

Particle Physics Conclusion (?!)



Paolo Bagnaia

SAPIENZA
UNIVERSITÀ DI ROMA

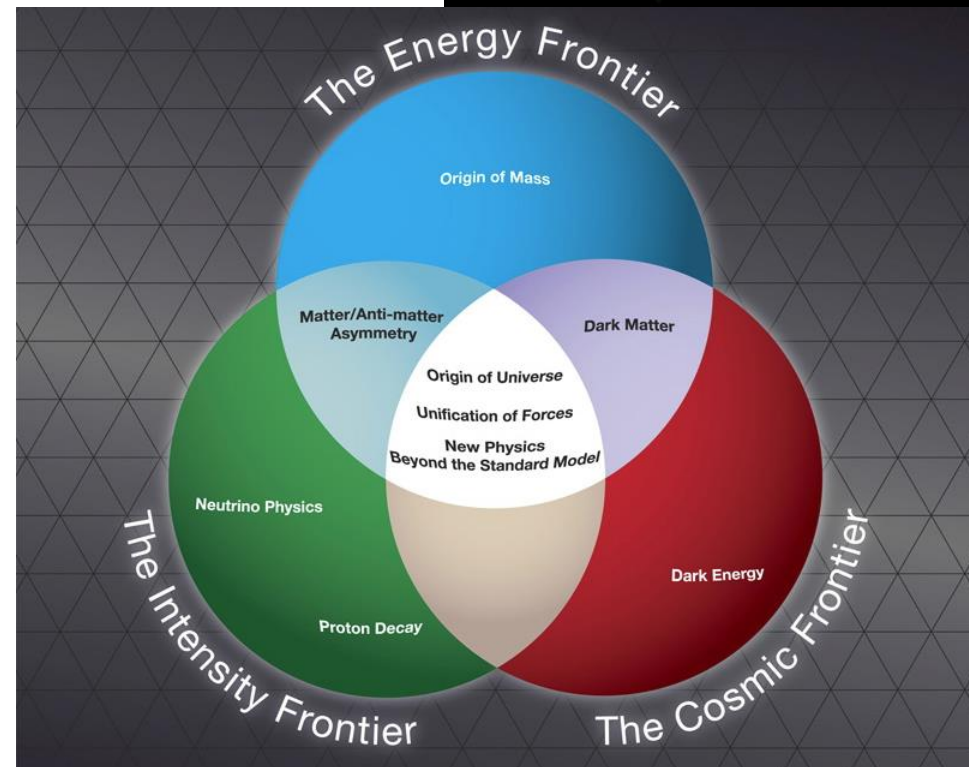
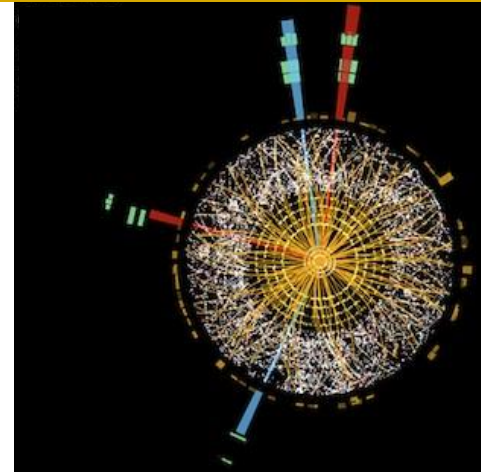
AA 21-22

Conclusion, if any

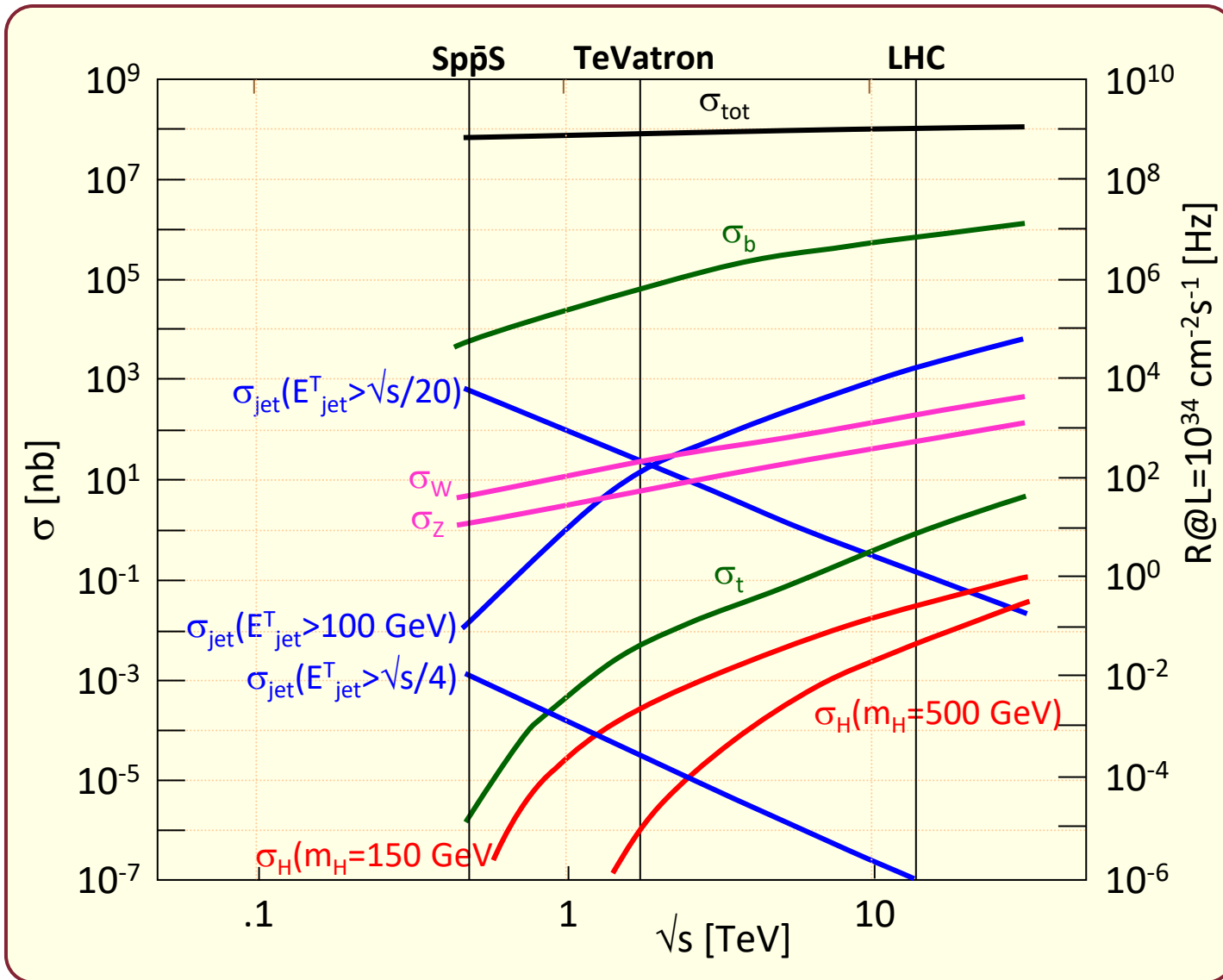
Well, not really. This is just the end of these lectures, but we have just arrived at the beginning of the modern era. The most exciting experiments and discoveries have not yet been discussed:

- **W and Z discovery at the CERN $\bar{p}p$ collider;**
 - **electroweak physics at the e^+e^- collider LEP;**
 - **Higgs discovery at the pp collider LHC;**
 - **modern astro-particle experiments;**
 - **quark-gluon plasma searches;**
 - **gravitational waves;**
 - **searches and limits (with/out accelerators) for physics bSM;**
 - **detectors, accelerators, applied physics;**
 - **... and much more (possibly the best)**
- ... will be covered in **the next semester.**

See you there !

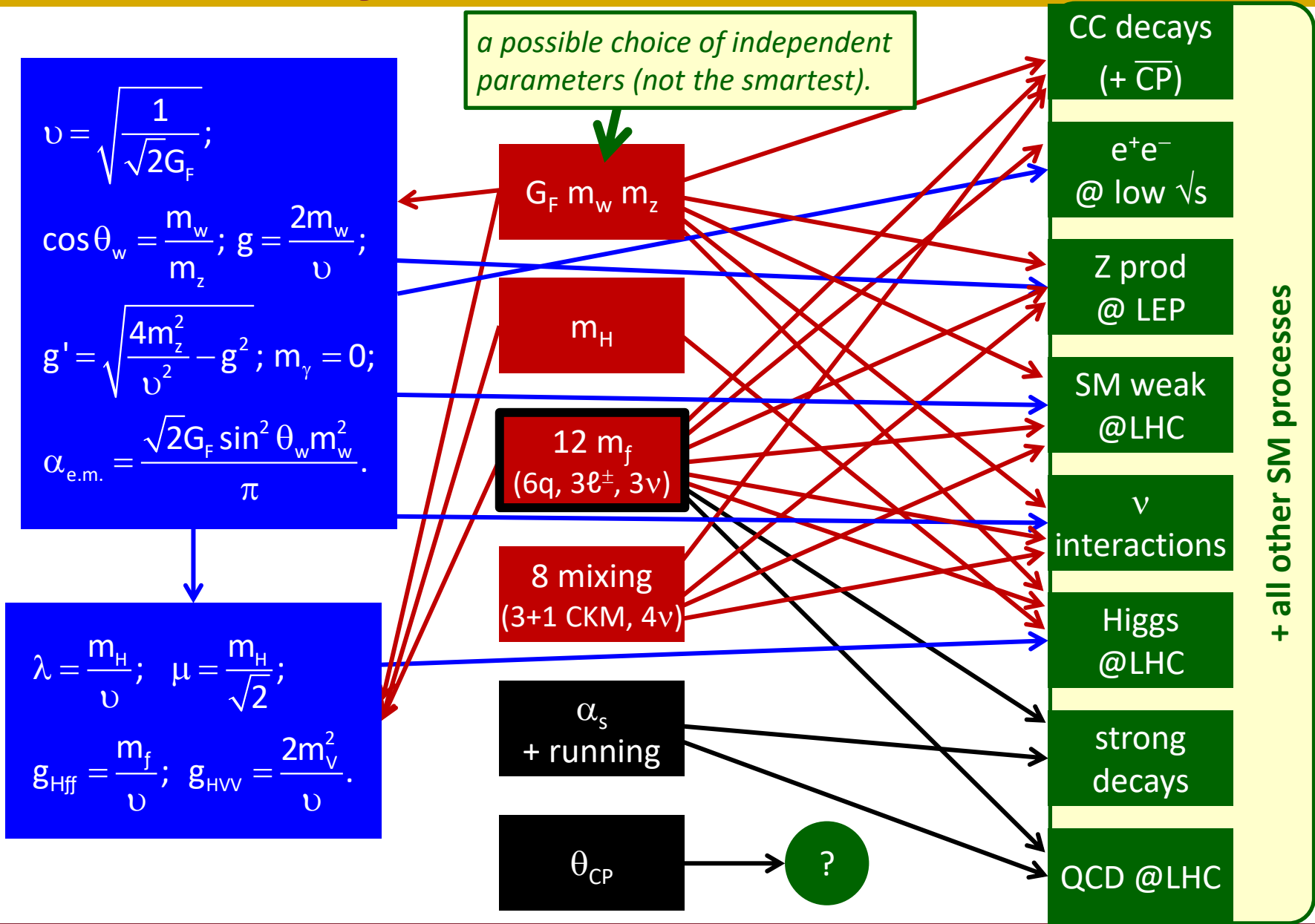


LHC results



no explanation,
just a trailer

SM today: a *simple* tree-level flow-diagram



a change of perspective

For the first time after (maybe) the birth of quantum mechanics, elementary particle physics is in an uncommon state:

- no major (nor minor) prediction awaits confirmation (e^+ , \bar{p} , ..., W^\pm , Z , t , ..., H all discovered);
- no major (nor minor) observed phenomenon awaits explanation (strong interactions have been tamed, CP violation is under control);
- exceptions : **dark energy + dark matter**;
- hope in the few missing pieces (ν masses and mixing, Higgs precision measurements, QCD @ low Q^2 , ...);

this is the common litany, however it looks to me a bit simplistic, "laPalice" style.



→ **conclusion:**

Either we are at the borders of a huge desert, or some new physics (e.g. SUSY, extra-dimensions, ...) is just above the present limits, but has not given us the slightest hint of a presence:

... however, much indirect evidence that this story has more chapters ...

why the SM is not final

THE SM DOES NOT EXPLAIN [SNOWMASS 2013, Energy frontier summary]:

- a. dark matter/energy [85% of the matter in the universe is "dark" - neutral, weakly interacting];
- b. excess of baryons over antibaryons in the universe [the SM contains a mechanism to generate baryons in the early universe and CP violation could explain a different behavior; however, it predicts a baryon-antibaryon asymmetry that is too small by ten orders of magnitude];
- c. grand unification [the quantum numbers of the quarks and leptons under the gauge symmetry $SU(3)\times SU(2)\times U(1)$ of the SM suggests that these symmetry groups are unified into a larger grand unification group, like $SU(5)$ or $SO(10)$; however, the precision measurements of the strengths of the gauge couplings is inconsistent with this hypothesis];
- d. ν masses [the SM could account for Weyl ν 's with few new parameters – technically simple, but intriguing];
- e. fermion mixing [the pattern of weak interaction mixing among neutrinos is completely different from that observed for quarks];
- f. gravity [no quantum theory of gravity is incorporated in the SM];
- g. (...)

These difficulties are not equally important [I am particularly impressed by (a) and (f)] – However, all together largely justify the claim that the present SM is not the last word of the story.

Now, it's up to you !

Thanks for attending

Best wishes !

P.B.

Seminars 2022: introduction

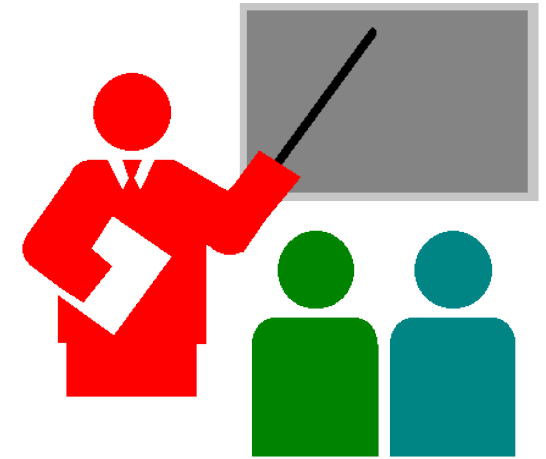
Since many years (a nice tradition), I ask the coordinators of the INFN groups to give a talk + a talk on applied physics. The idea is

- show the active experiments in our Department
- propose some possible theses
- give names and contacts of possible thesis advisors
- slides and recording available in the usual web place.

Program of the year 2022:

- Mon 30 May 12:00 : Gruppo 1 (D.DelRe)
- Tue 31 May 16:00 : Gruppo 3 (C.Gustavino)
- Wed 01 June 14:00 : Applied Physics (R.Faccini)
- Mon 06 June 12:00 : Gruppo 2 (M. Vignati)

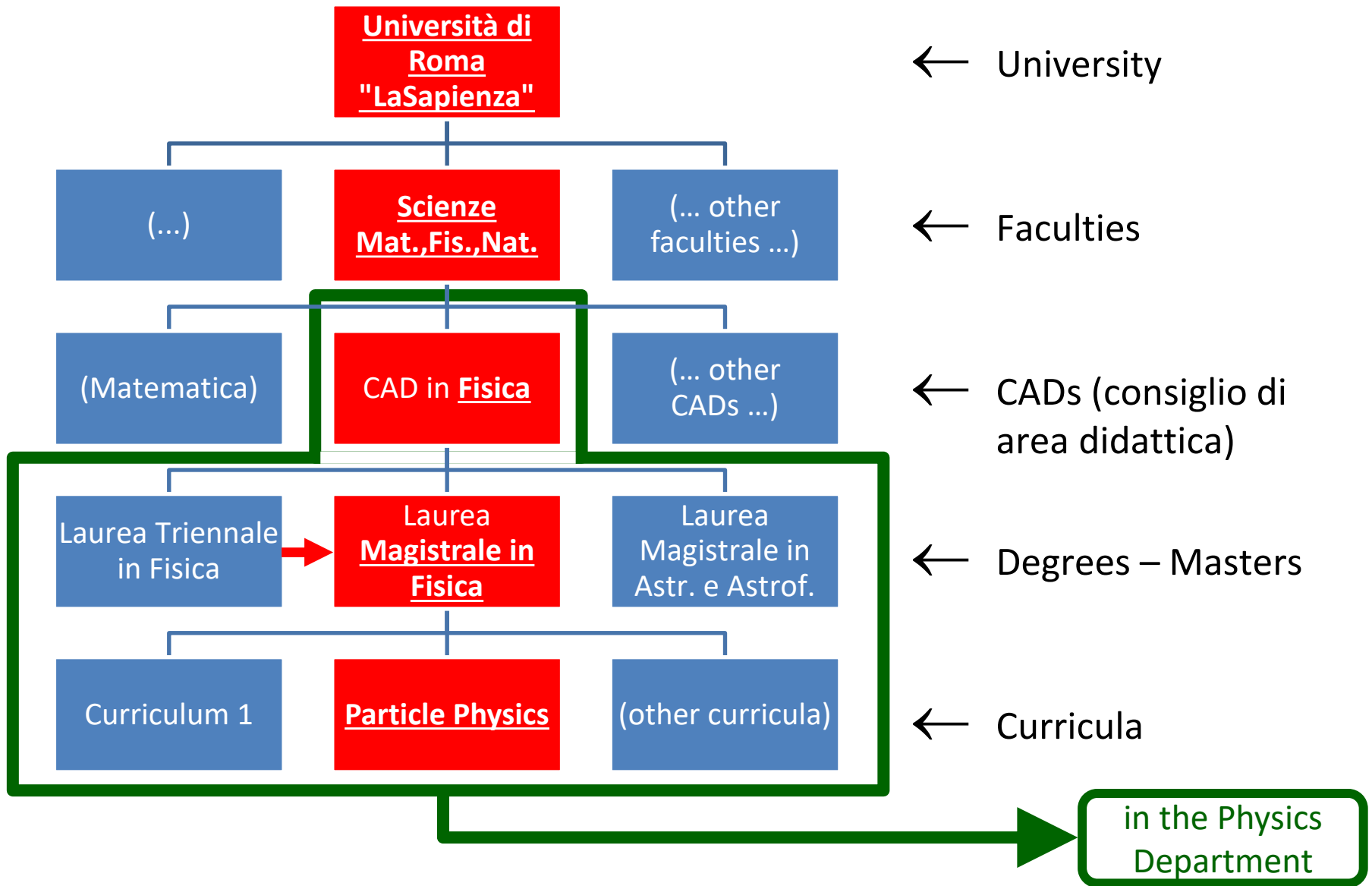
These seminars are an actual part of the course, because it is very instructive to know how/when/by whom the real research is performed. So I kindly ask also people not interested in a thesis to follow them.



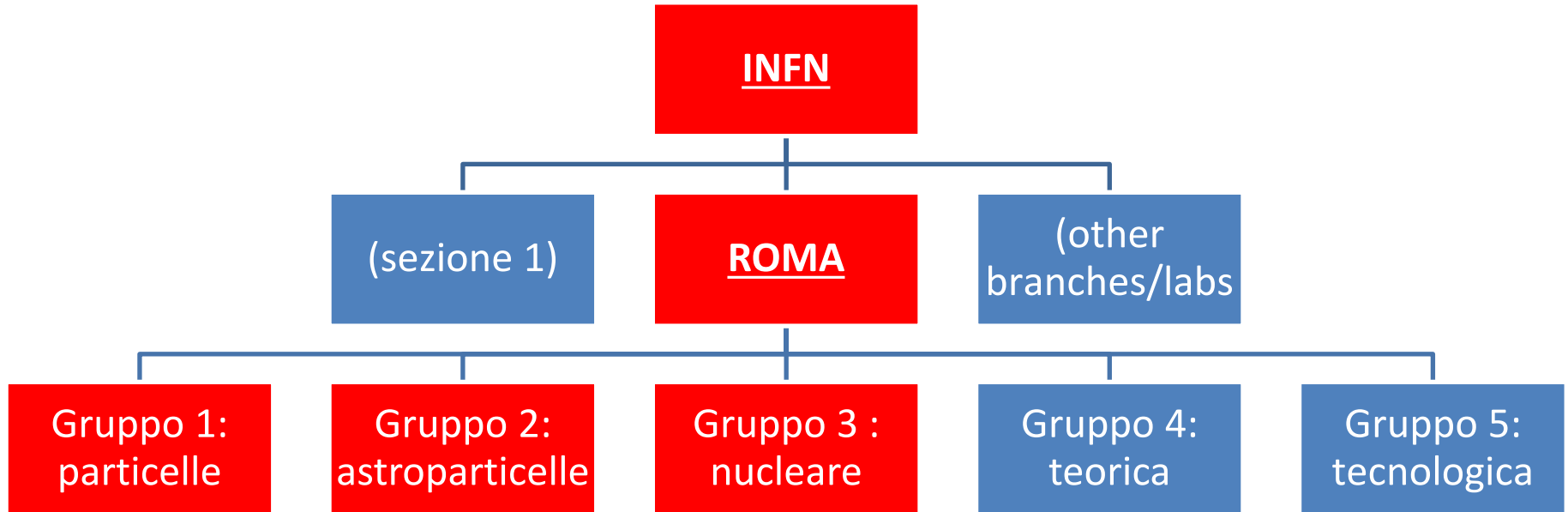
standard
time/room

Now a brief introduction
on the organization of
lectures and research in
Particle Physics in Italy

studying in our University



research in particle physics



INFN ("Istituto Nazionale di Fisica Nucleare") is the Italian agency which funds the fundamental research in particle and astroparticle physics.

Its branches ("Sezioni") live within the physics Departments of the Universities. Also independent branches (Laboratori Nazionali, e.g. Frascati) exist.

INFN has its own staff, but funds equally projects proposed by university members. Almost all research teams (e.g. ATLAS and CMS) contain both INFN and university staff (aka "professors").

Each group has an elected "coordinator", in charge for three years for administrative and scientific purposes.



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The end