PAN 2007

Introduction to Nuclear (Astro) Physics

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Slides by Thomas Duguet/ JINA

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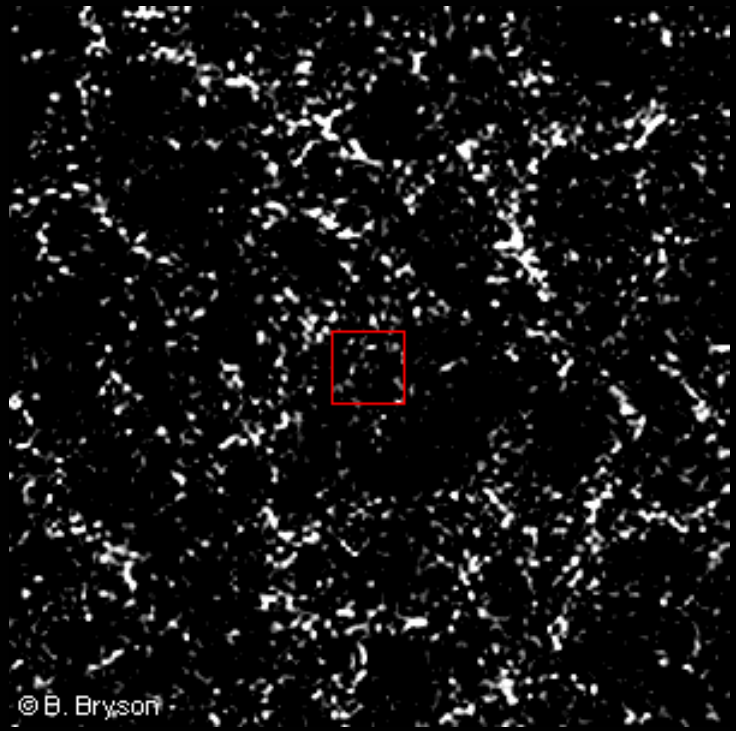
What we know…

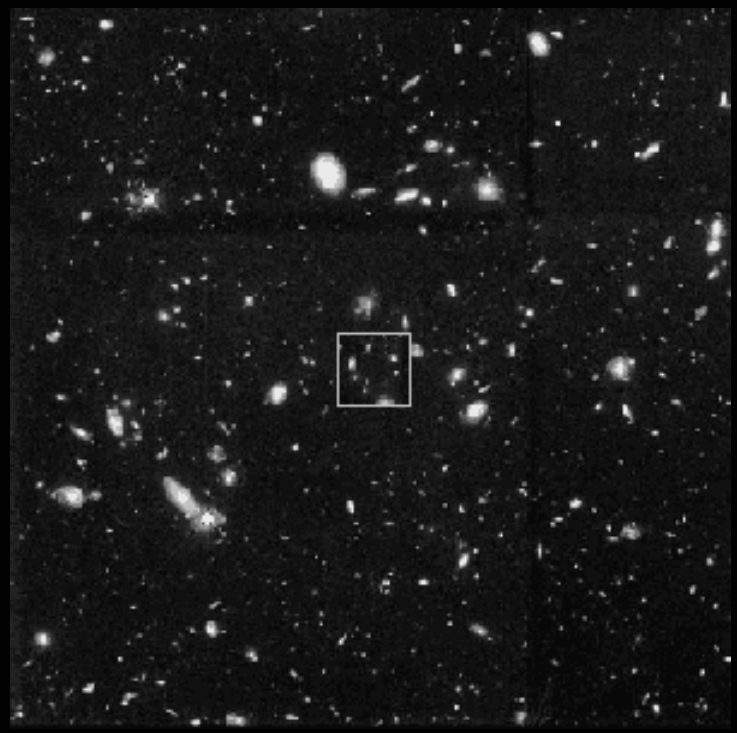
- 10^{26} m — universe
- 10^{24} m — cluster of galaxies
- 10^{22} m — milky way
- 10^{14} m — solar system/star
- 10^{7} m — earth
- 10^{0} m — human beings
- 10^{-2} m — insects
- 10^{-5} m — cells
- 10^{-8} m — DNA
- 10^{-10} m — atom
- 10^{-14} m — nucleus
- 10^{-15} m — nucleons
- 10^{-16} m — quarks/gluons

10^{26} m: the universe



The dots are the brightest galaxies

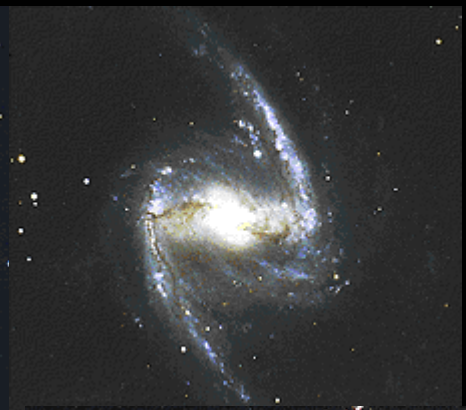
10^{24} m: cluster of galaxies



~200.000.000 light years away

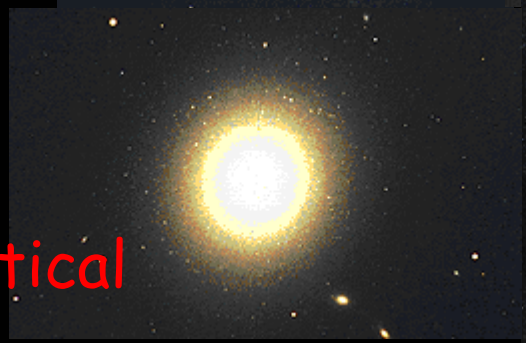
10^{22} m: our milky way

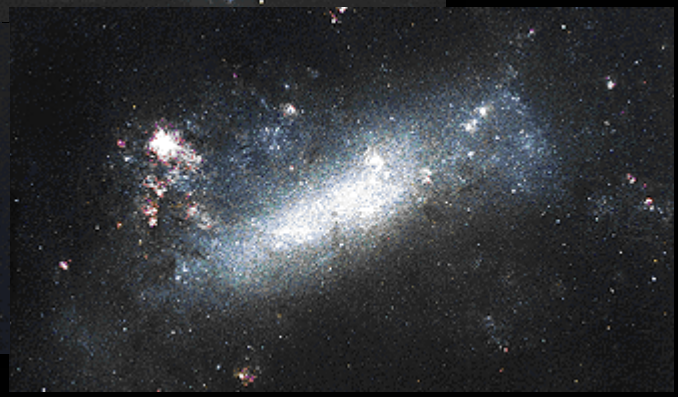
Spiral



Barred spiral

Elliptical

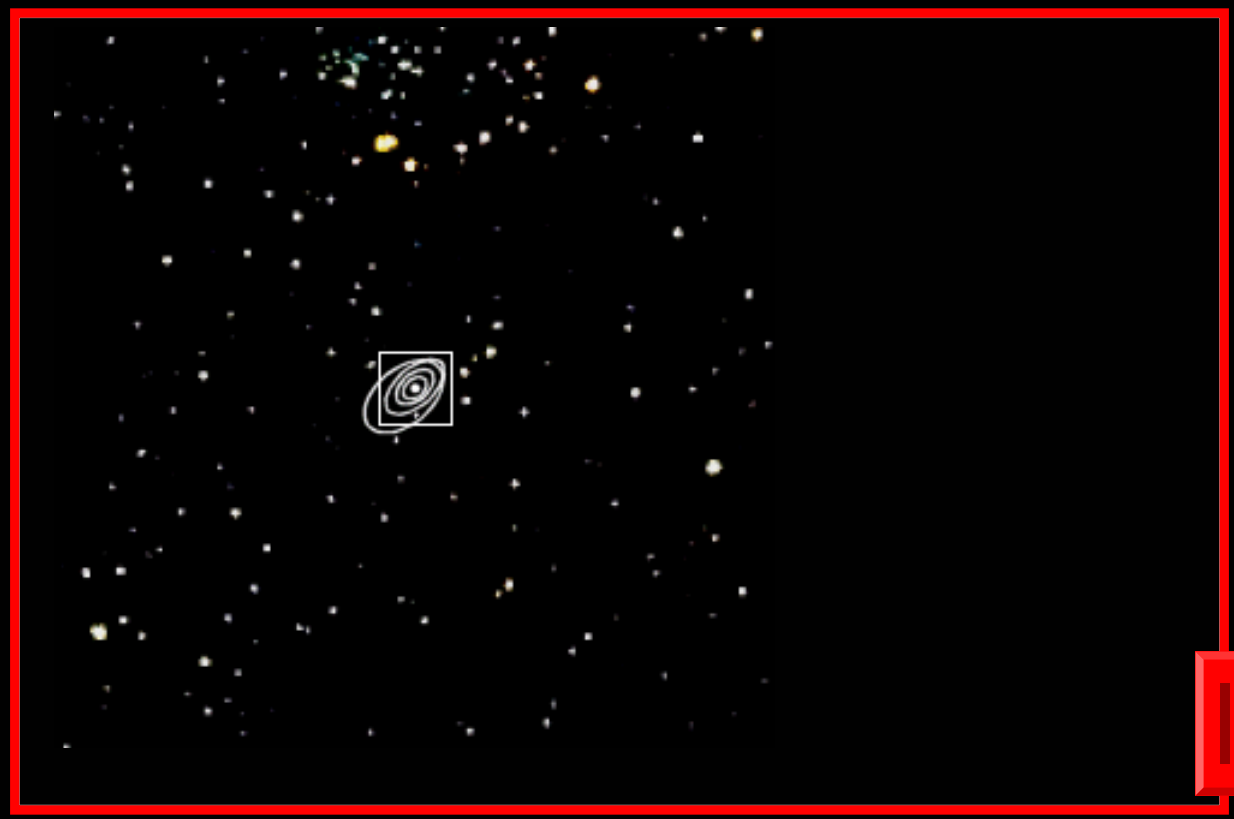




Irregular

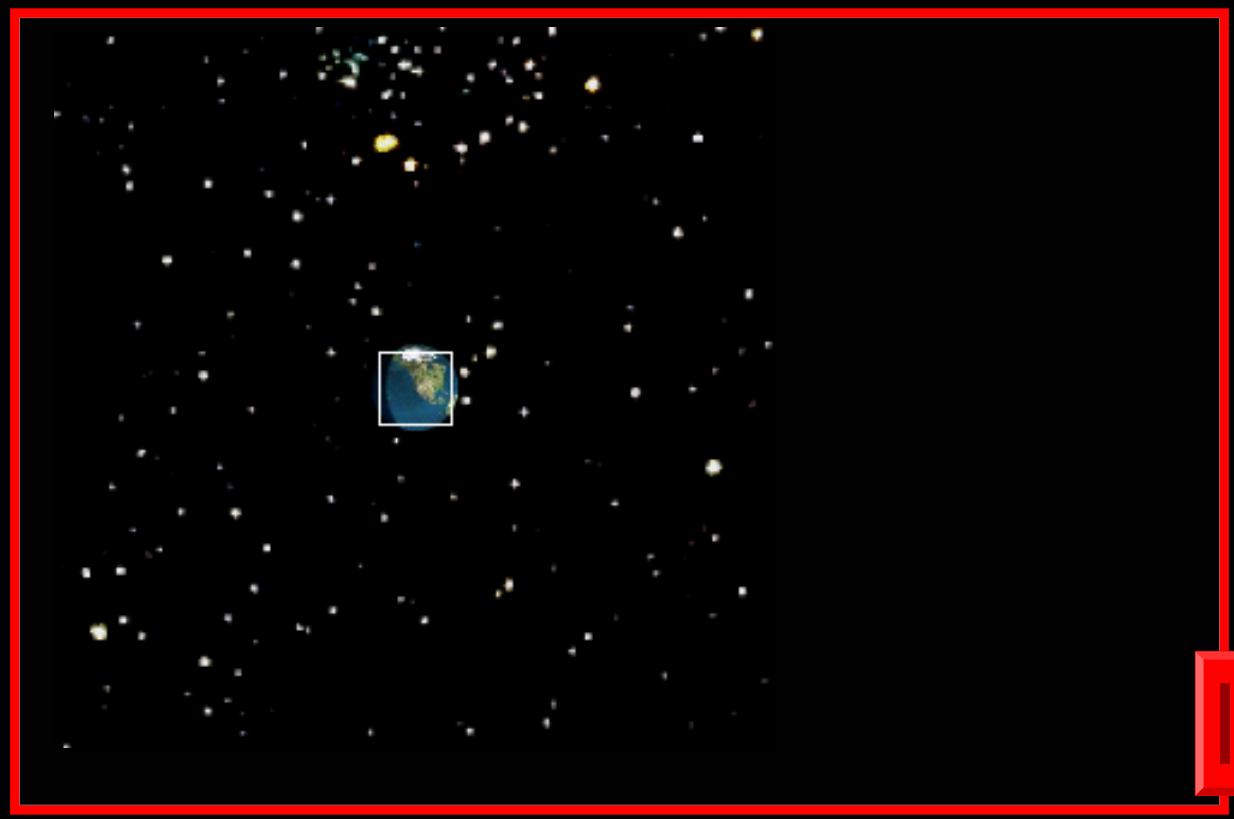
Our milky way is a spiral galaxy

10^{14} m: The solar system/star



The orbits of the nearby planets

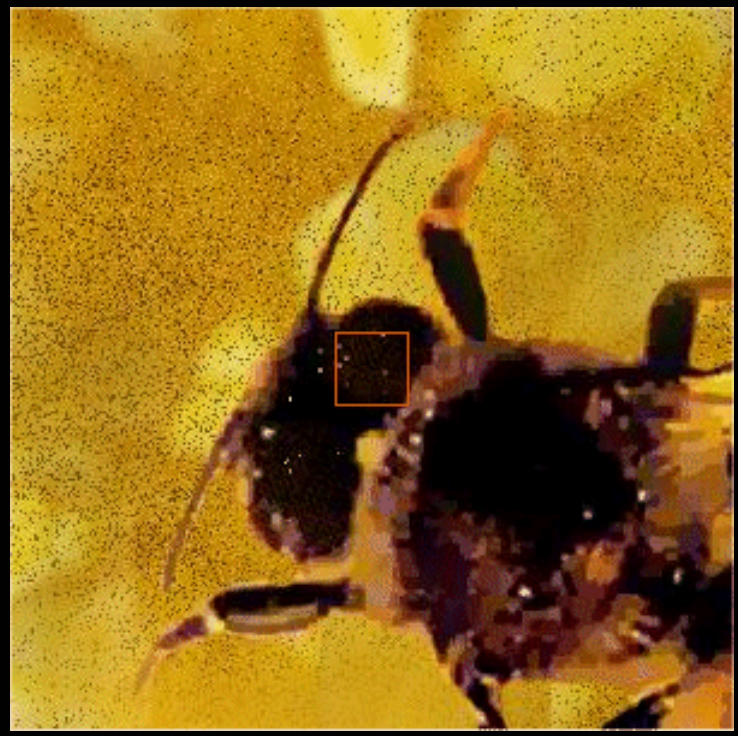
10^7 m: earth



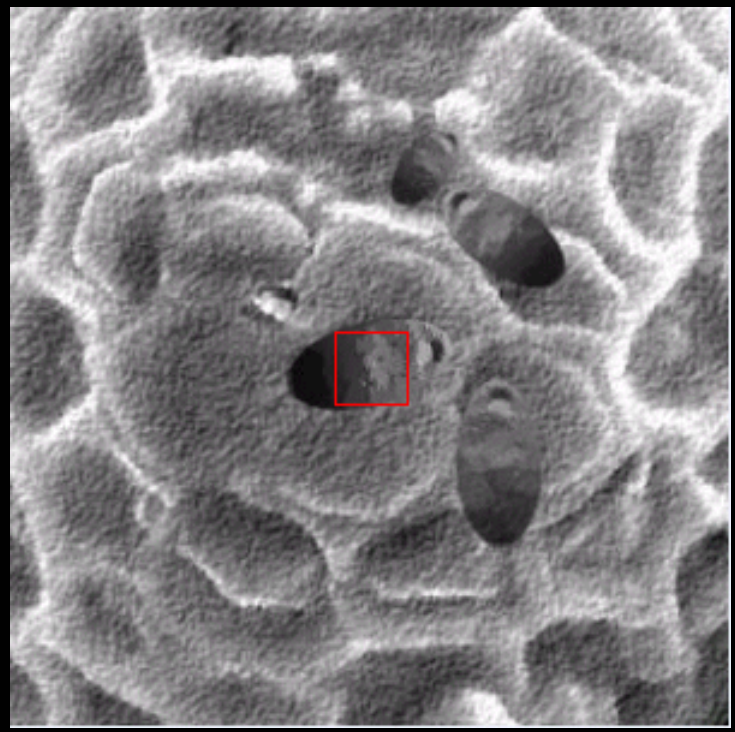
10^0m: humans

Marie Curie

10^{-2} m insects

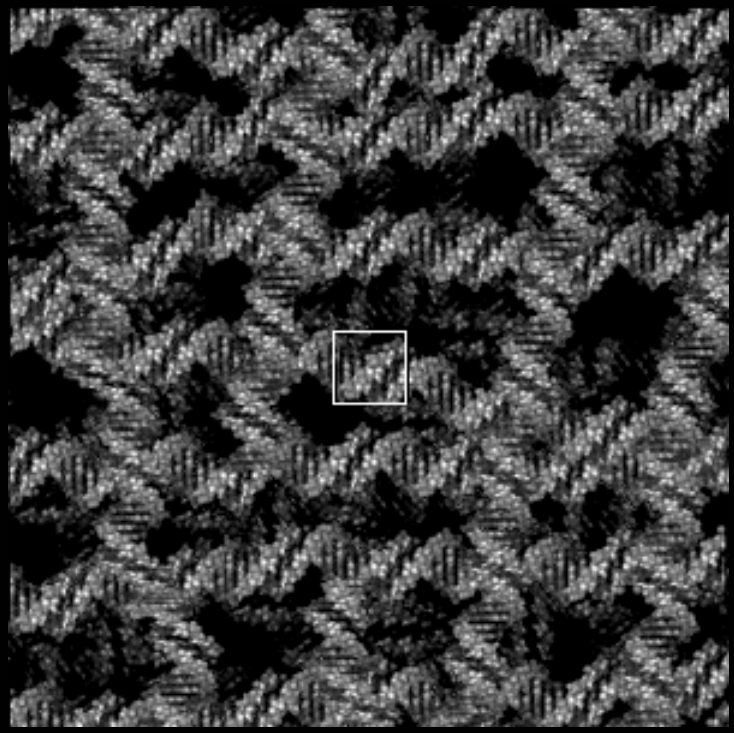


10^{-5} m: a lymphocyte (cell for immune system)

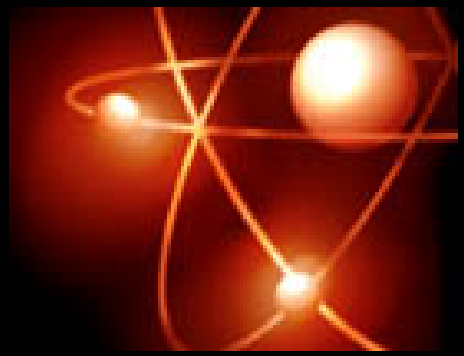


Scale of cellular biology

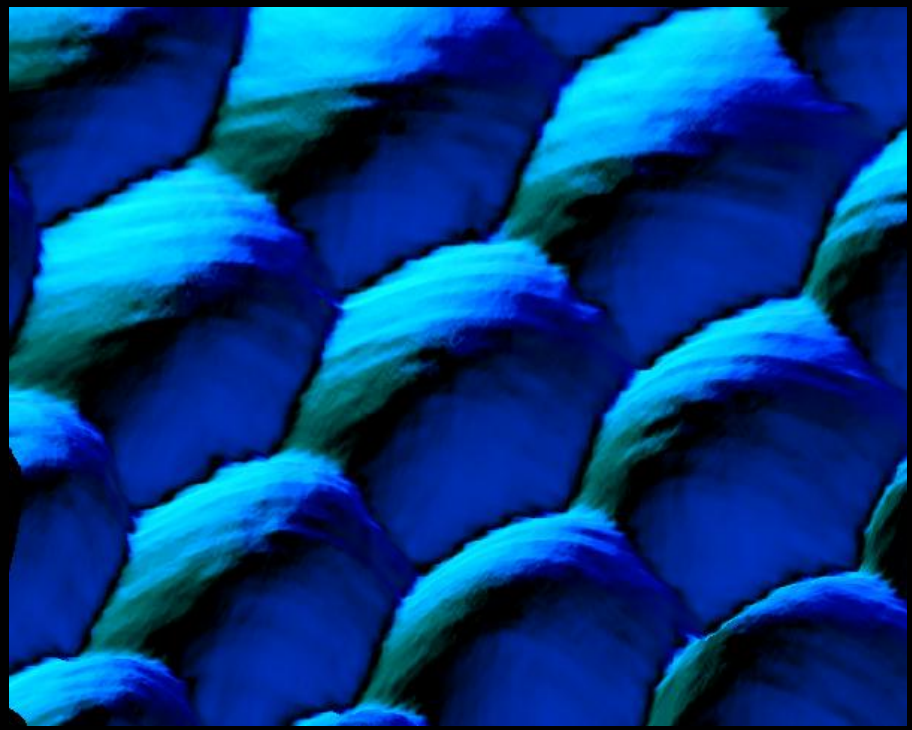
10^{-8} m: DNA



A double helix structure

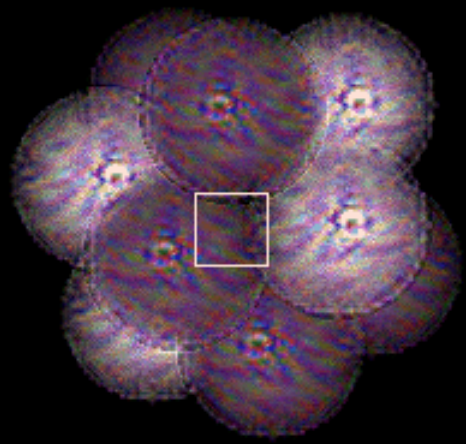


10^{-10} m: atom



Field Emission Scanning Microscope image of Platinum surface

10^{-14} m: The nucleus



^{12}C (6 protons and 6 neutrons)

10^{-15}m: nucleons & the particle zoo

U = "up" quark $+\frac{2}{3}$ e

D = "down" quark $-\frac{1}{3}$ e

Proton

$m_p = 1836.15\ m_e$

Mass = 1.6726×10^{-27} kg

$= 938.27231\ \text{MeV/c}^2$

$= 1.00727647$ u

U = "up" quark $+\frac{2}{3}$ e

D = "down" quark $-\frac{1}{3}$ e

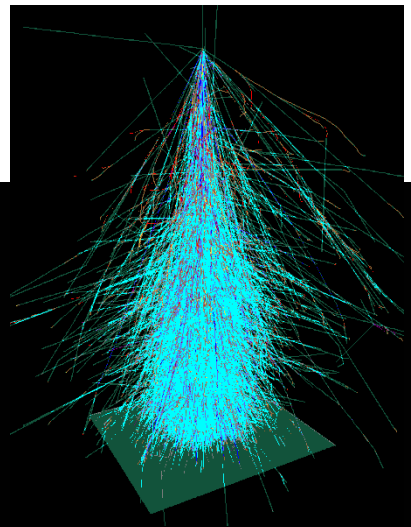
Neutron

$m_p = 1838.68\ m_e$

Mass = 1.6749×10^{-27} kg

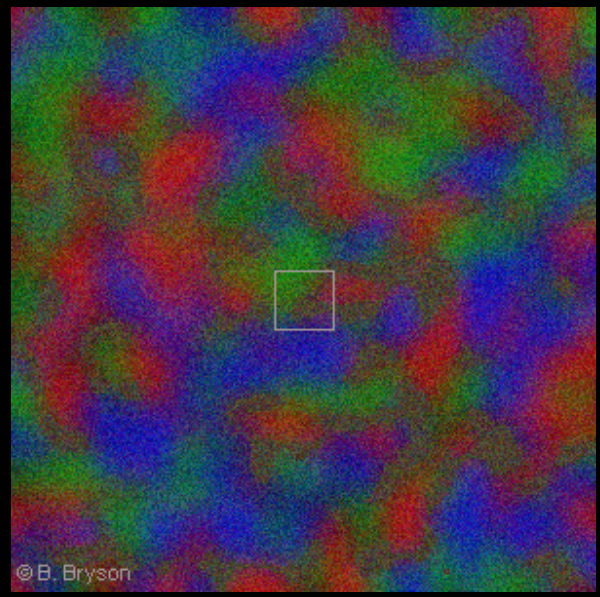
$= 939.5656\ \text{MeV/c}^2$

$= 1.0086647$ u



cosmic rays

10^{-16} m: quarks and gluons

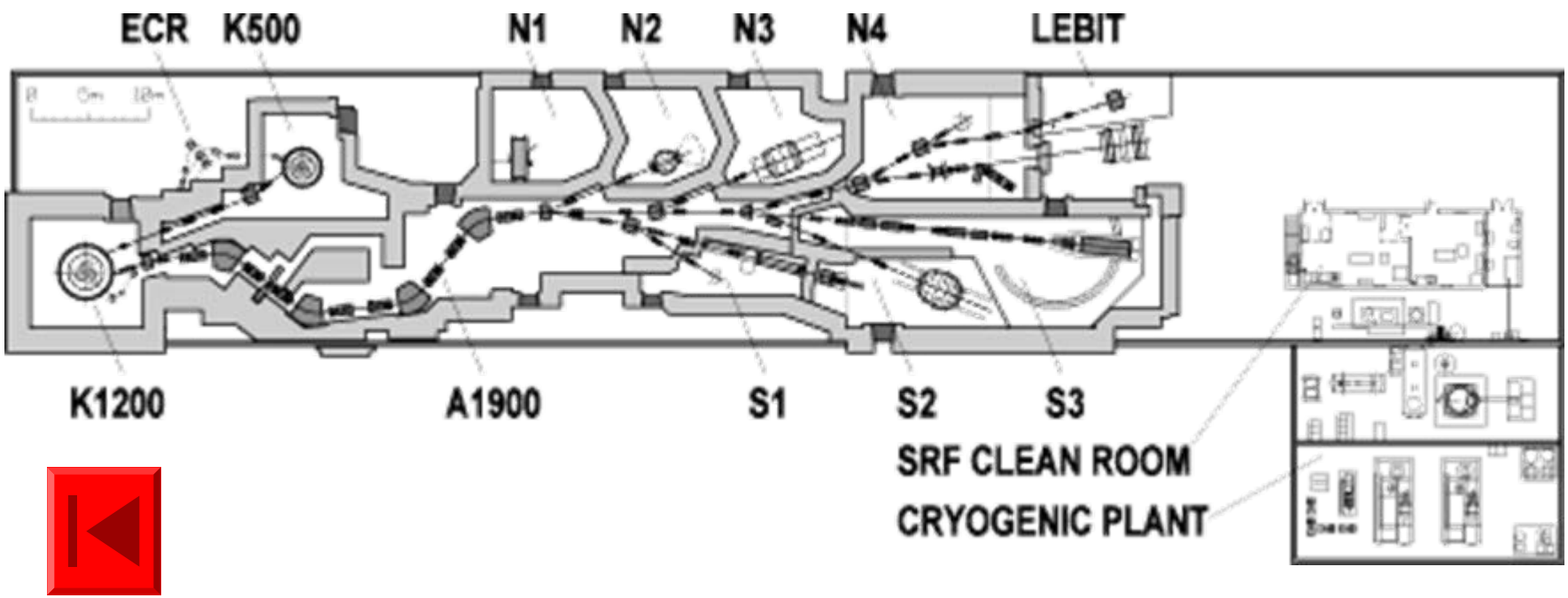


The smallest known building blocks

flavor	Up	Down	Strange	Charm	Bottom	Top
charge	+2/3	-1/3	-1/3	+2/3	-1/3	+2/3
mass (GeV)	0.005	0.01	0.15	1.5	5.0	180

NSCL

nuclear physics



Jefferson Lab

THOMAS JEFFERSON NATIONAL ACCELERATOR FACILITY

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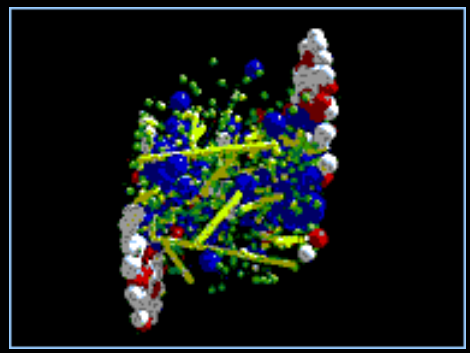
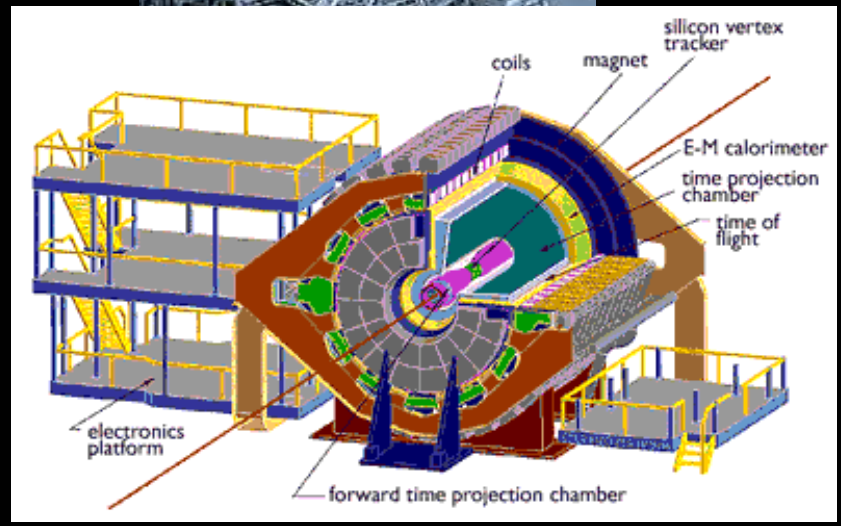
particle physics

RHIC

quark-gluon physics





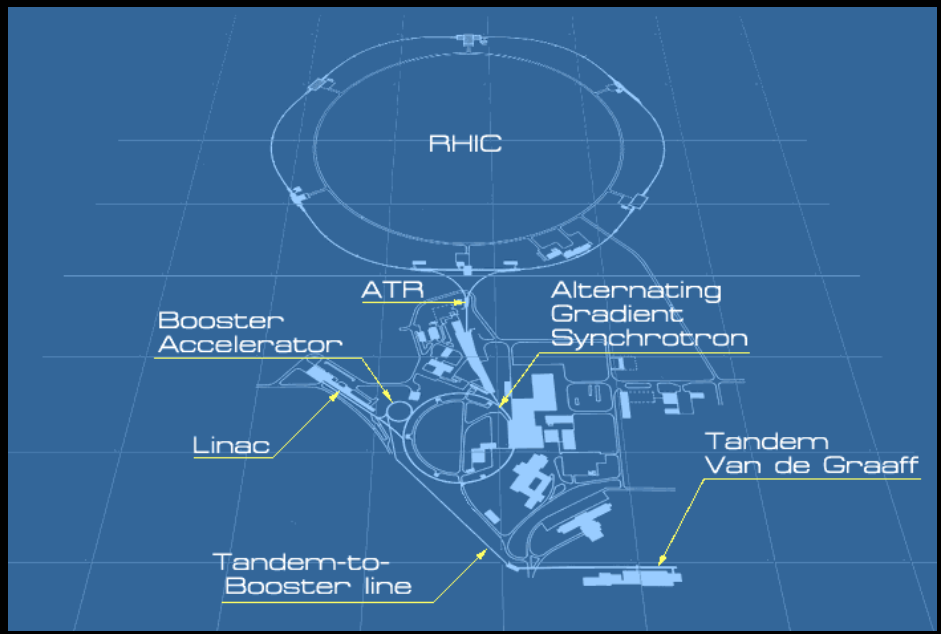


Table of the elements

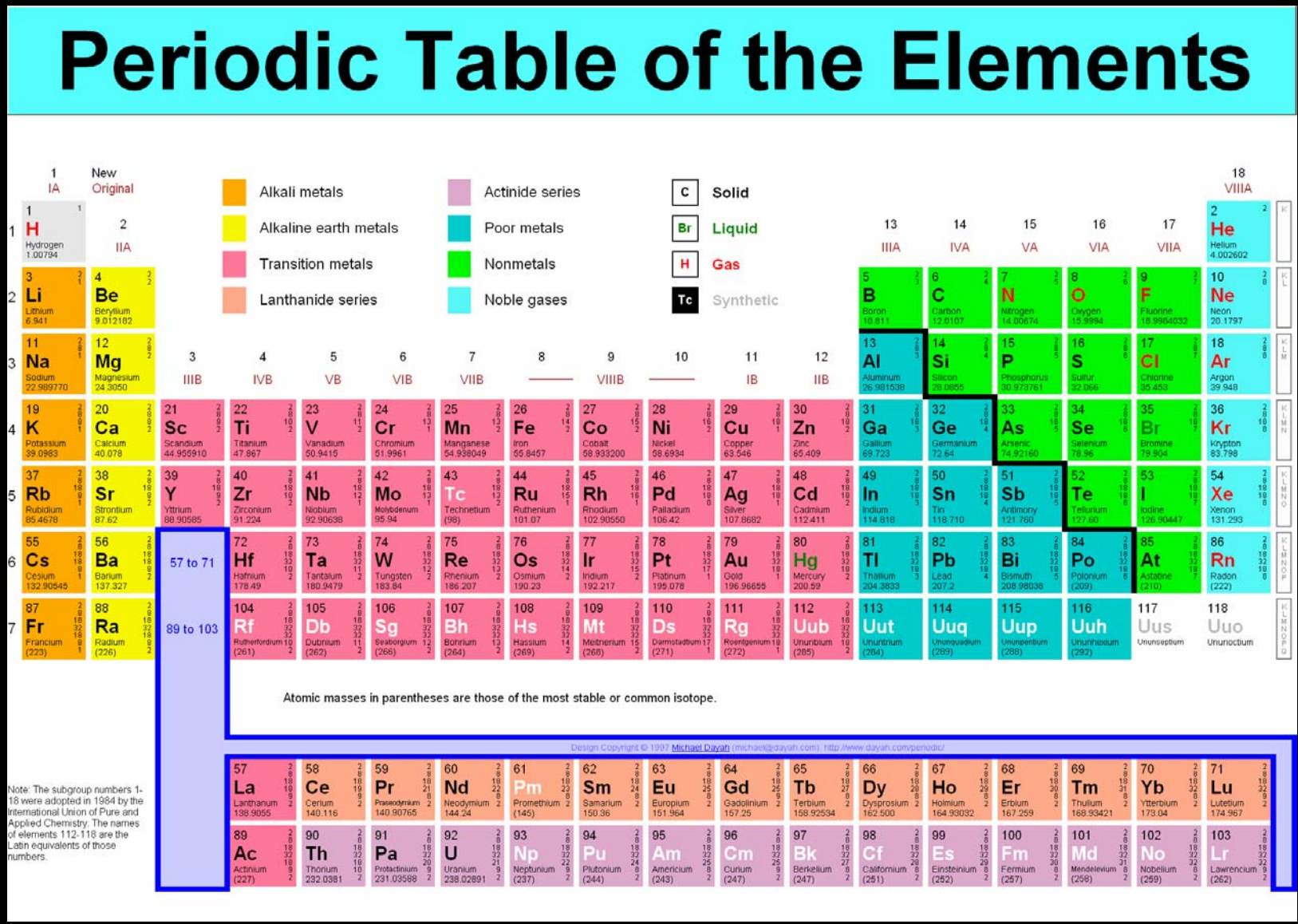


Chart of nuclei