

Minor – 2nd semester (2017)

Nuclear & Particle Physics

Nuclei (I.Matea)

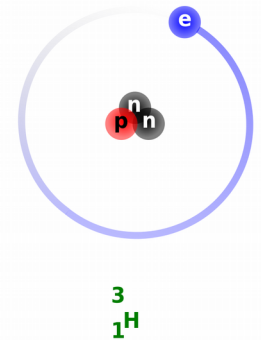
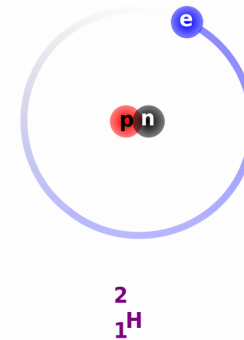
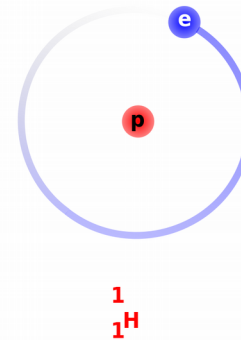
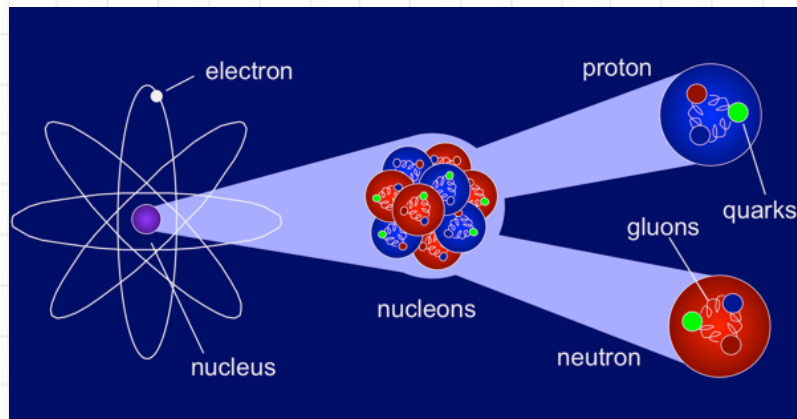
Particles (G.Moreau)

Neutrinos (L.Simard)

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Nuclear physics

(I.Matea)



Description of the atomic nucleus

The nuclear landscape and basic facts for **nuclear models**

The deuteron properties

Shell model and residual interaction

Collective excitations in even-even nuclei

Vibrational and rotational motion

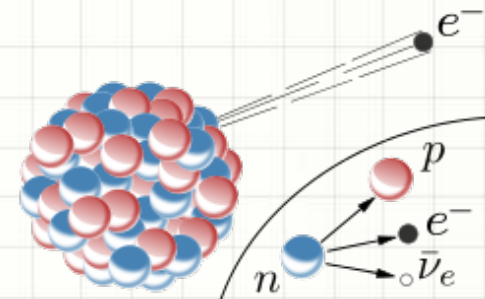
Analyses of the atomic nucleus

Exciting the nucleus :

- Particle Accelerators
- Reactions: direct and indirect reactions
- Insight: production and separation of exotic nuclei, Observing the nucleus
- Radiation interaction with matter
- Particle detection: general properties of radiat. detectors; semiconductor detectors

Selected experimental techniques :

- Particle-gamma detection for nuclear structure studies
- Life-time measurement techniques: from fast timing to beta decay



Applications of nuclear physics (*selected topics*)

Nuclear radioactivity and radioactive dating

Particle physics

(G. Moreau)

Quantum formalism

- * **Basic particles**.....described by **wave functions**
Fermions (spin ½).....described by **spinors**
- * Extension of the quantum formalism to **relativity**

=> Equation of motion : the **Dirac Equation**

$$(i\gamma^\mu \partial_\mu - m)\psi = 0$$

Particle physics

(G. Moreau)

Quantum formalism

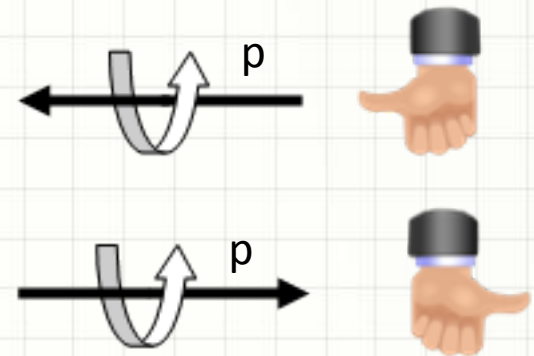
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Involving...

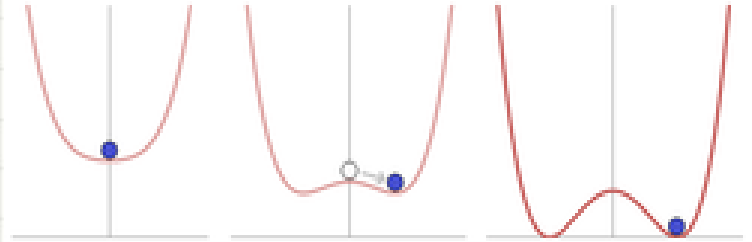
- **Dirac matrices**
- Notion of **Anti**-particles
- **Chirality** vs. **Helicity** operators



Generating the particle masses

Higgs mechanism

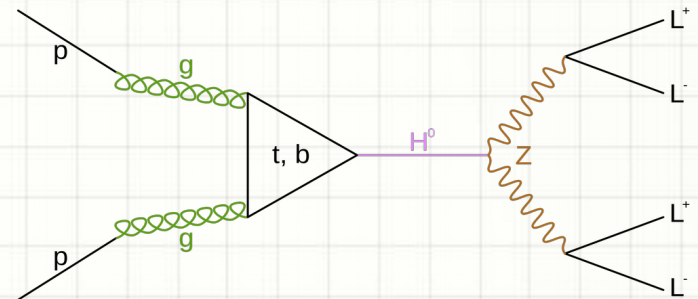
Spontaneous breaking of symmetry



Tests at high-energy colliders

Discovery (2012) of the Higgs boson at LHC

Seminar by an experimentalist

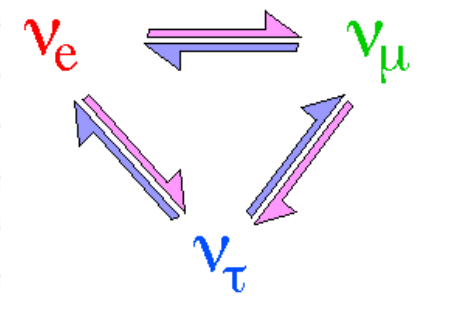


Neutrino physics

(L.Simard)

Particle with very low interaction probability.

- The number of families : existence of **sterile** neutrinos?
- Its nature : identical to its anti-particle? (**Double beta decay**)
- Its mass : **oscillation**, direct measurement, cosmology...





Recommendations for this Minor :

-> **better to have followed the Major course**
« **Particles, Nuclei and Universe** » (1st semester)

-> **complementary to the Major course**
« **Statistical and Quantum Mechanics** » (2nd semester).