

ESR 9: Higgs bosons in the Next-to-Minimal Supersymmetric Standard Model

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Secondment: Three months at Freiburg (Germany) with M. Schumacher

Supersymmetric extensions of the Standard Model predict additional CP-even and CP-odd Higgs states;

in the Next-to-Minimal Supersymmetric Standard Model – which explains best the mass of ~ 126 GeV of the Standard Model like Higgs boson – one expects 2 more CP-even and 2 more CP-odd neutral Higgs states.

These additional states have smaller couplings to gauge bosons, quarks and leptons (with the possible exception of b -quarks and τ -leptons); their masses cannot be predicted, however.

→ Their production rates are smaller than the ones of Standard Model like Higgs bosons of the same mass, their branching fractions will be different. If heavy, they can decay dominantly into lighter Higgs pairs.

Tasks of the PhD student:

- 1) To familiarize with the parameter space of the Next-to-Minimal Supersymmetric Standard Model (NMSSM): which masses/couplings of the additional states are compatible with the mass **and** signal rates of the 126 GeV Higgs boson and constraints from LEP?
- 2) Which search channels for a Standard Model like Higgs boson at the LHC – but at masses below and above 126 GeV – put constraints on masses and couplings of such additional states? Which search channels are most promising in the future, given the allowed variations of masses and couplings of extra states within the NMSSM?
- 3) In the cases of dominant Higgs-to-Higgs decays, unconventional search channels have to be employed (some of which have already been applied). Verify the sensitivity of such unconventional channels to the NMSSM, optimise the search strategies.

4) Properties of the Higgs bosons and the dark matter are related: Higgs exchange dominates the direct dark matter detection cross section, and dominates often the dark matter annihilation cross section which determines the relic density. What is the impact of present constraints on dark matter – together with present constraints from the LHC – on the extra Higgs bosons? What would we learn from possible signals?

Tools:

The code NMSSMTools for masses, couplings and branching fractions of extra Higgs states;

Good knowledge of all available potentially relevant search results of ATLAS/CMS;

Simulations of Higgs-to-Higgs decays, e.g. MadGraph/Pythia/Delphes;

The code MicrOMEGAS for dark matter relic density/direct and indirect detection cross sections.