

Particle physics activities in Morocco

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Outlines

- ▶ Our Universities
- ▶ Research activities
- ▶ Projects

Our Universities: Prologue



The University of Al-Karaouine is located in Fez.

Our Universities: Prologue

- ▶ The University of Al-Karaouine is located in Fez.
- ▶ It was founded by **Fatima al-Fihri in 857–859**. Originally it was a mosque and later on it became one of the leading spiritual and educational centers of the historic Muslim world.
- ▶ During Marinid period 13th century: Several subjects such as the Qur'an and Fiqh, grammar, rhetoric, logic, medicine, mathematics, astronomy and geography.
- ▶ Scientific collaboration in Africa is quite old, since Fatima-Al-Fihri, the founder of the oldest Moroccan university, is from Tunisia.

Our Universities:

- ▶ 13 public Universities: Oujda, Tetouan-Tanger, Fes(2), Meknes, Beni-Mellal, Kenitra, Rabat, Casablanca, Settat, El-Jadida, Marrakech, Agadir,
- ▶ 9 Private Universities: Ifrane, Fes, Rabat, Casablanca, Ben-guerir
- ▶ We are about 20 faculty members,
- ▶ About 23 ongoing PhD thesis,
- ▶ 4 Master programs (Rabat, Casablanca, Benimellal, Marrakech)

Our research activities:

- ▶ Phenomenology of Particle Physics: Tangier (A.A), Marrakech (M. Chabab), Safi (R. Benbrik), Agadir (L. Rahili) , Benimellal (B. Manut), Rabat (E.H Saidi),
- ▶ Tools for HEP: Tangier (A.A), Marrakech (M. Chabab) , Safi (R. Benbrik), Agadir (J. ElFalaki)
- ▶ Cosmology, Black Holes, Branes and String theory: Marrakech (M. Chabab), Rabat (R. Ahl Laamara, A. Belhaj), Oujda(T. Ouali), Agadir (H. Moumni), Casablanca (M. Benai)
- ▶ Cryptography and Quantum informations: Kenitra (M. Daoud), Rabat (Y. El Hassouni), Benimellal (M. Mansour)

Research topics

1. Radiative corrections in the SM and beyond.

- ▶ Computation of several SM observables at 1-loop level and try to find a hint for new physics: $h \rightarrow f\bar{f}$; $h \rightarrow VV$; $\gamma W^+ W^-$, $ZW^+ W^-$; $e^+ e^- \rightarrow Zh_{SM}, H^+ H^-$; $pp \rightarrow hh$; triple Higgs coupling hhh .
- ▶ Renormalization of: wave functions, mixing angles and coupling constants.
- ▶ Very complicated calculation, too many Feynman diagrams
- ▶ www.FeynArts.de , www.FormCalc.de
- ▶ Model file for FeynArts: 2 Higgs doublet model w/wo CP violation
- ▶ Model file for FeynArts: Higgs triplet Model (type II seesaw)

2. Perturbative unitarity and boundedness from below for scalar potentials and EWPT

3. Naturalness and Veltman conditions

- ▶ Many BSM models, involve Higgs with high representation: more doublet, more singlet, doublet and triplet...
- ▶ Detail study of several scalar Potentials:
 - i) Type II seesaw Model,
 - ii) Type II seesaw Model with 2 Higgs doublets.
 - iii) 2 Higgs doublet and singlet fields,
 - iv) 2 Higgs doublet Model and inert Higgs model,
- ▶ Several CP-even Higgses, CP-odd, charged Higgs, doubly charged Higgs...

4. Charged Higgs phenomenology

- ▶ Charged Higgs decay in extended Higgs sector: Bosonic decay of the charged Higgs $H^\pm \rightarrow W^\pm h, W^\pm A$
- ▶ Signal rates and MC
- ▶ Radiative corrections to $e^+e^- \rightarrow H^+H^-$

5. Vector like quarks(VLQ): T, B, X, Y...

- ▶ VLQ associated with extended Higgs sector may lead to new signatures for the new quark decays.
- ▶ Tools

Research topics

6. Cosmology, Black Holes, Branes and String theory:

- ▶ Finding out phase transitions and thermodynamical properties of black holes in general relativity and beyond.
- ▶ Probing the behavior of black holes in the presence of perturbation: quintessence, cloud of strings... in modified gravities
- ▶ String theory and branes,
- ▶ Inflationary Cosmology:
Non-minimal Higgs inflation in the context of holographic cosmology.
An interacting holographic dark energy model within an induced gravity brane.

Research topics

7. HEP tools:

- ▶ radiative corrections is a very complicated task, too many Feynman diagrams
- ▶ www.FeynArts.de , www.FormCalc.de
- ▶ Model file for FeynArts: 2 Higgs doublet model with/without CP violation
- ▶ Model file for FeynArts: Higgs triplet Model (type II seesaw)
- ▶ HEP tools (include VLQ in the existing tools)

Research topics

8. Astronomy and astrophysics:

- ▶ Qualification studies of astronomical sites
- ▶ Detection of exoplanets by photometric and velocimetric measurements
- ▶ Trappist Nord (Marrakech-Oukaimden and Liege): (TRAnsiting Planets and Planetesimals small Telescope), to observe both exoplanets and comets. A twin telescope is already operating in Chili.

9. Experimental Physics and collaborations :

ATLAS (Rabat, Casablanca, Marrakech, Oujda and Kenitra) and CNRST

Search for high energy cosmic neutrino and determination of the neutrino mass hierarchy with KM3NET and Antares undersea telescopes (Rabat, Marrakech, Oujda)

Projects and workshops

- ▶ Réseau Universitaire de Physique des Hautes Energies RUPHE
- ▶ GDRI and LIA
- ▶ Projets Prioritaires de Recherche "PPR" on Higgs physics: Tanger-Marrakech-Safi and Agadir
- ▶ Non Minimal Higgs project: H2020-MSCA-RISE-2014 no. 645722: (Portugal-United kingdom, Sweden, France, Egypt, Finland, Japan, United States and Morocco)
- ▶ Associate and Federation scheme with ICTP.
- ▶ Several joint cooperation agreement with Portugal, France
- ▶ several workshops and conferences have been organized in Marrakech, Rabat and Tangier. Last one was: 1st Mediterranean Conference on Higgs Physics, Tangier, 23-27 Sept 2021

Needs

- ▶ Computing power
- ▶ MC training for students