

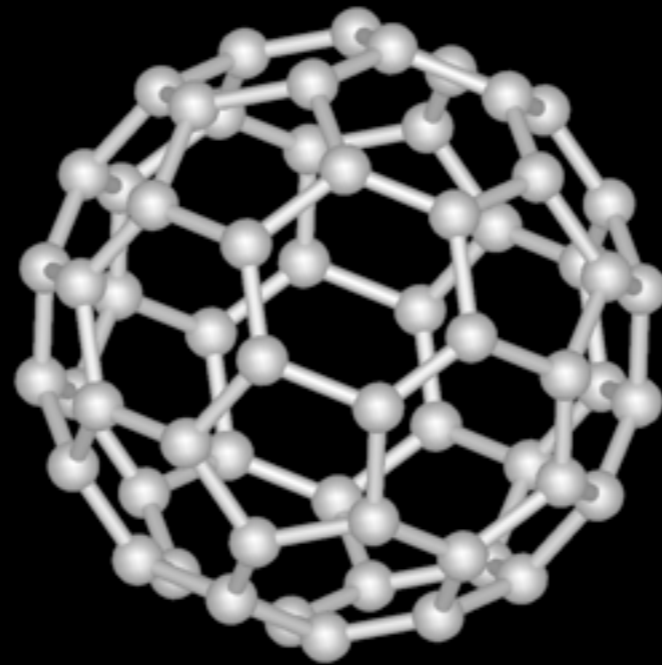
Teoria e Fenomenologia dei Nuclei e degli Adroni

Granello di sabbia (Ministruttura)



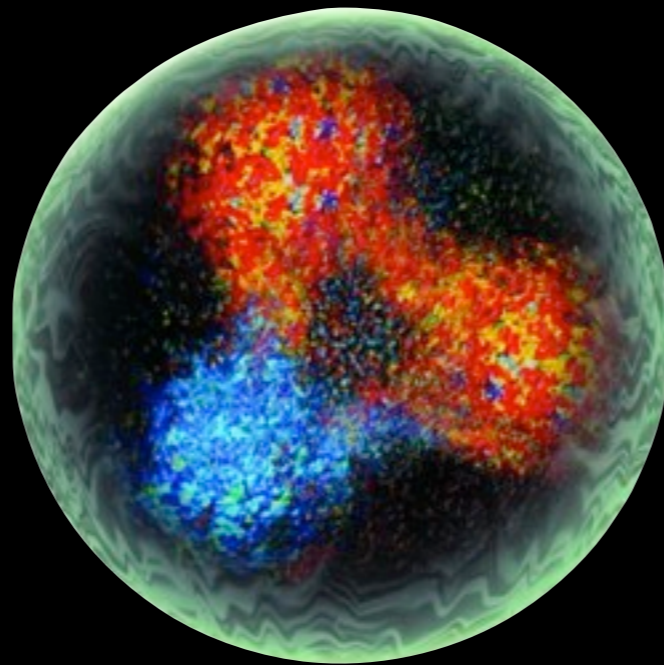
10^{-3} m

Fullerene (Nanostruttura)



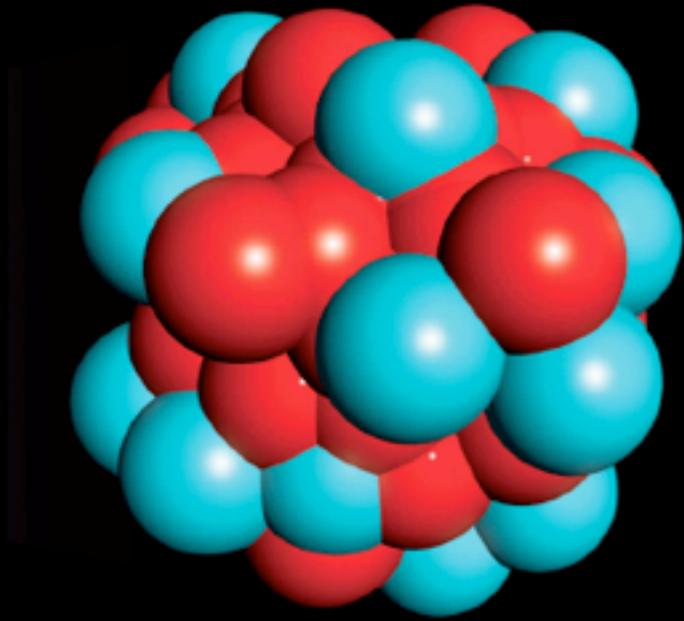
10^{-9} m

Protone (Femtostruttura)

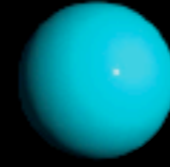
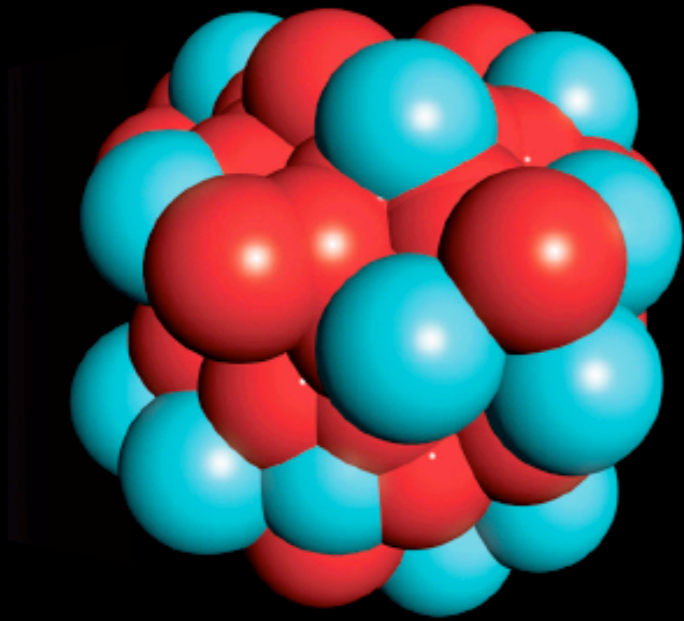


10^{-15} m

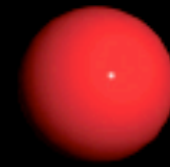
nucleo



nucleo

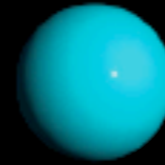
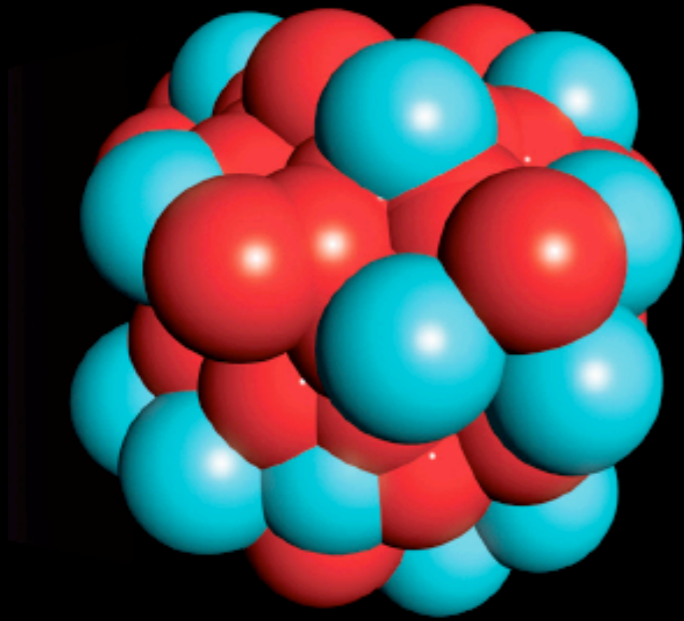


neutrone

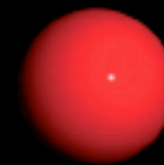


protone

nucleo



neutrone

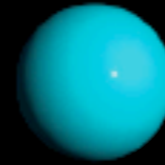
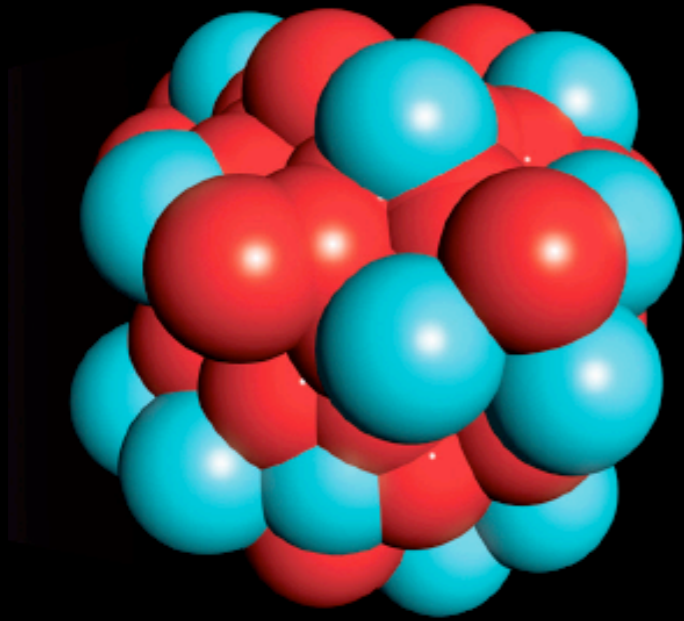


protone

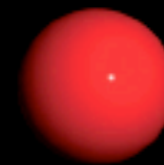


nucleoni

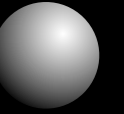
nucleo



neutrone



protone



pione

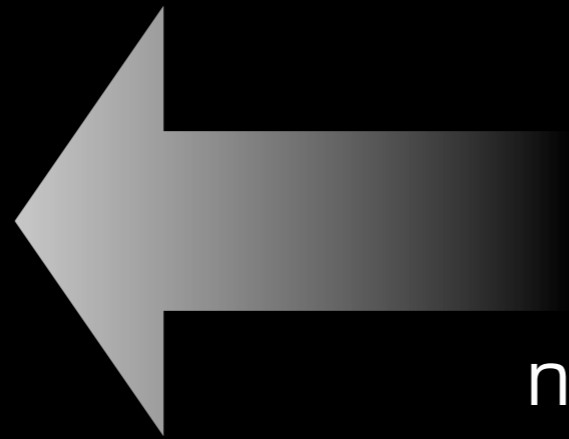
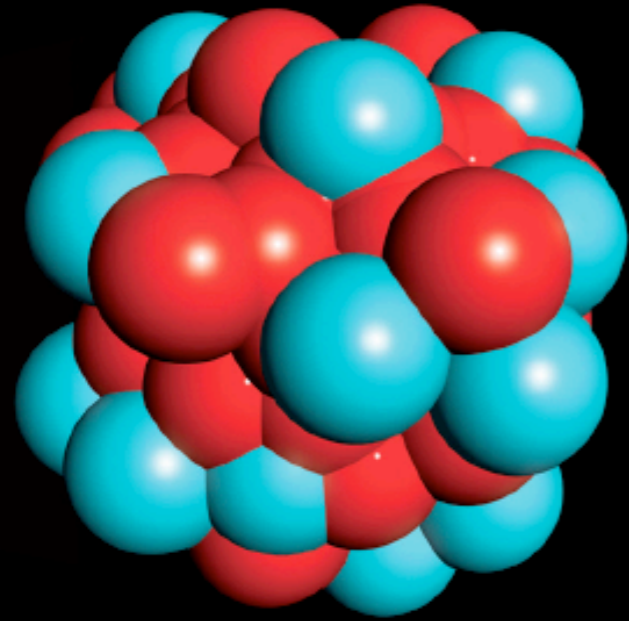


nucleoni

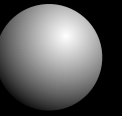
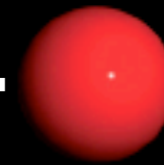
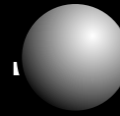
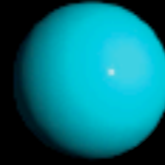


adroni

nucleo



pione



neutrone

protone

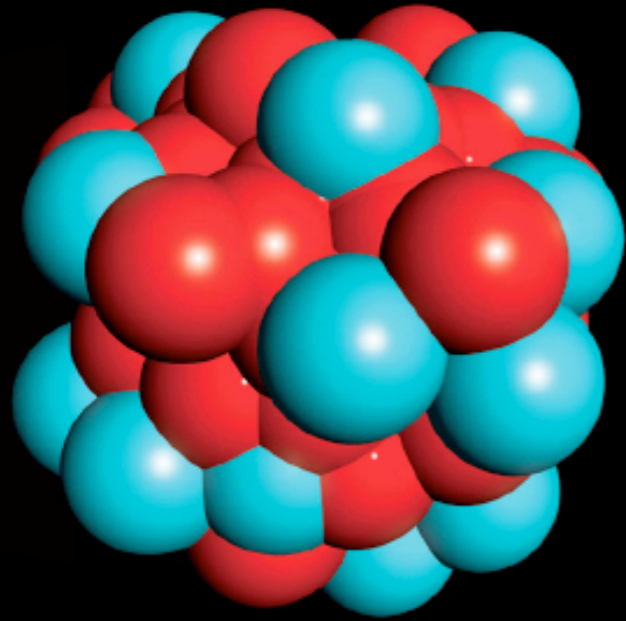
pione

nucleoni

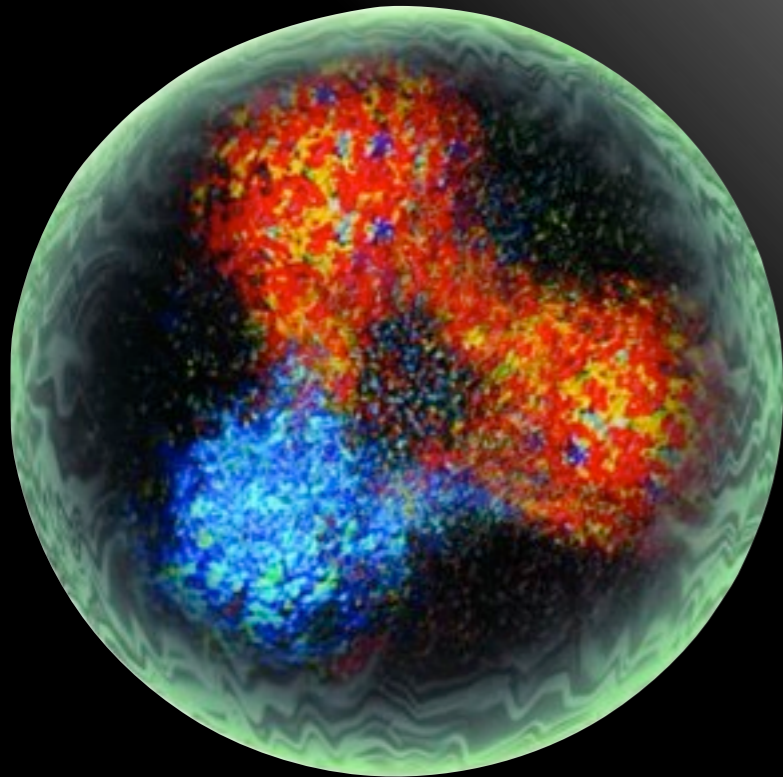
adroni



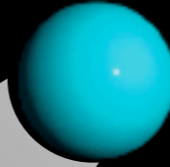
nucleo



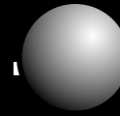
nucleone



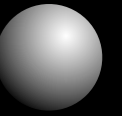
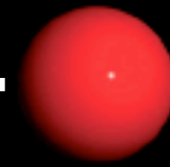
pione



neutrone



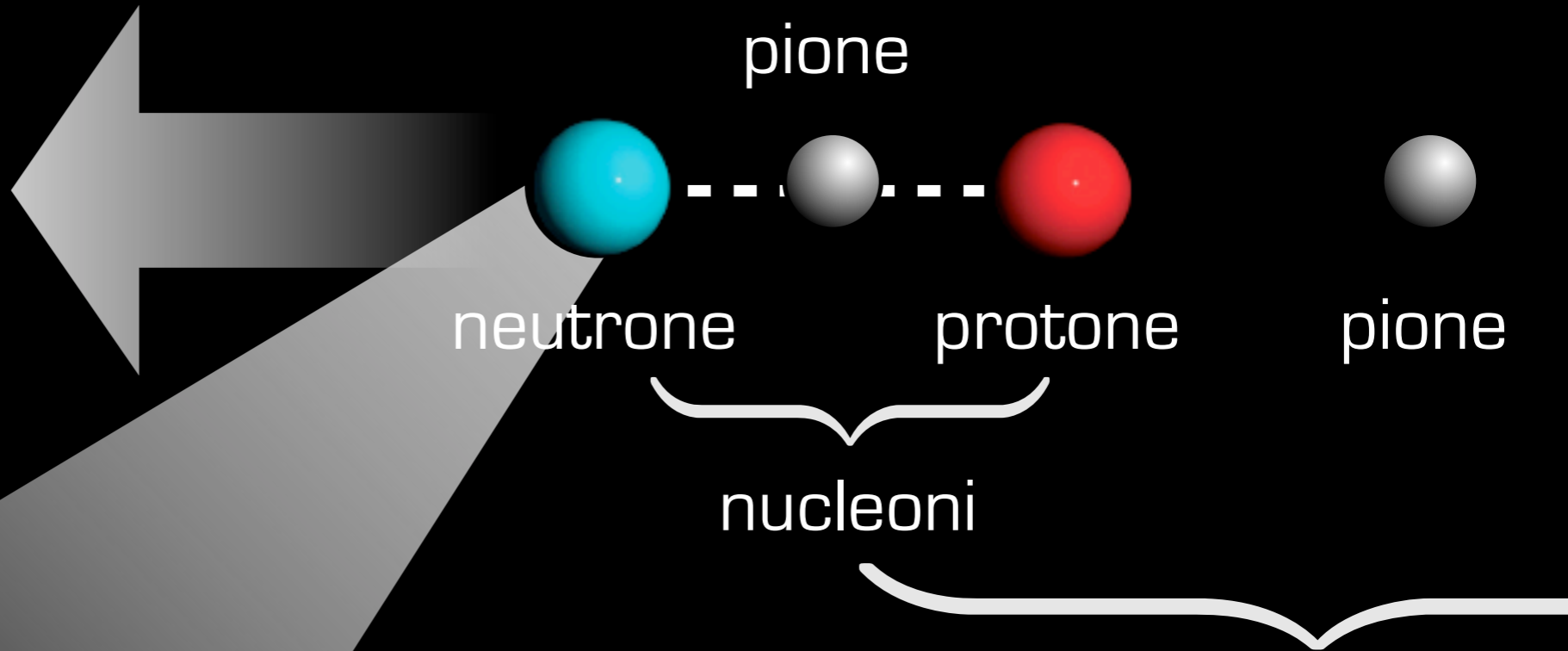
protone



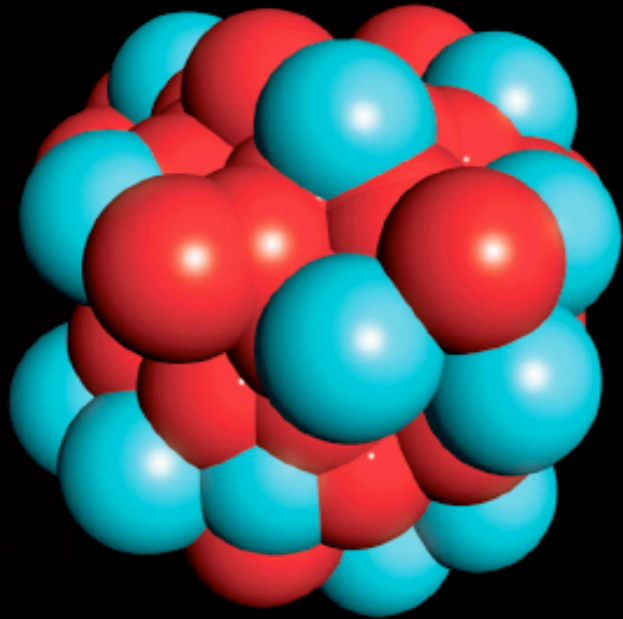
pione

nucleoni

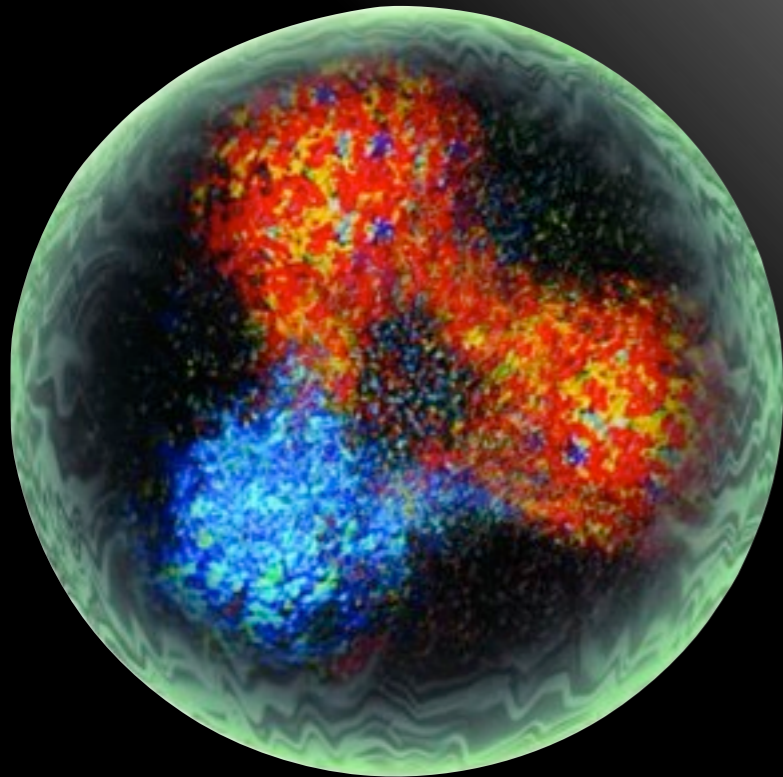
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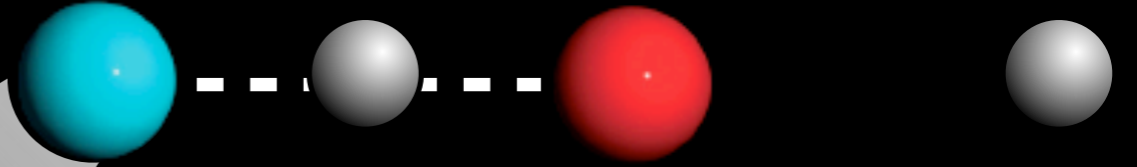
nucleo



nucleone



pione



neutrone

protone

pione

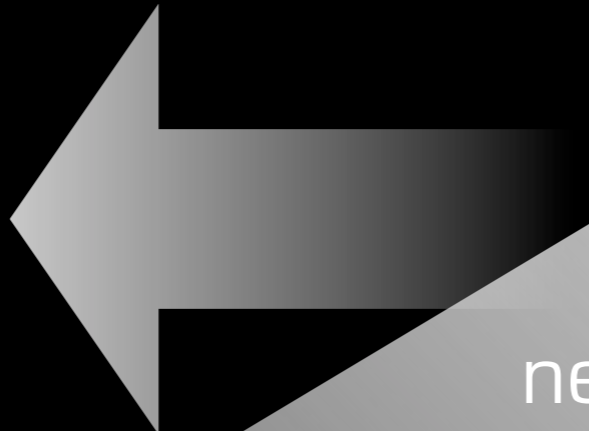
nucleoni

adroni

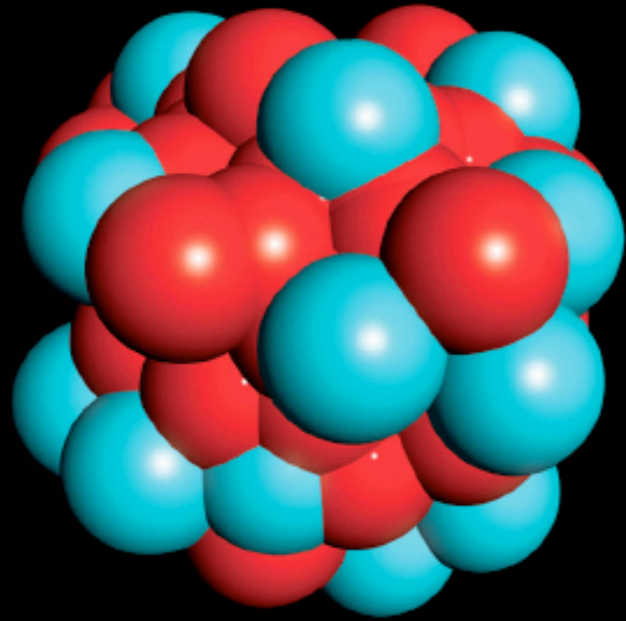


quark

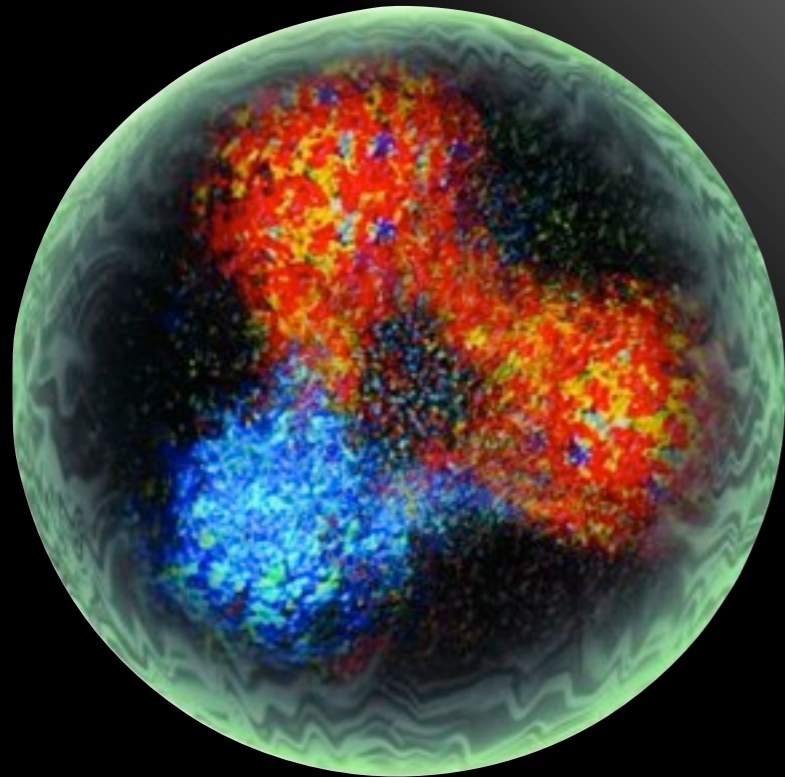
quark



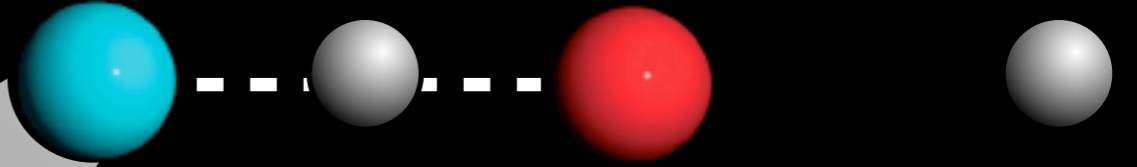
nucleo



nucleone



pione



neutrone

protone

pione

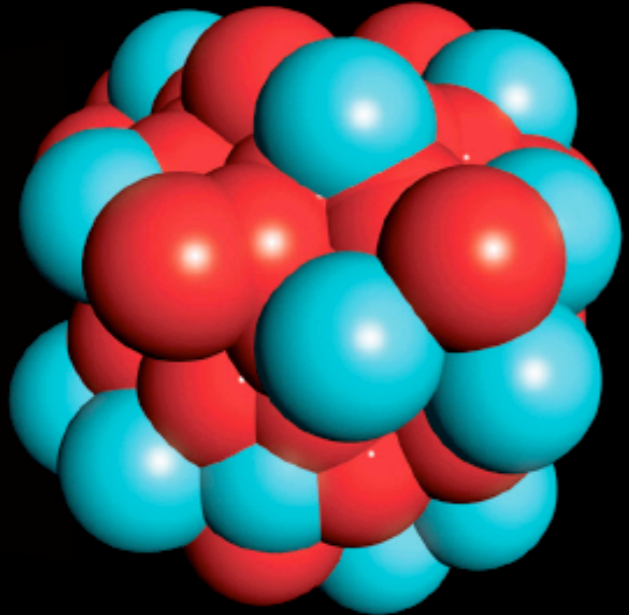
nucleoni

adroni

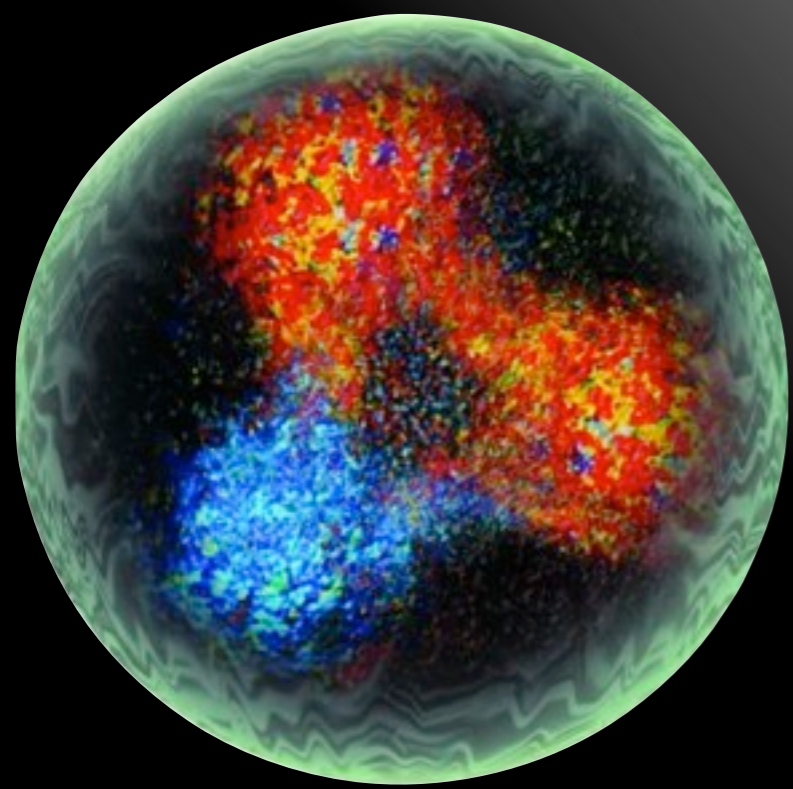


quark gluone quark

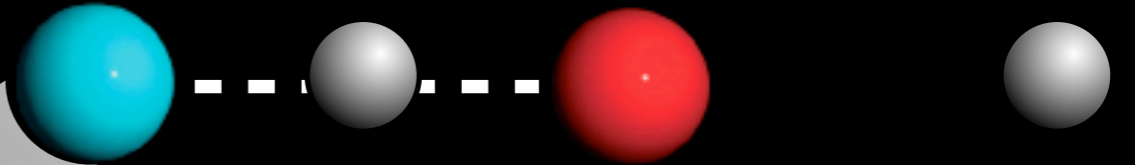
nucleo



nucleone



pione



neutrone

protone

pione

nucleoni

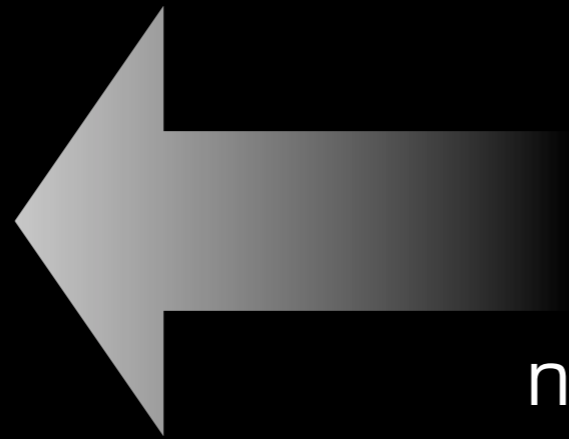
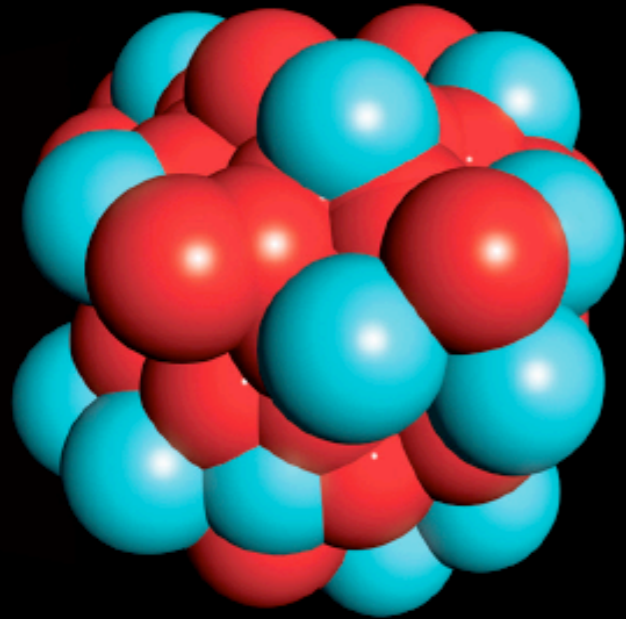
adroni



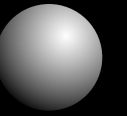
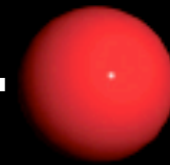
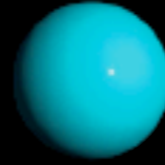
quark gluone quark

partoni

nucleo



pione



neutrone

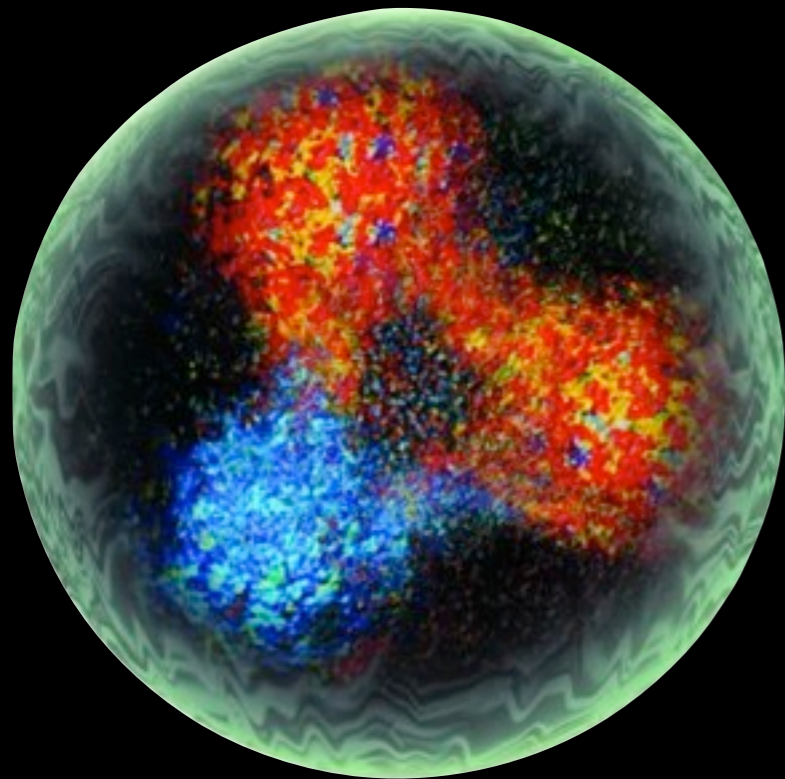
protone

pione

nucleoni

adroni

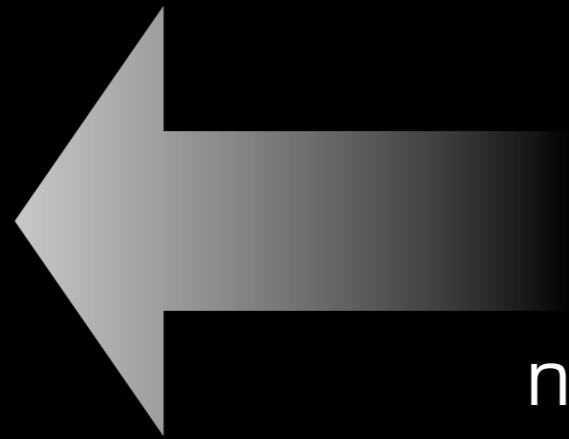
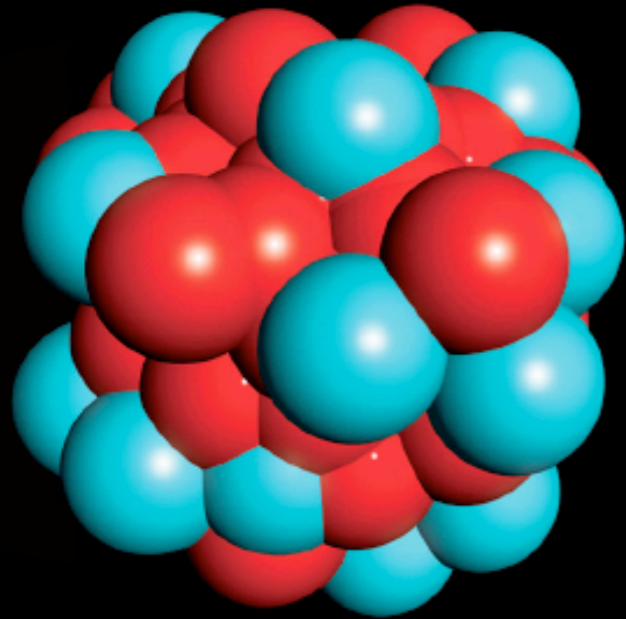
nucleone



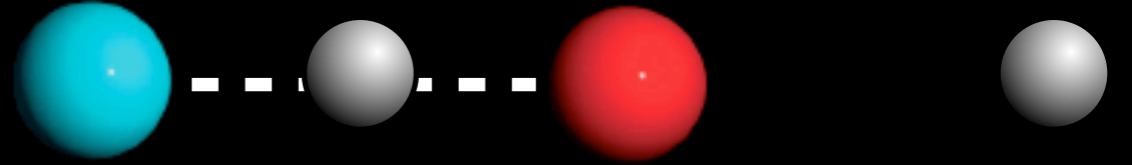
quark gluone quark

partoni

nucleo



pione



neutrone

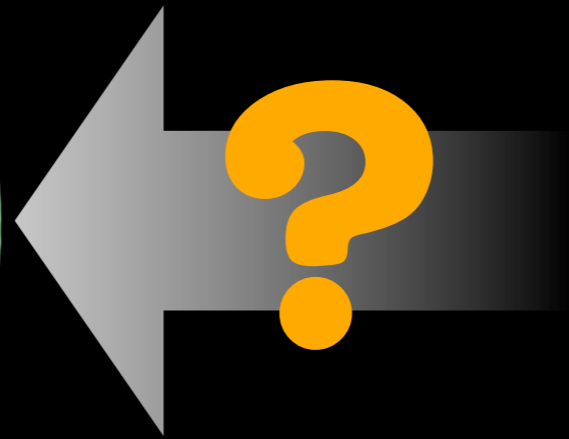
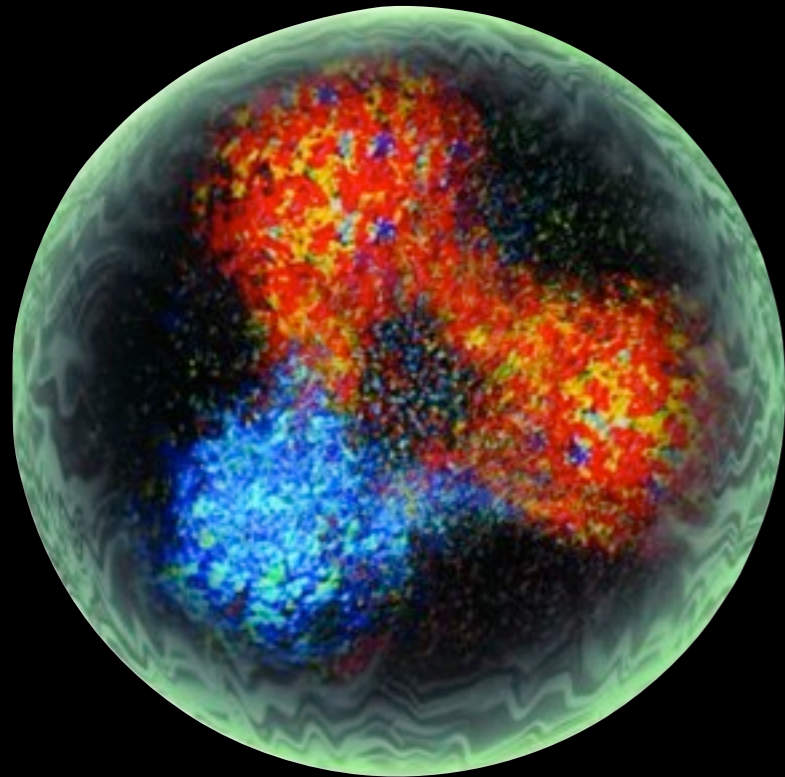
protone

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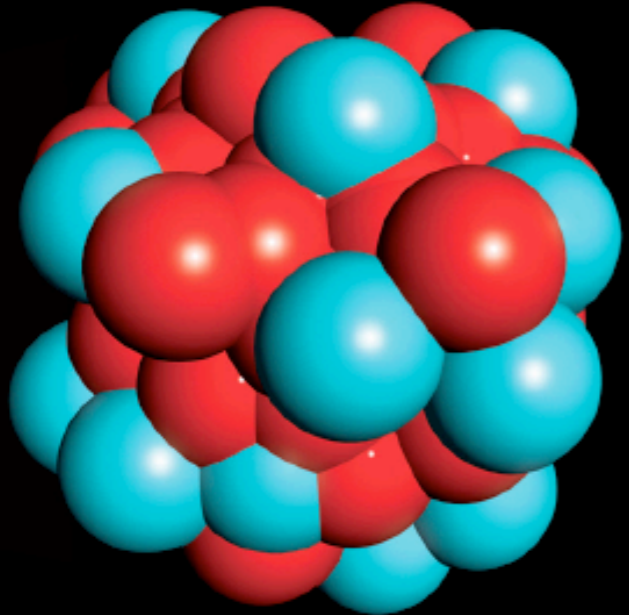
nucleone



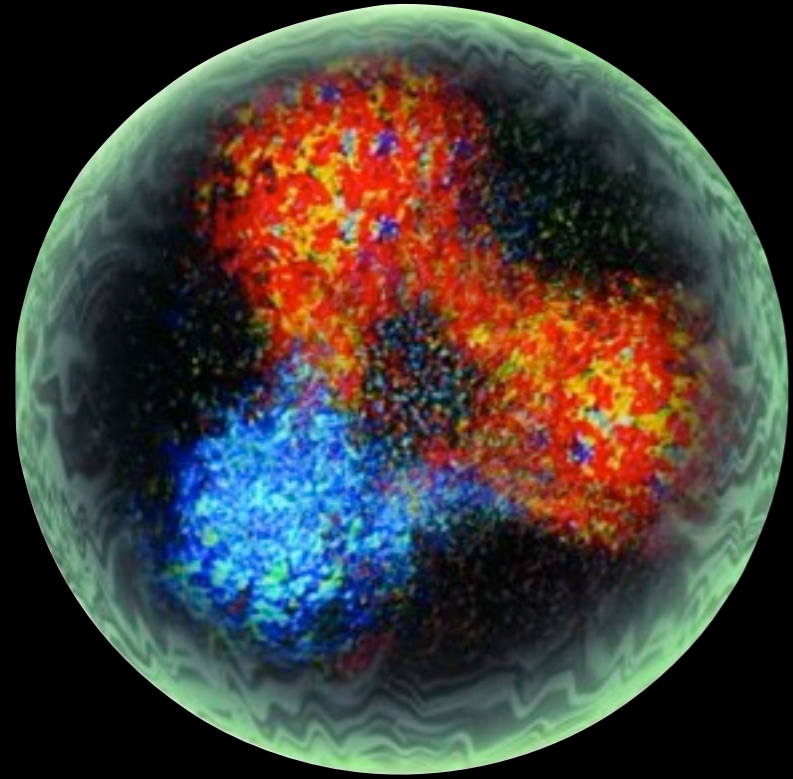
quark gluone quark

partoni

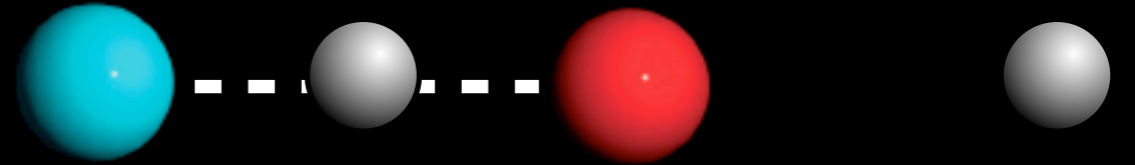
nucleo



nucleone



pione



neutrone

protone

pione

nucleoni

adroni



quark

gluone

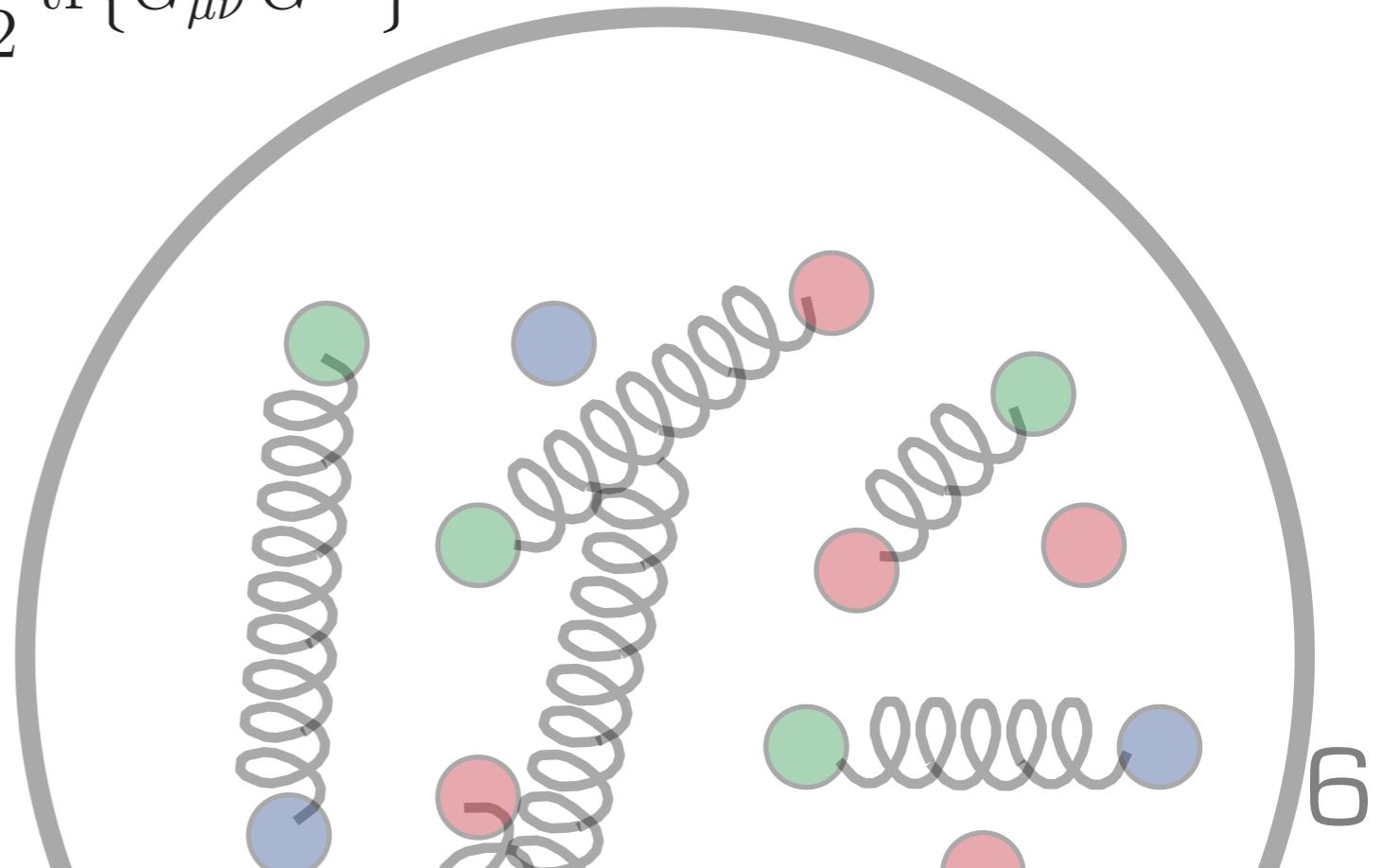
quark

partoni

La teoria sottostante

Cromodinamica Quantistica QCD

$$\mathcal{L}_{\text{QCD}} = \bar{\psi} (i\gamma_{\mu} D^{\mu} - m) \psi - \frac{1}{2} \text{tr} \{ G_{\mu\nu} G^{\mu\nu} \}$$



Chi fa parte del gruppo?

Fisica Nucleare

Carlotta Giusti

Franco Pacati

Franco Capuzzi

Matteo Vorabbi

Andrea Meucci

Fisica Adronica

Marco Radici

Barbara Pasquini

Marco Guagnelli

Alessandro Bacchetta

Sigfrido Boffi



UNIVERSITÀ
DI PAVIA



Istituto Nazionale
di Fisica Nucleare

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WE WANT YOU



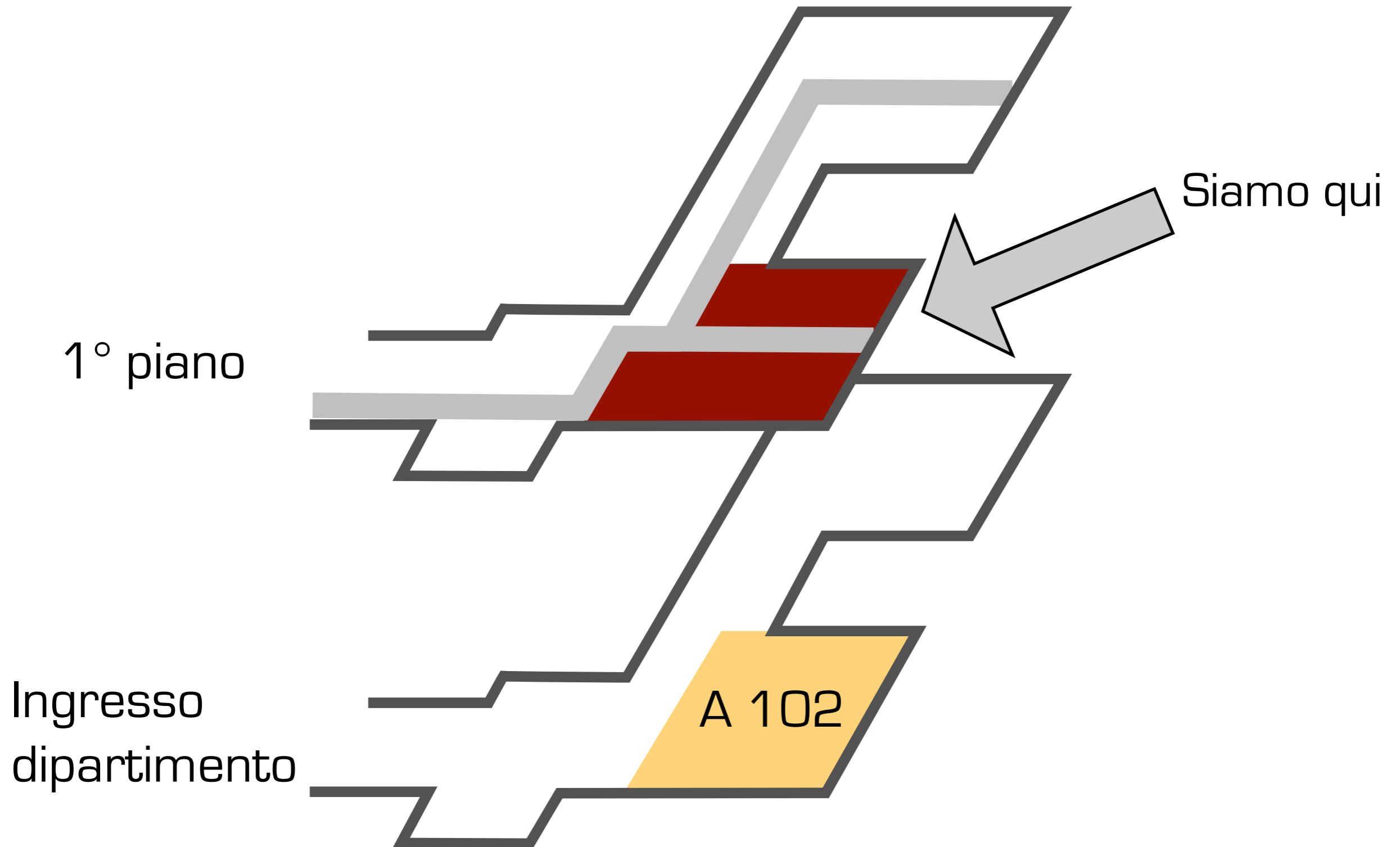
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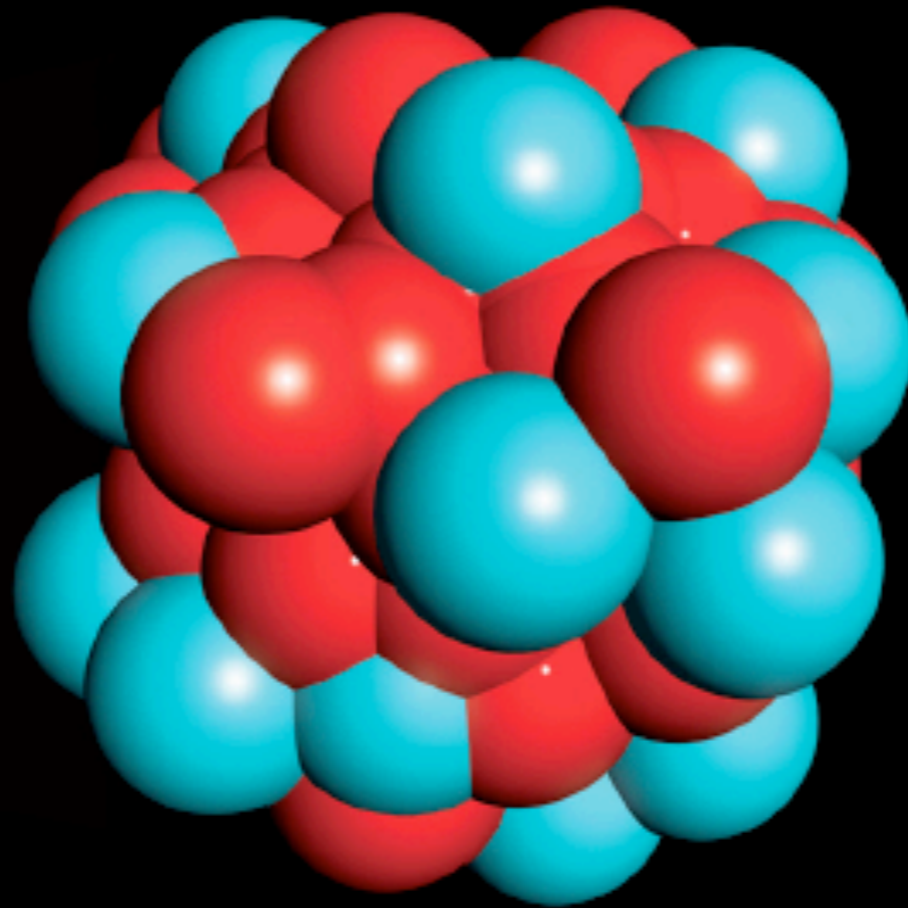
Istituto Nazionale
di Fisica Nucleare



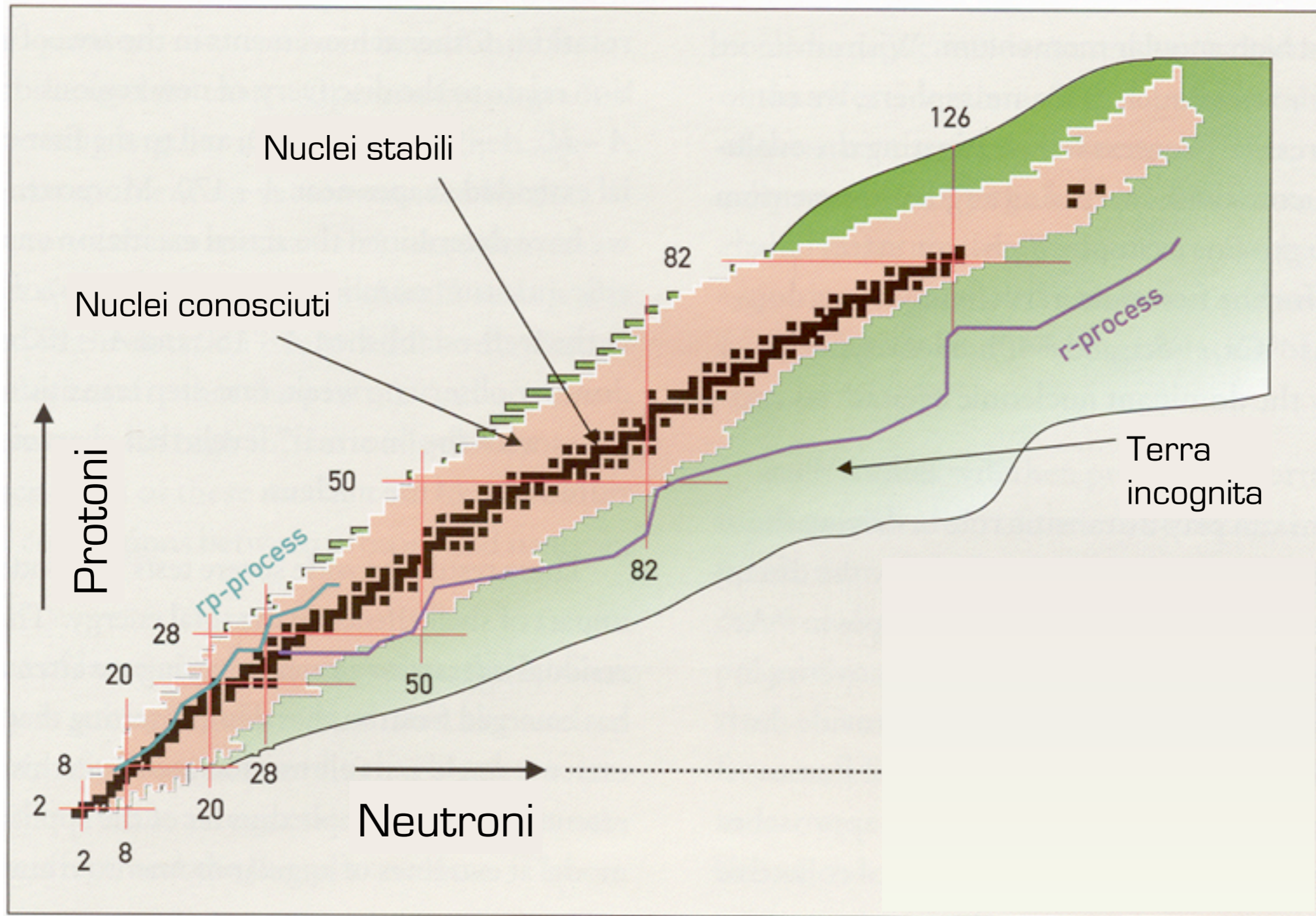
Dove ci trovate?



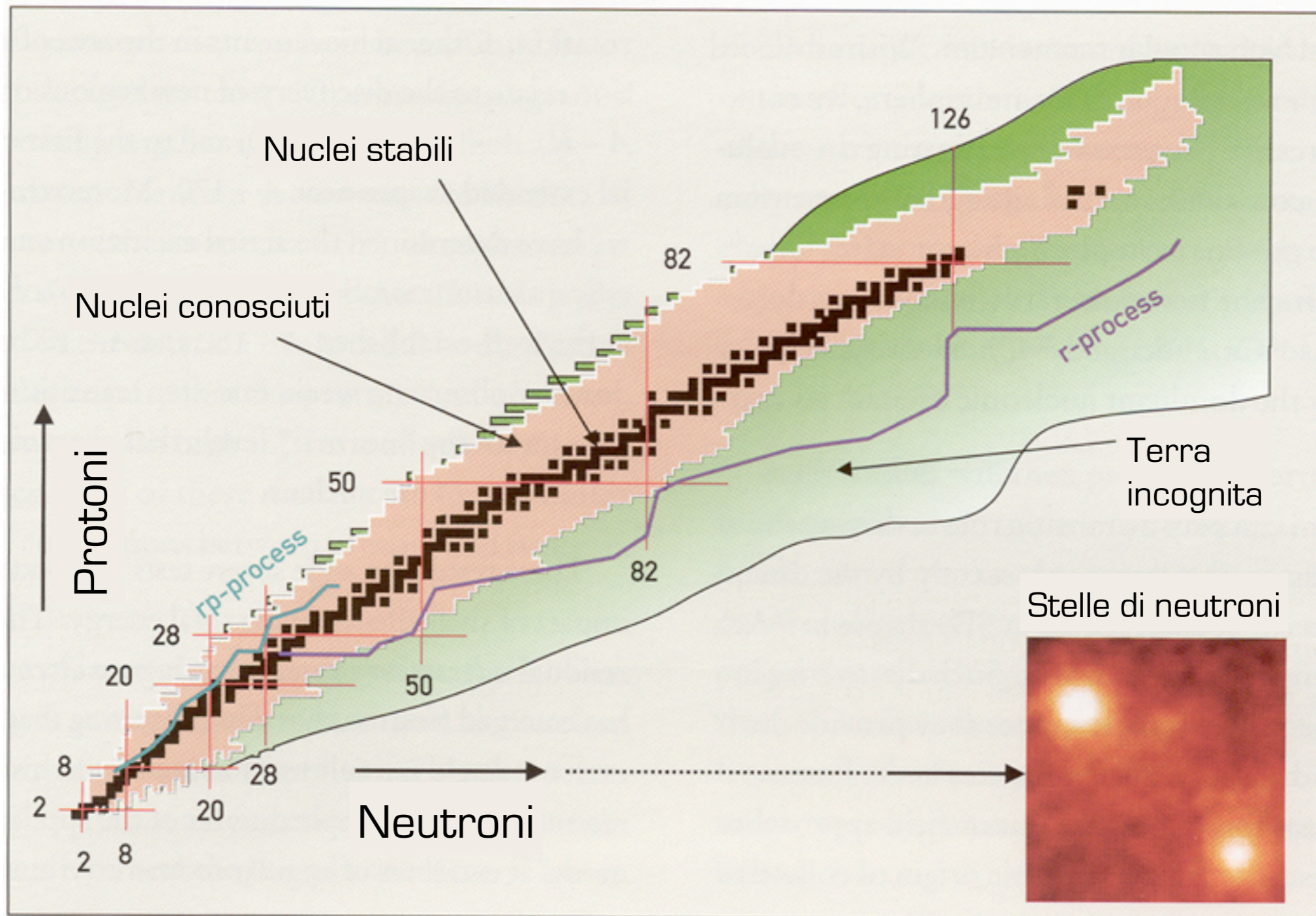
La struttura del nucleo



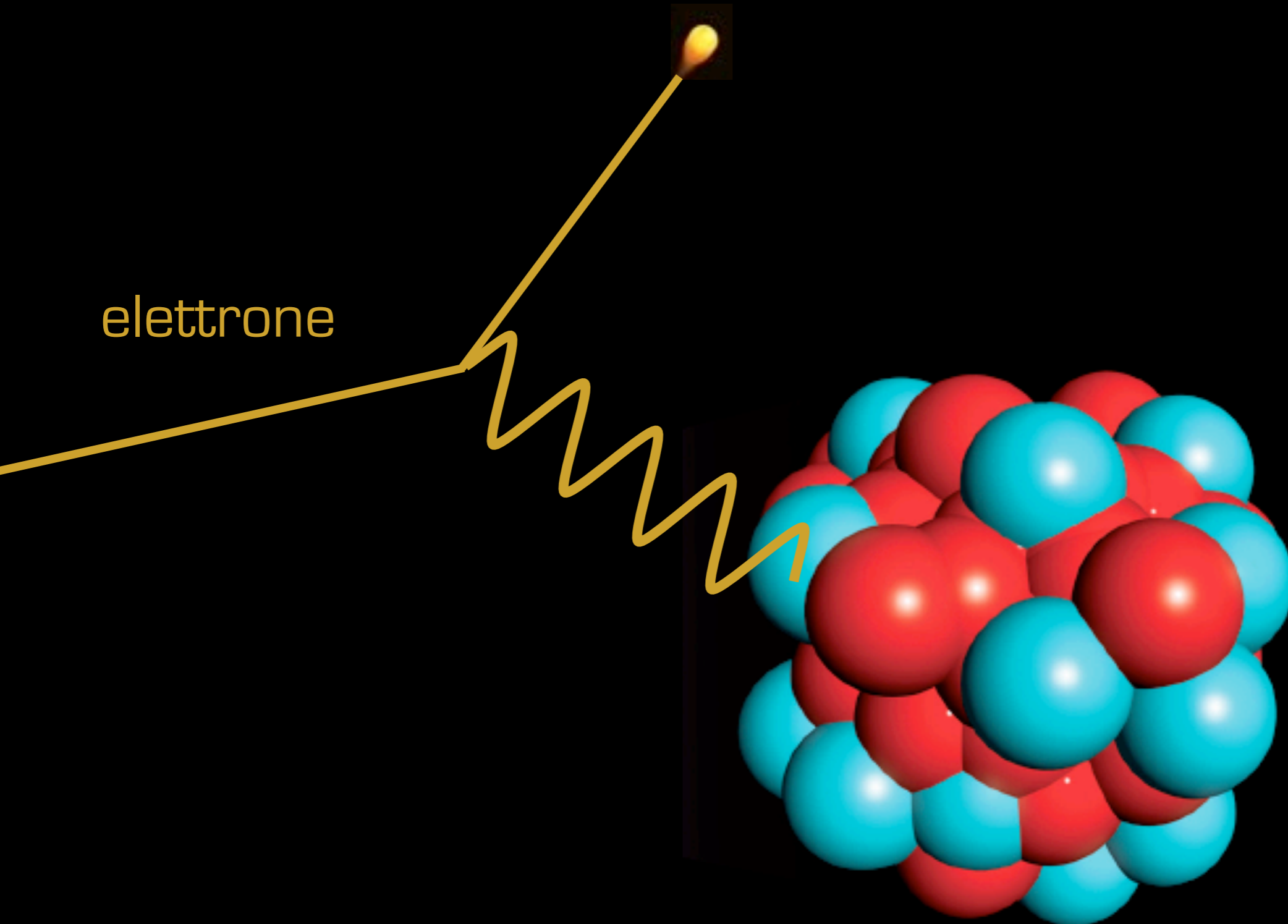
Il “nuclear landscape”



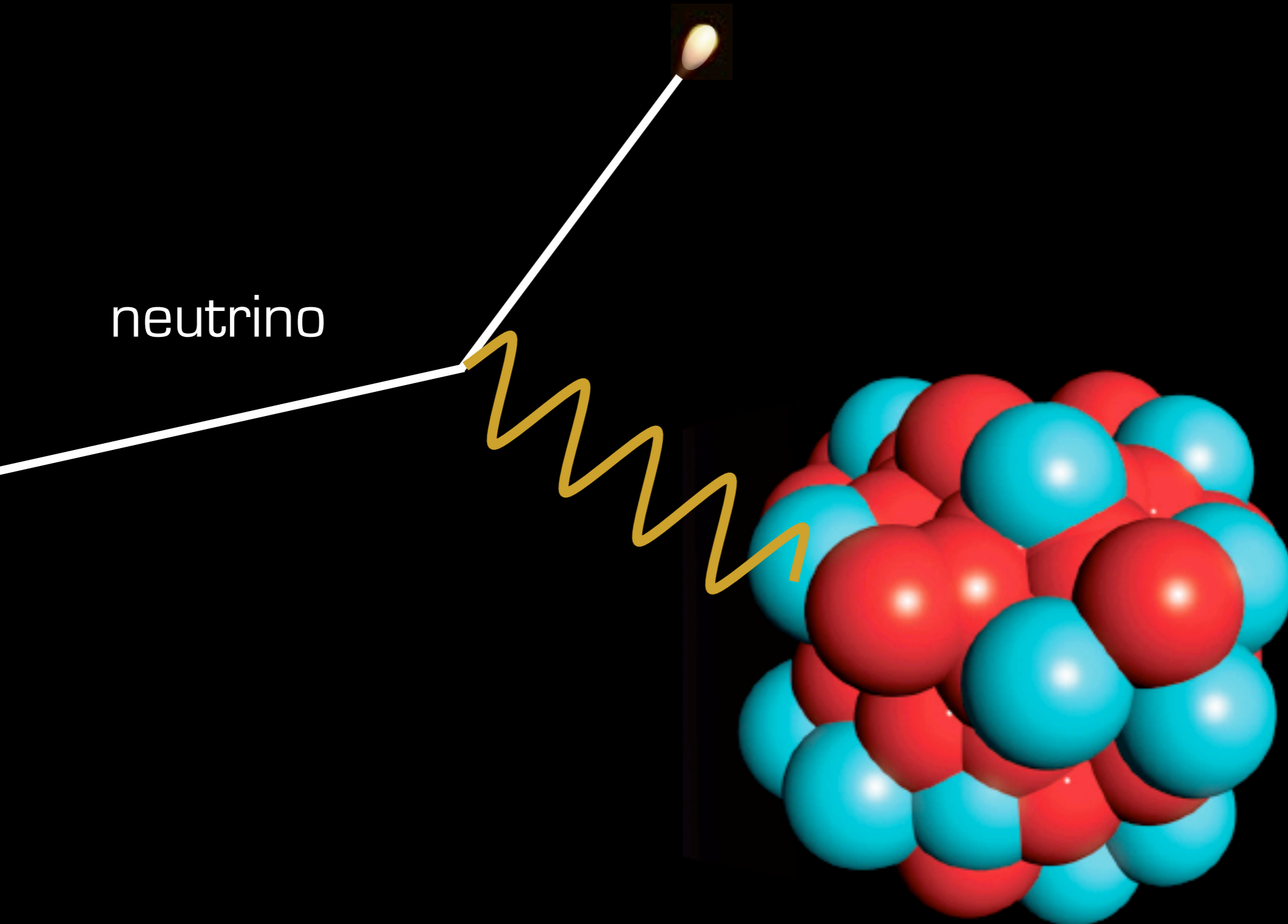
Il “nuclear landscape”



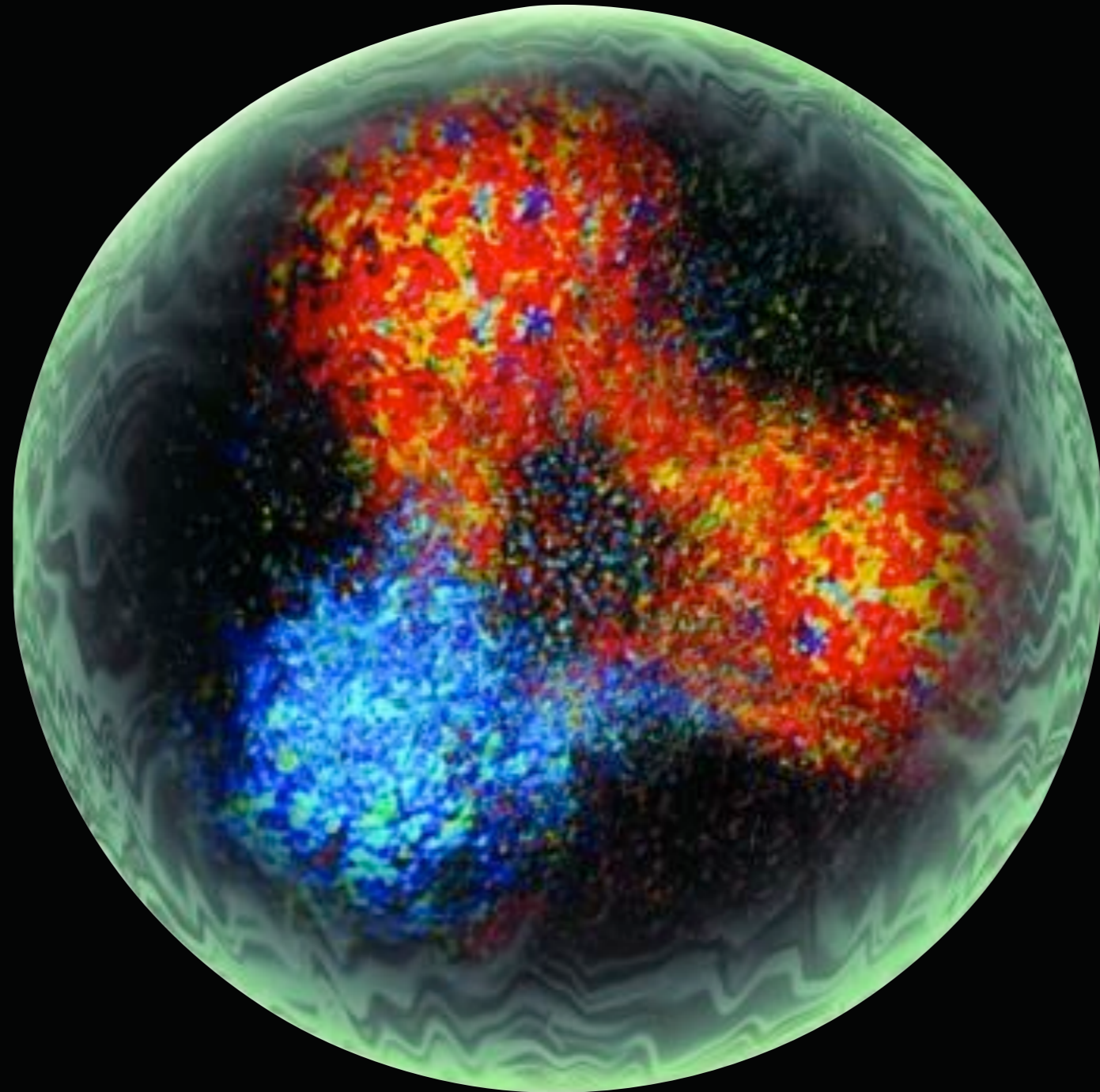
Sonde leptoniche



Sonde leptoniche

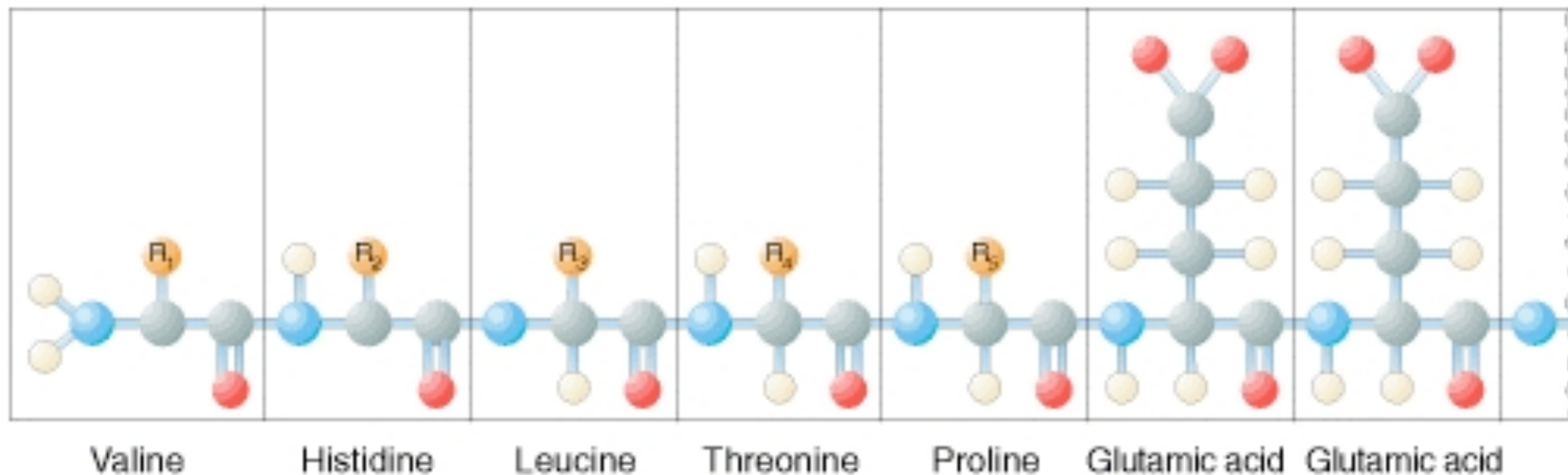


La struttura del nucleone



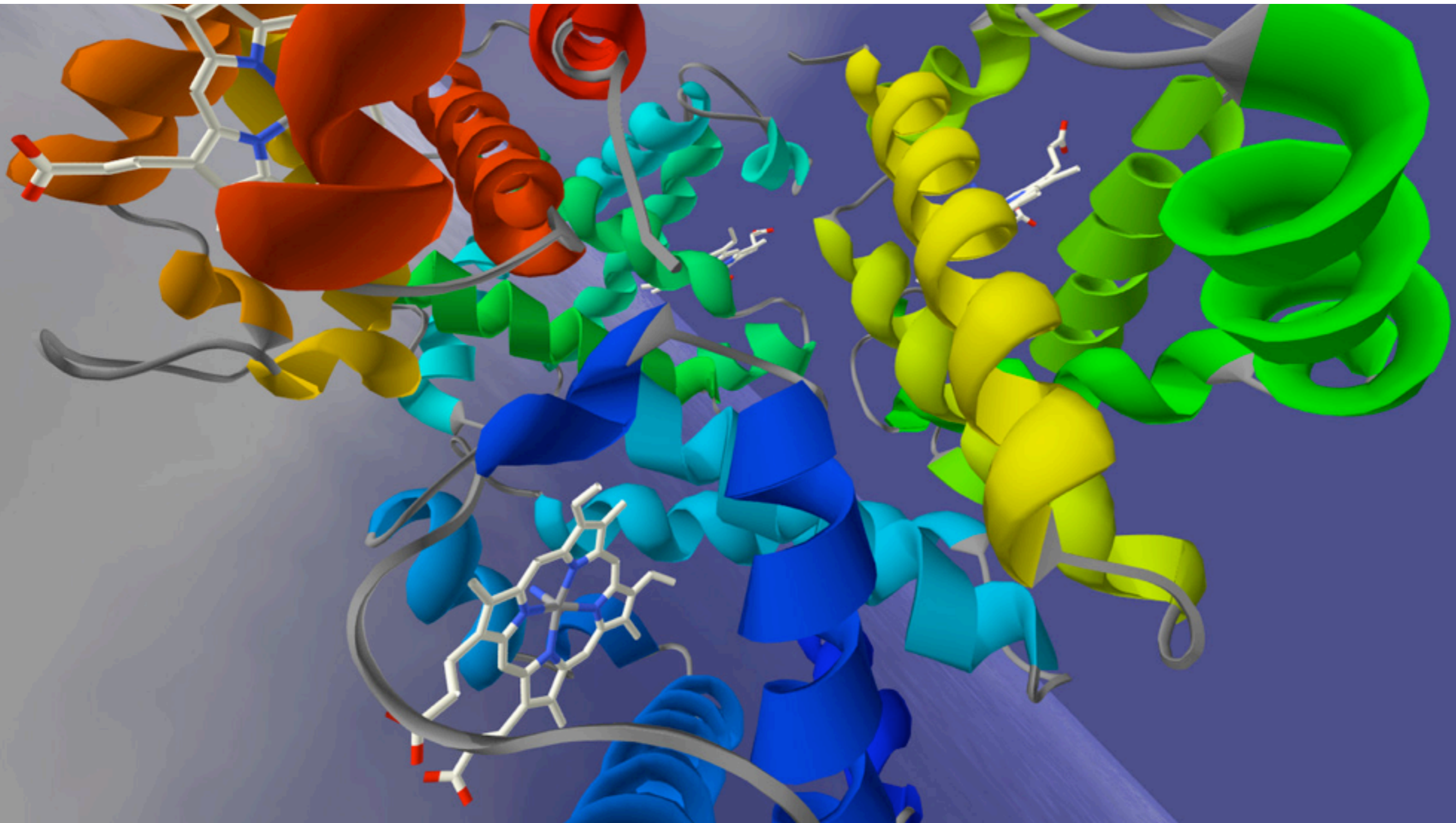
Attuale conoscenza del protone

Monodimensionale, simile alla sequenza degli aminoacidi di una proteina

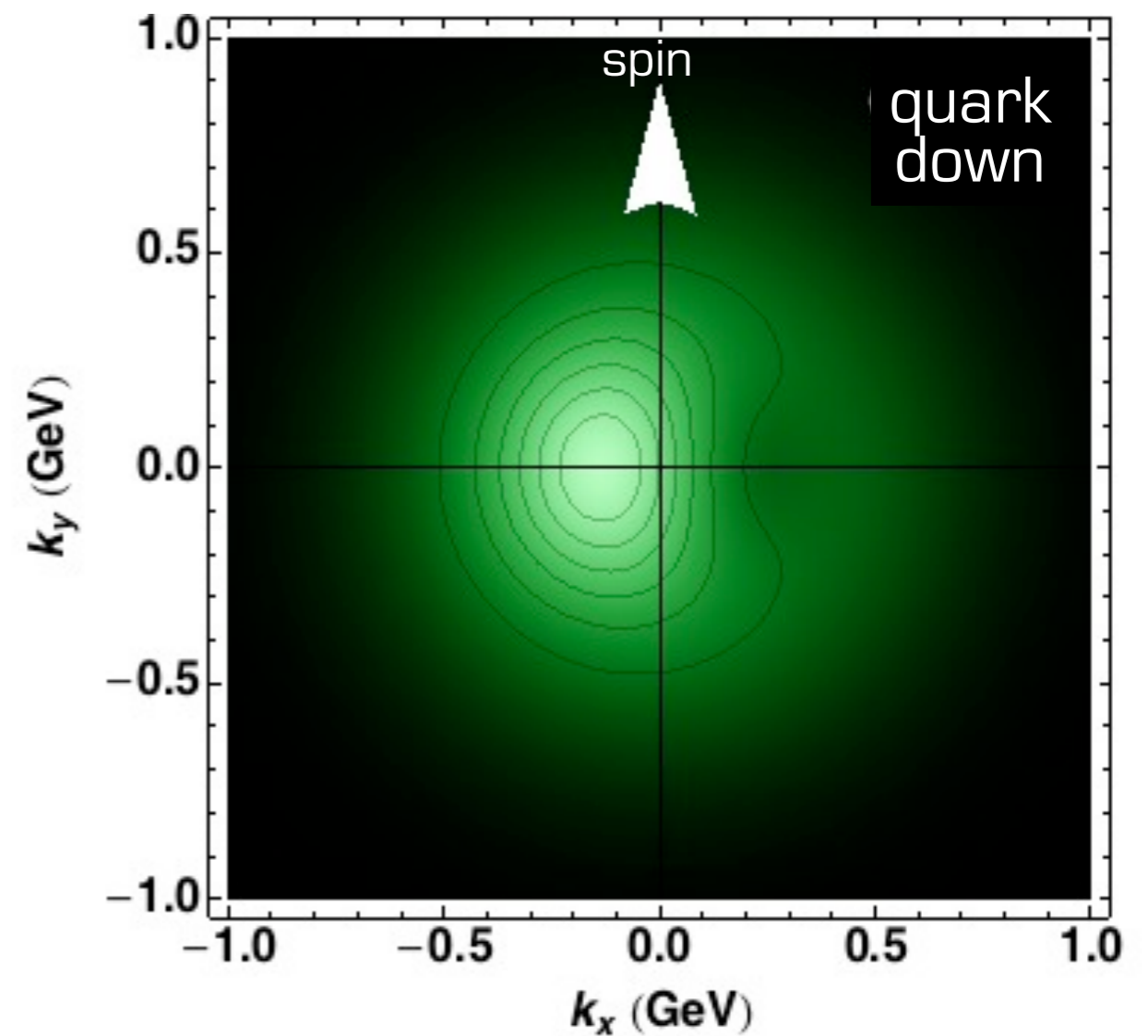
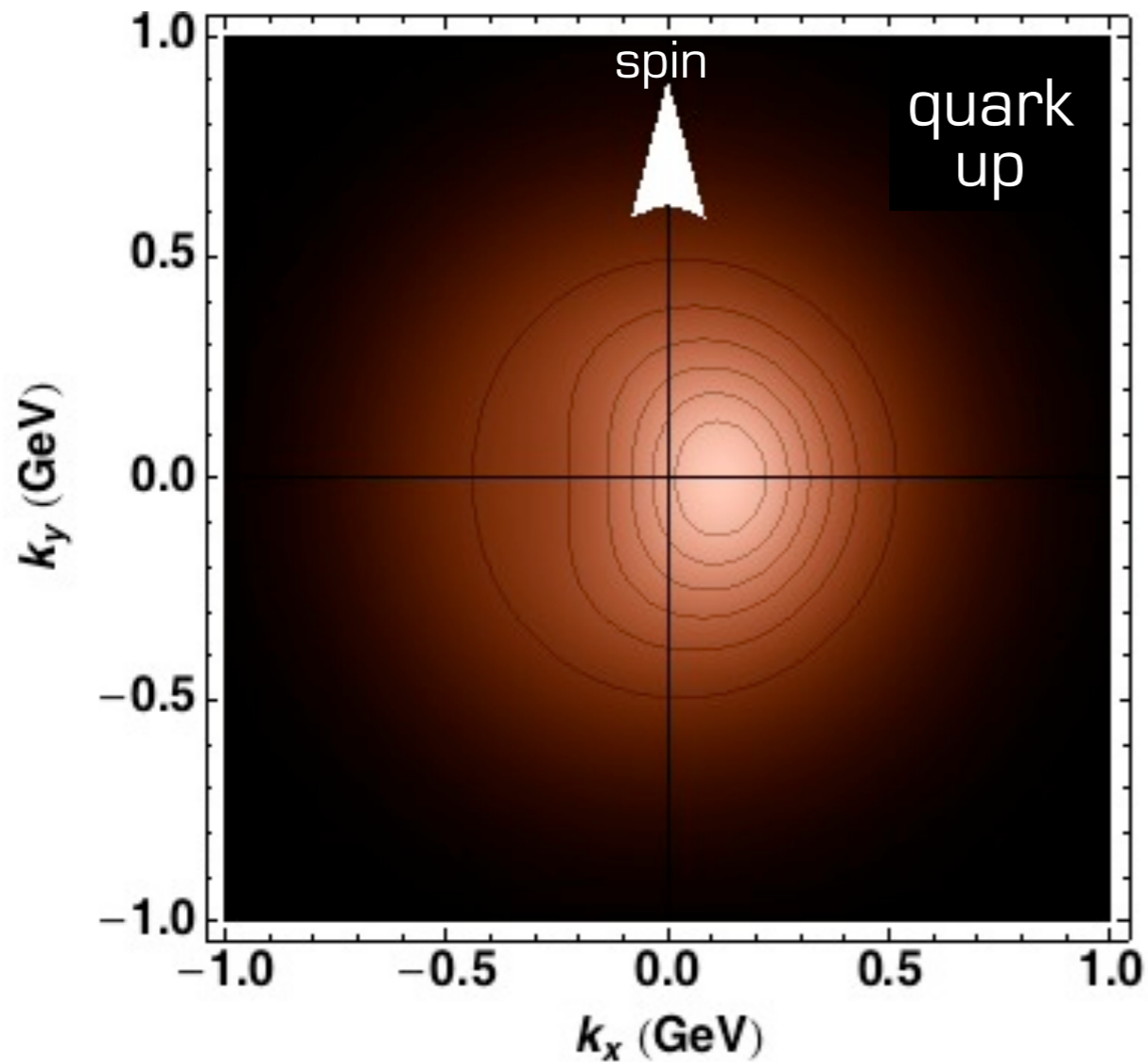


La nuova frontiera:

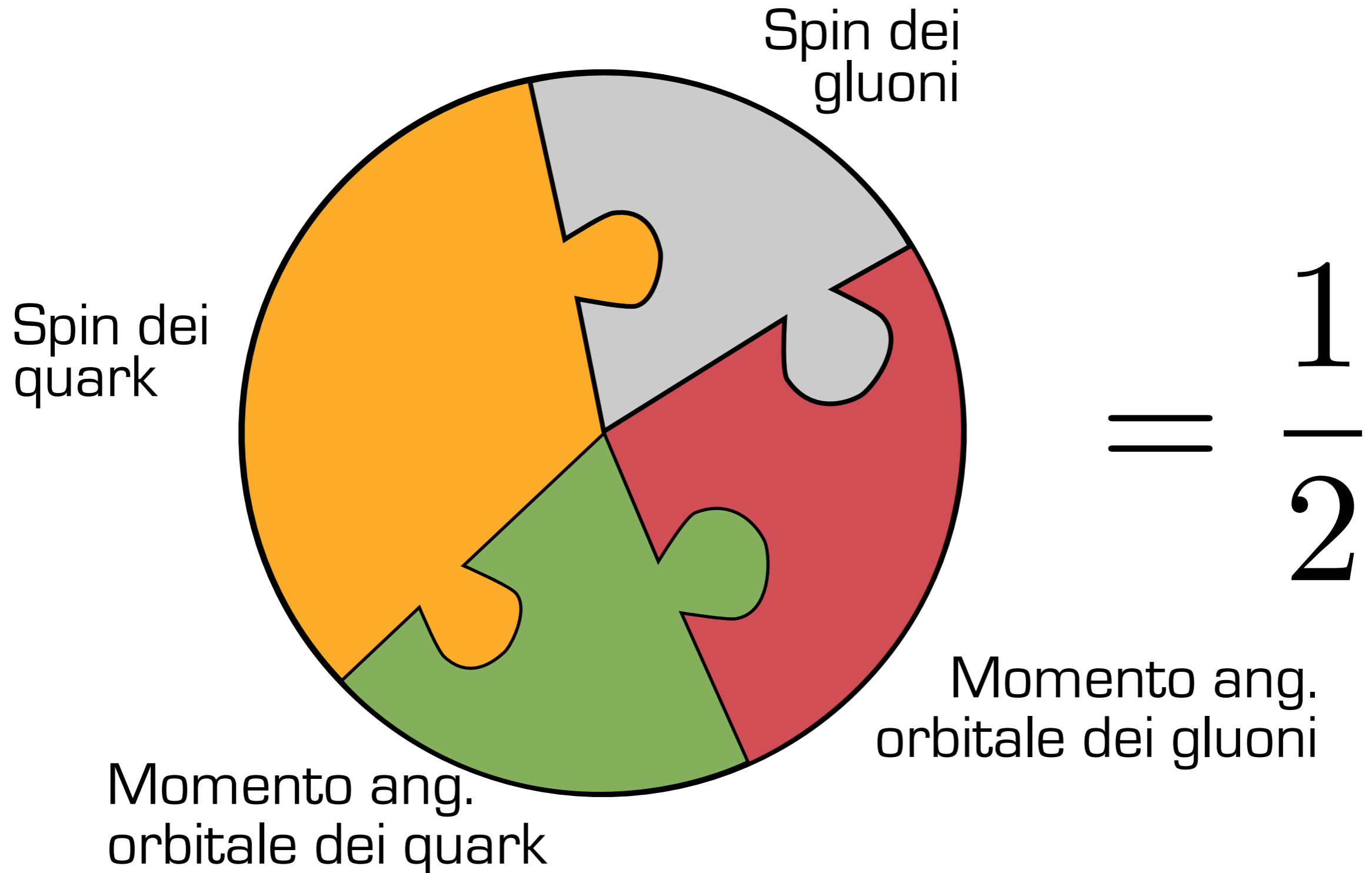
Struttura multidimensionale



Tomografia del protone



Il puzzle dello spin del protone



Argomenti e metodi

Aspetti formali

$$f_1(x, k_T; Q) = \frac{1}{2\pi} \int db_T J_0(k_T b_T) [C \otimes f_1](x, b_T) e^{-S'(b_T, Q)}$$

Metodi analitici

$$f_{1T}^\perp(x, k_T; Q) = -\frac{1}{2\pi k_T} \int db_T b_T J_1(k_T b_T) e^{-ik_T b_T} [C^S \otimes f_1]$$

Modelli

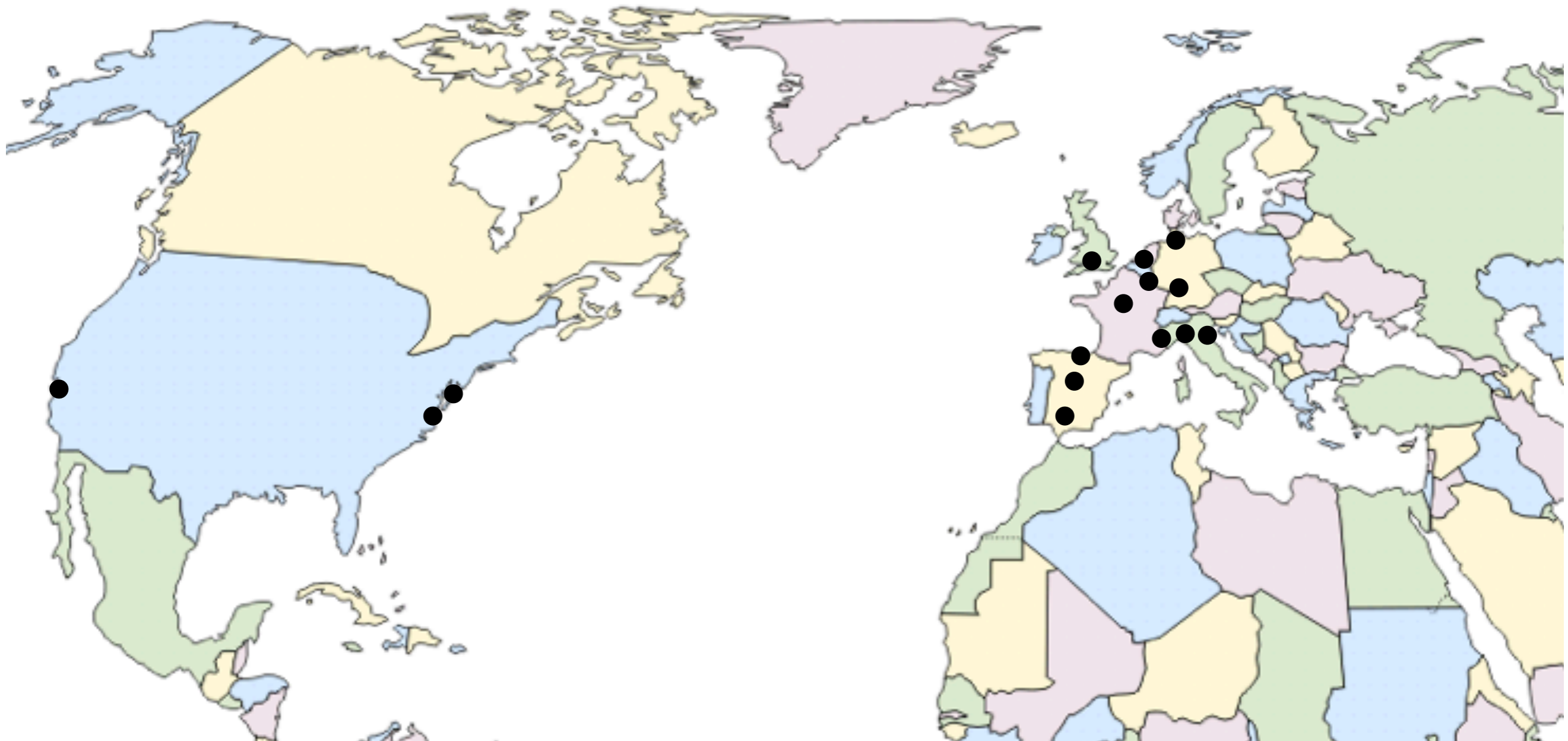
Metodi analitici e numerici

Estrazione dai dati

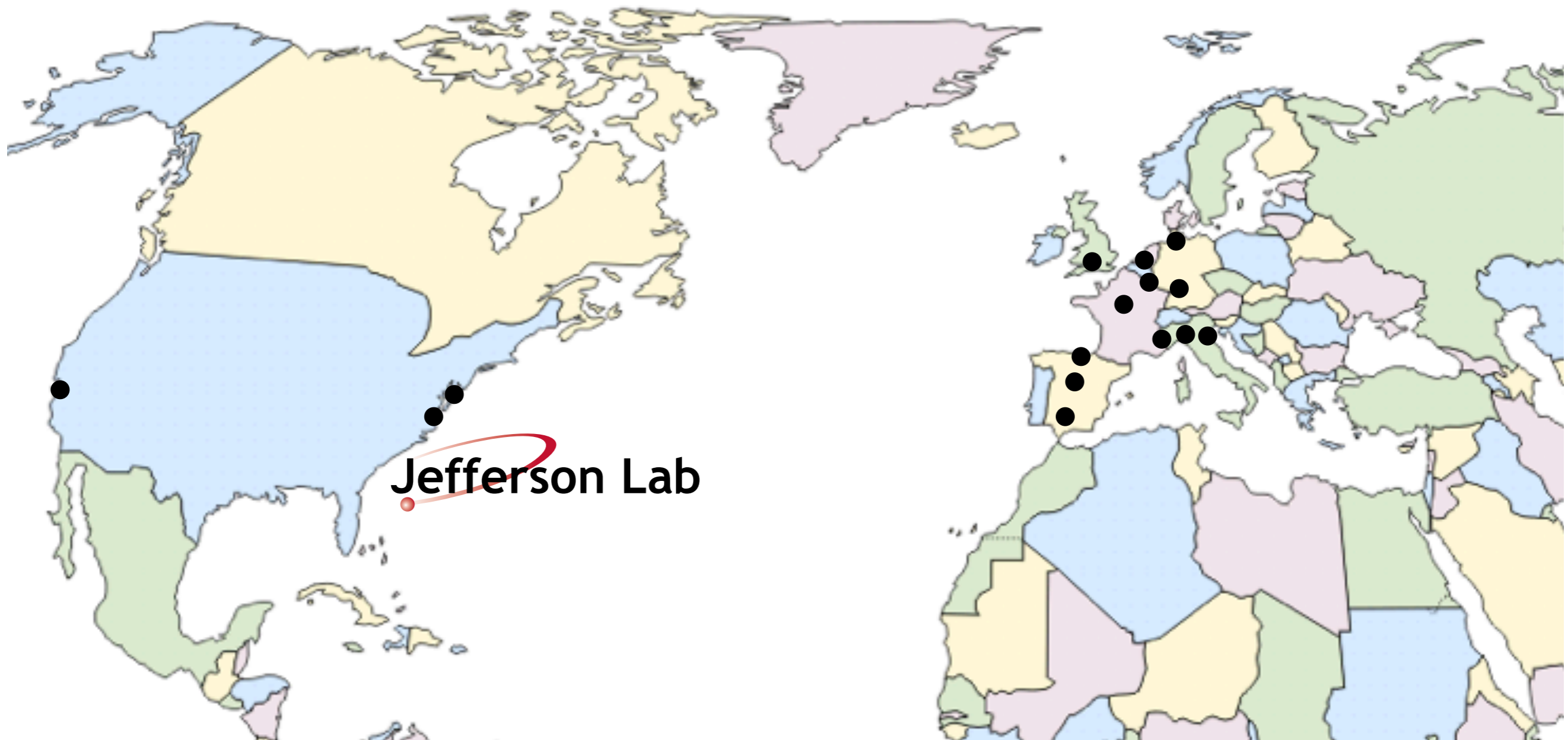
```
do k=1,1000
  i=nbins+k
  c insert the identity of target and f.s. hadron at the beginning, as real numbers
  datamat(1,i)= dble(itar)
  datamat(2,i)= dble(ihad)
  READ(UNIT=15,FMT=200,END=999) (datamat(j,i),j=3,9)
200  FORMAT(4x,7(1x,D13.6))
  nbinpar=nbins
  ! just to confirm that the data are OK
  if (k.eq.1) then
    print *, 'Reading data from file ',fname
  end if
  write(*,300) i, (datamat(j,i),j=1,9)
300  FORMAT(I4,2(F4.0),7(1x,D13.6))
end do
```

Metodi numerici

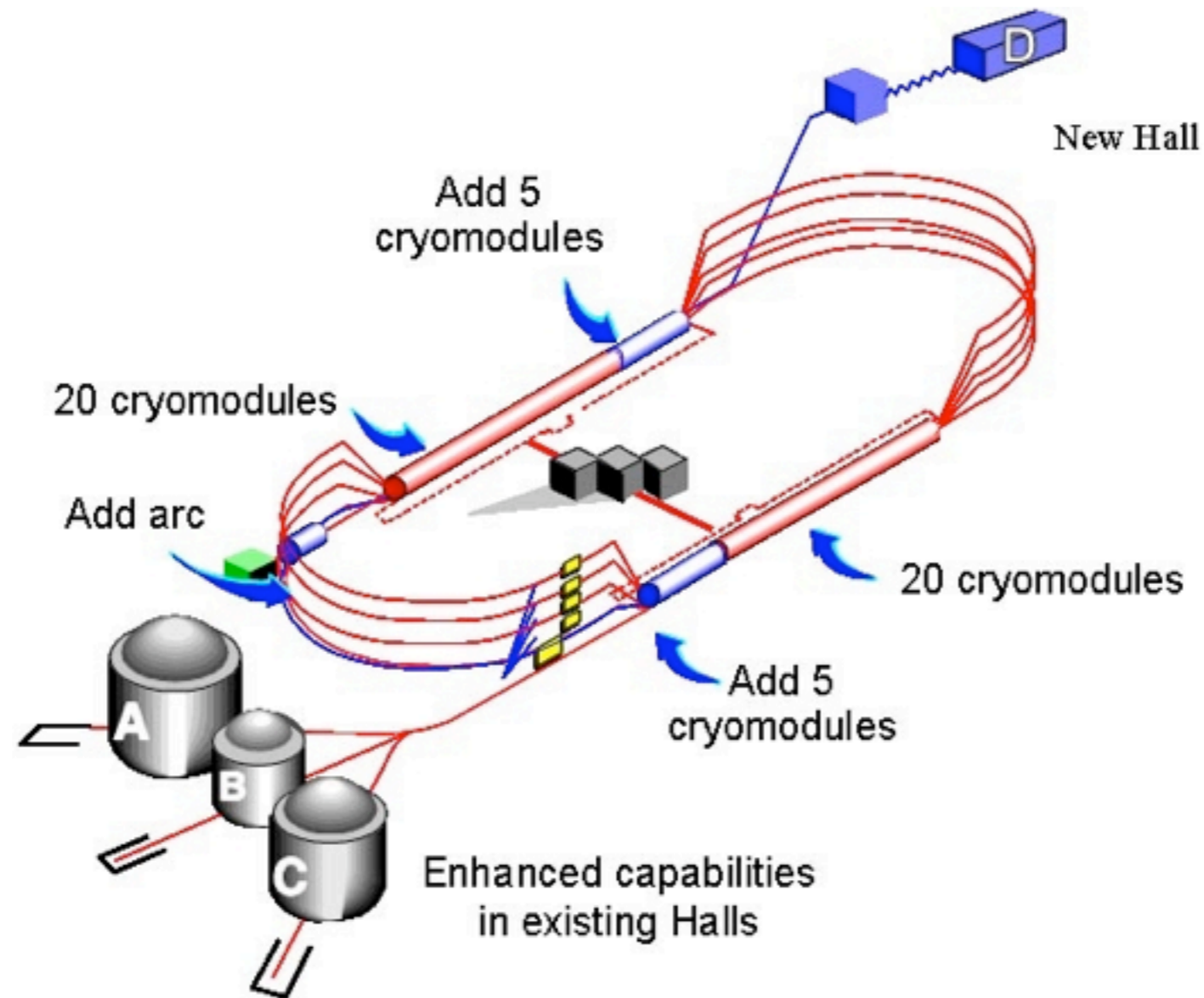
Contatti nazionali e internazionali



Contatti nazionali e internazionali



Esperimenti: ad es. Jefferson Lab



Prospettive

- Carlo Barbieri: lecturer a Univ. of Surrey
- Ilaria Jemos: post-doc a Vienna
- Andrea Signori: dottorando a Amsterdam
- Francesco Conti, Chiara Fornarola: finanza
- Manuel Pincetti, Silvia Entradi: consulenza
- Sofia Cazzaniga: dottoranda in finanza
- Marina Dorati: industria nucleare

Per chi ne vuole sapere di più

Colloquium di dottorato

prof. Marc Vanderhaeghen

(Mainz)

30 maggio

(settimana prossima)

Per chi ne vuole sapere di più

Per chi ne vuole sapere di più

<http://www.sif.it/attivita/saggiatore/econtents>



SCIENZA IN PRIMO PIANO

THE PROTON IN 3D

ALESSANDRO BACCHETTA^{1*}, MARCO CONTALBRIGO^{2}**

¹ Università di Pavia and INFN Pavia, Italy

² INFN Ferrara, Italy

Protons and neutrons constitute the building blocks of normal matter, accounting for almost all the mass of our world. We are still far from understanding the intricacies and mysteries of their inner structure. In the course of several decades of successful studies, we dedicated our efforts to delving deeper and deeper into them. A few years ago, thanks to a fruitful synergy of theoretical and experimental progress, we started to collect unprecedented multi-dimensional information on the distribution of

1 Introduction

Atoms are made of protons, neutrons, and electrons, approximately in equal numbers. Electrons weigh about 0.5 MeV, protons and neutrons about 1000 MeV. It follows that nucleons (i.e., protons and neutrons) are responsible for about 99.97% of the mass of matter around us.

When we study nucleons, we are embarked on the quest to understand the ultimate constituents of matter, one of the most fascinating adventures of the history of human thought.

Nucleons are not elementary particles. They have an extension of the order of 1 femtometer (10^{-15} m). The nucleon is thus a "femtostructure", i.e., one million times smaller than nanostructures. The smallness of this scale is astonishing. The internal structure of the protons (10^{-15} m) in the magazine you are reading is visible from outside the Solar System