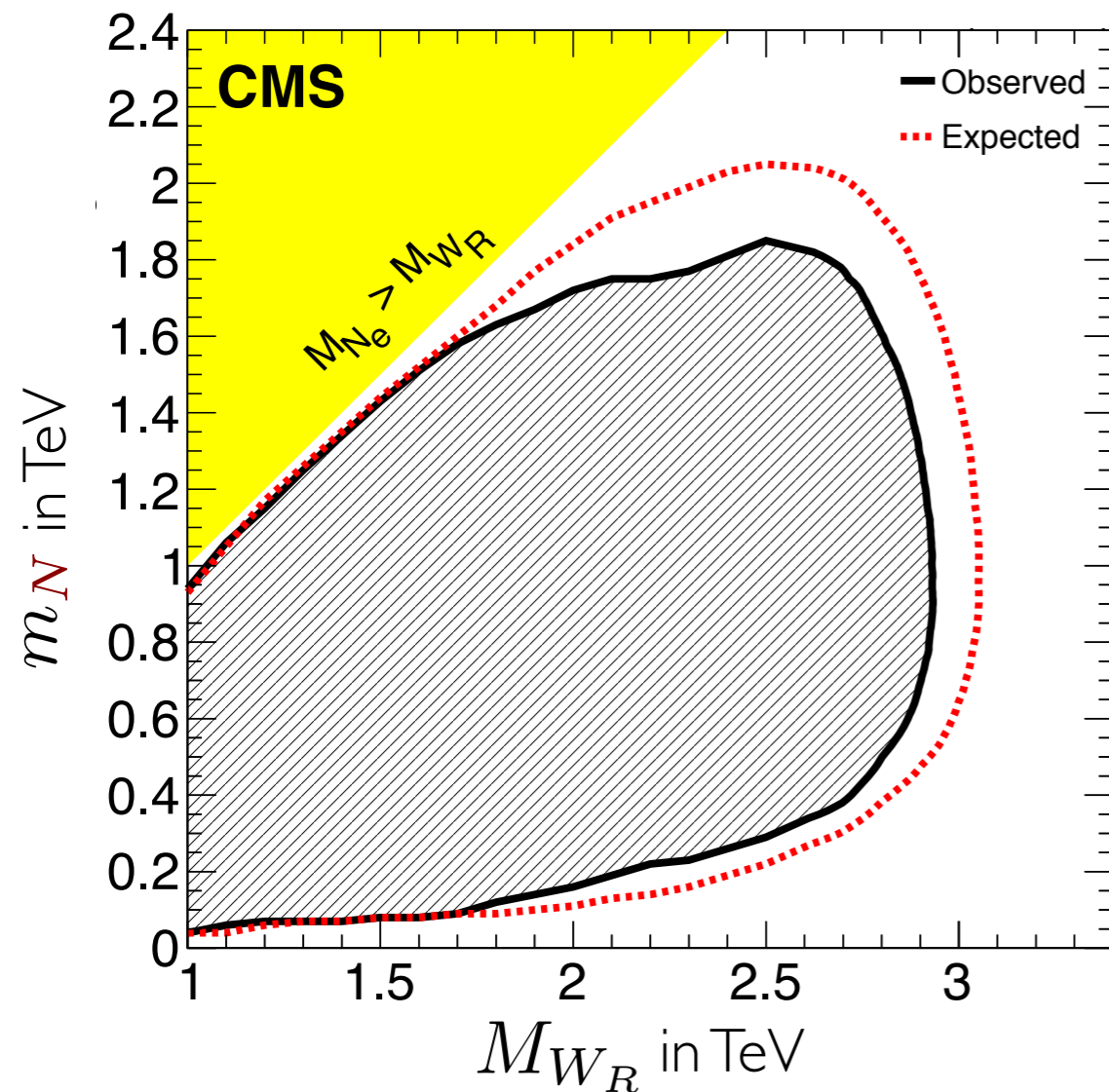
MN, Nesti, Senjanović, Zhang '11



2011 Prva analiza za LHC

Majorana nevtrino in LHC

1983 Keung in Senjanović: N na trkalniku

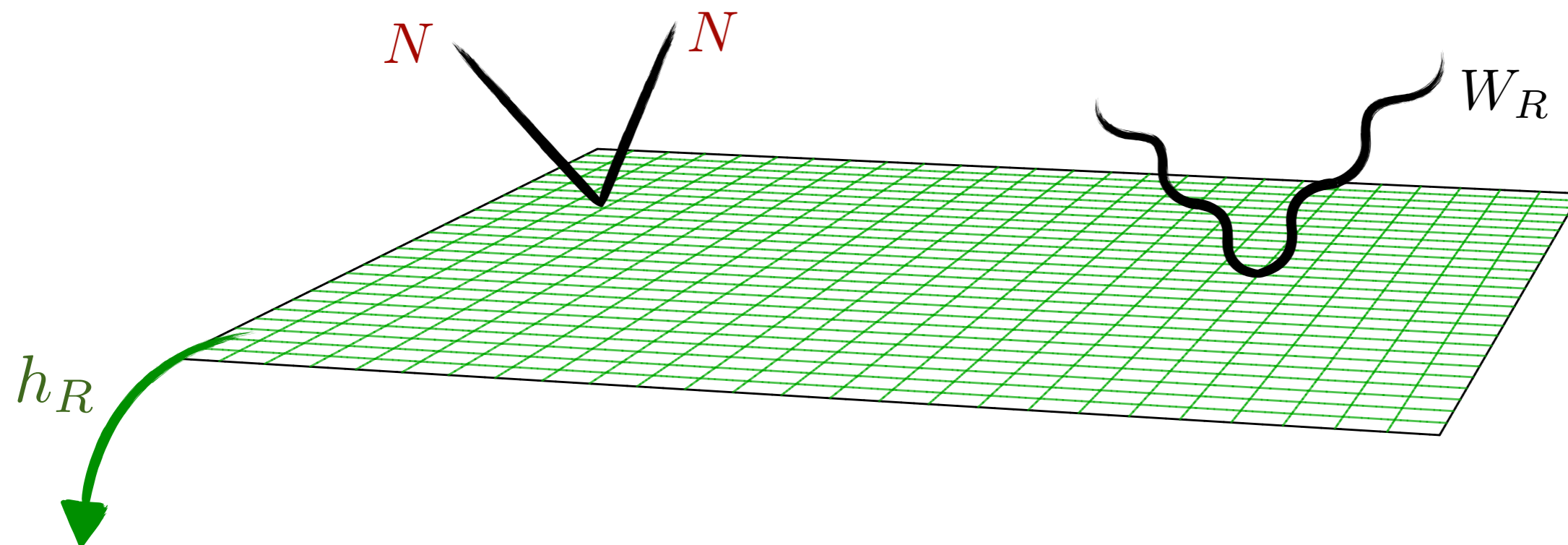


2014 Zanimivi rezultati iz LHC

Prvi signal nove fizike?

Izvor mase N

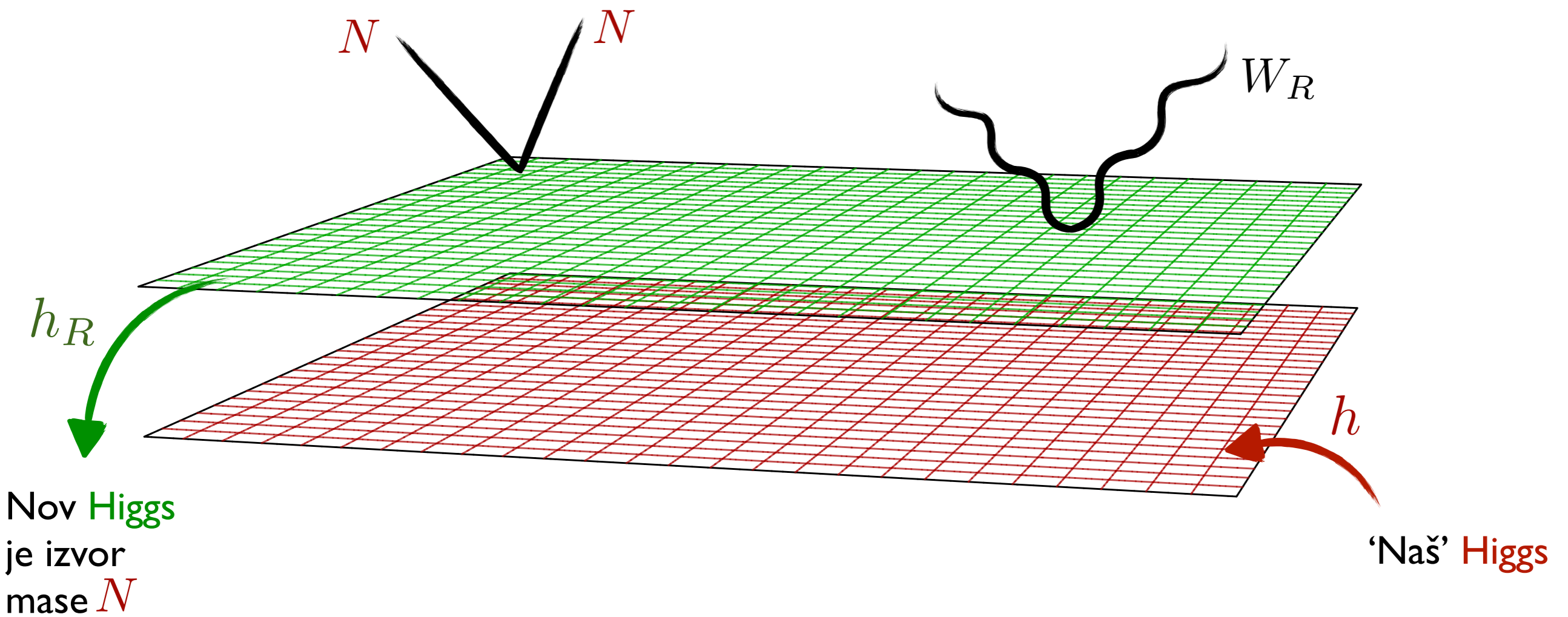
1979 Minkowski ter Mohapatra in Senjanović



Nov Higgs
je izvor
mase N

Izvor mase N

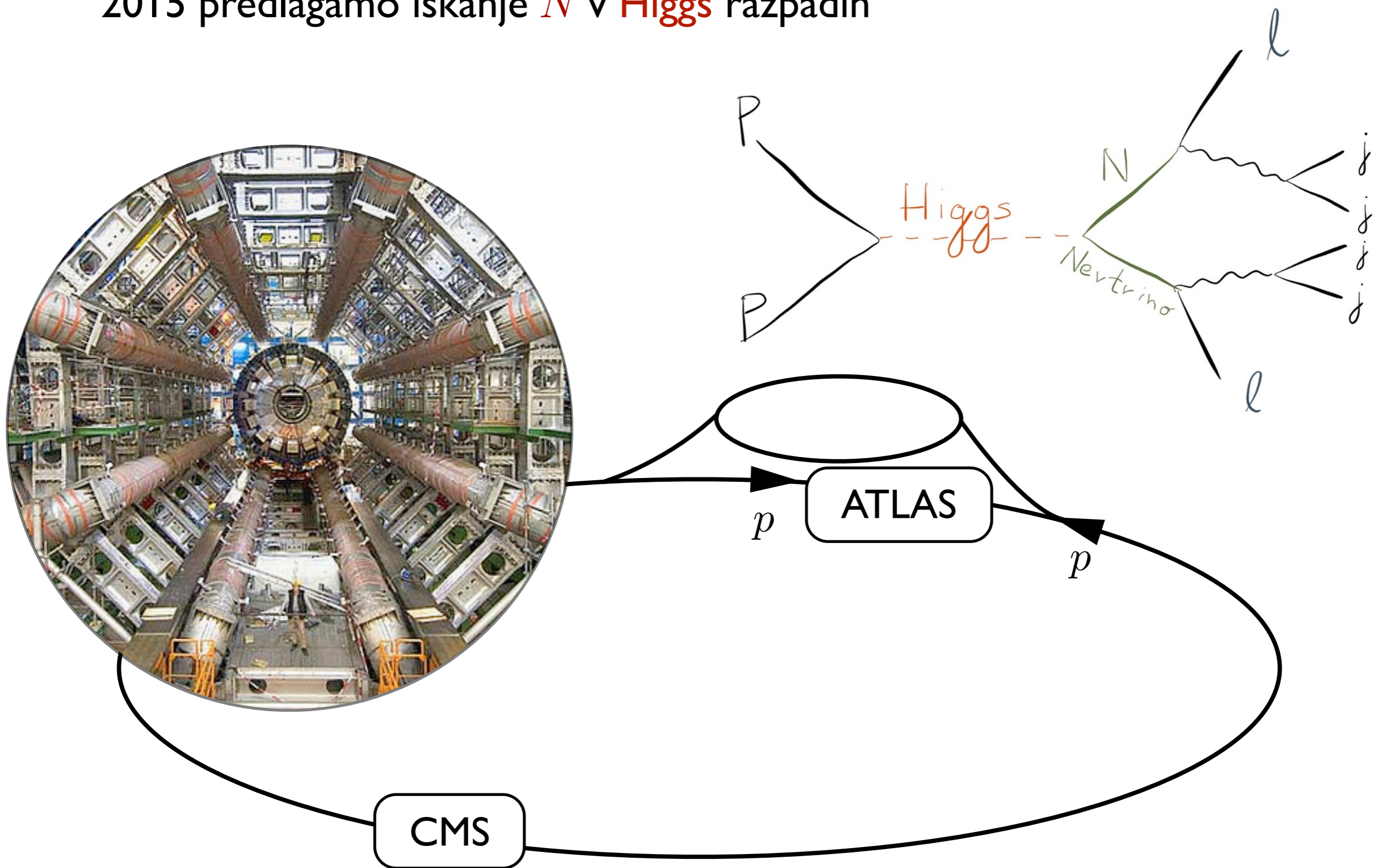
1979 Minkowski ter Mohapatra in Senjanović



h_R in h se lahko pogovarjata...

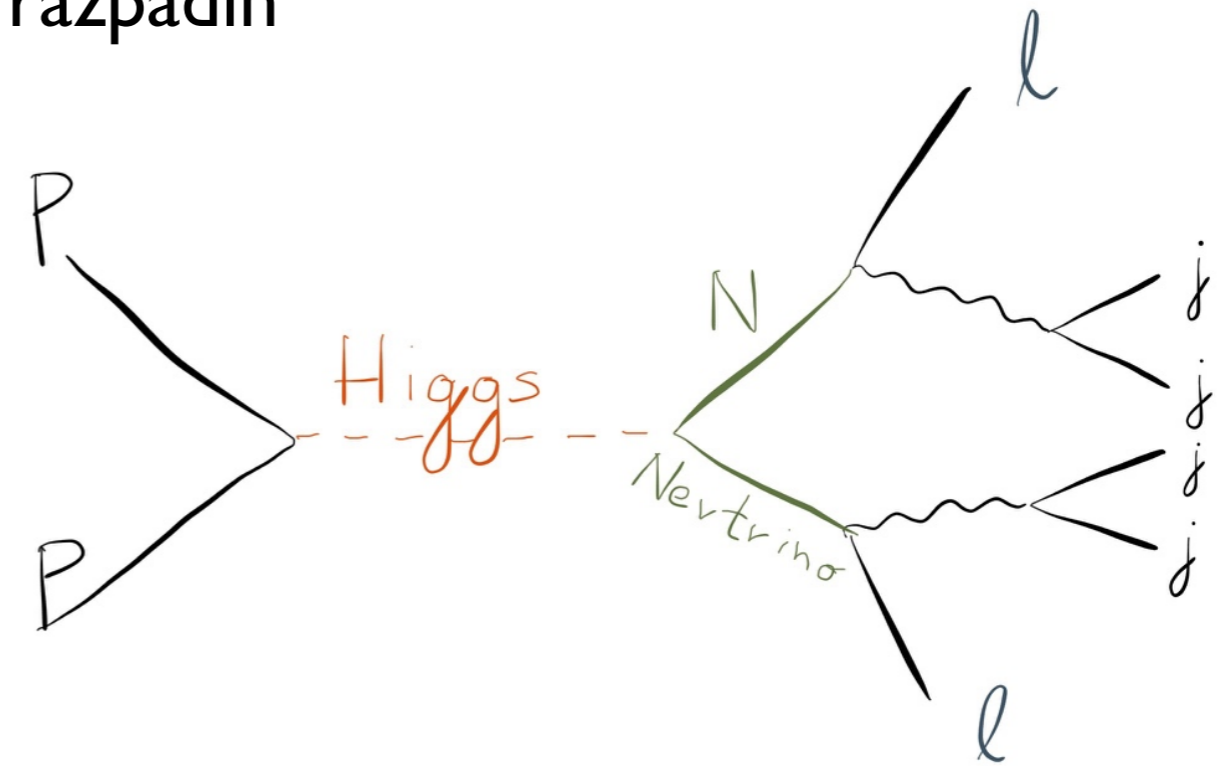
Izvor mase N na LHC

2015 predlagamo iskanje N v Higgs razpadih



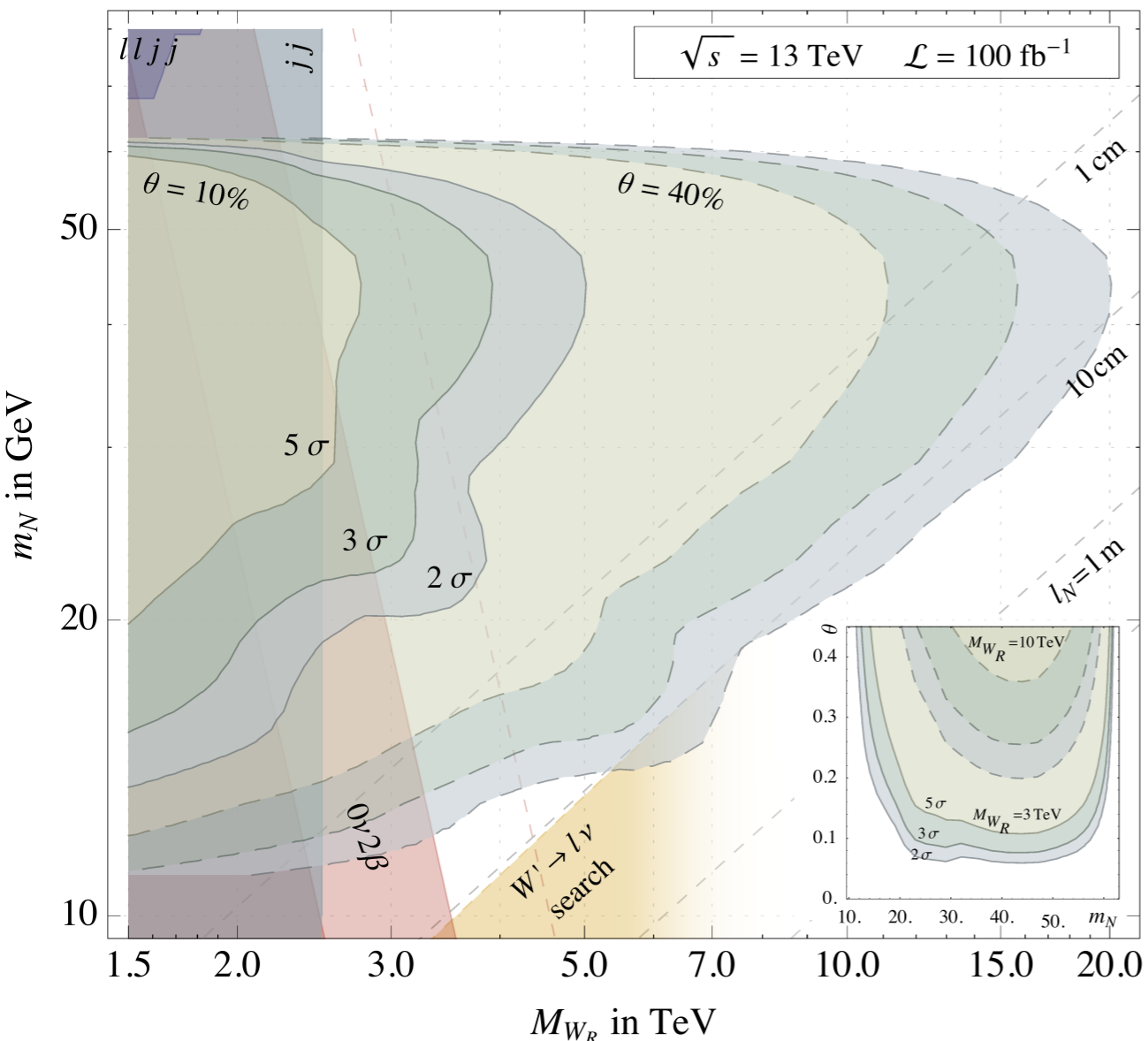
Izvor mase N na LHC

2015 predlagamo iskanje N v Higgs razpadih



Maiezza, MN, Nesti '15

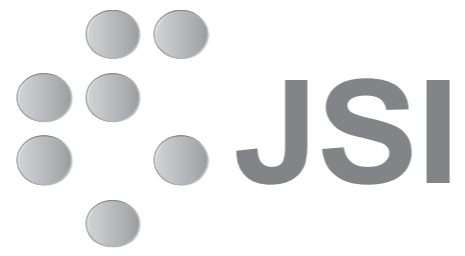
$\sqrt{s} = 13 \text{ TeV}$ $\mathcal{L} = 100 \text{ fb}^{-1}$



Iskanje v teku

ATLAS skupina na IJS

Znanost na
cesti



Hvala

Znanost
na
cesti



28. oktober 2015 ob 19h

Kako obvladati poplave?

prof. Primož Banovec, UL
Renata Dacinger, RTV Slovenija