ENP: Exploring New Physics

G. Corcella (Resp.), V. Del Duca, G. Pancheri (Ass. Senior)

The research undertaken within the ENP project concerns the phenomenology of particle physics at present and future colliders: precision tests of the Standard Model (SM) as well as investigation of new physics signals at the LHC.

We studied the phenomenology of top quarks at the LHC and the theoretical error on the top-mass determination, taking particular care about its interpretation in terms of the pole mass and the uncertainty due to the description of bottom-quark fragmentation. Work is in progress on the inclusion of hadronization corrections by using NNLO calculations of the partonic cross section and phenomenological models tuned first to electron-positron annihilation data (LEP and SLD) and then to LHC data too. We extended previous work on the phenomenology of the 331 model, based on a $SU(3)_C \times SU(3)_L \times U(1)_X$ gauge symmetry and predicting doubly-charged vectors and scalars, so-called bileptons with lepton number $L = \pm 2$, as well as exotic quarks, with charge 4/3 or 5/3. According to the mass spectrum, one can produce at the LHC either bilepton pairs, then decaying into exotic plus SM quarks, or exotic-quark pairs decaying into bilepton plus SM quark. This work is in progress and will result in a recasting of the current ATLAS and CMS searches for bileptons and non-standard quarks too. Contribution was also given to the searches for axion-like particles (ALP) at the PADME experiment at LNF in processes like $e^+e^- \to a\gamma$, a being an ALP, by providing the experimentalists by a user-friendly computing code based on the FeynRules and MadGraph programs. (G. Corcella)

We have improved the theoretical accuracy of the Higgs-production inclusive rate and Higgs+jet cross section: planar master integrals for 2-loop Higgs+jet were developed and mixed QCD-electroweak corrections to Higgs production calculated. The computation of the scattering amplitudes was performed by means of advanced methods in modern algebra. (V. Del Duca)

Finally, we explored the precision near-foward TOTEM data and computed the elastic proton-proton differential cross section at 13 TeV, using an empirical model to account for non-perturbative corrections. (G. Pancheri)

The main achievements are summarized in the following publications:

1. V. Del Duca, S. Druc, J.M. Drummond, C. Duhr, F. Dulat, R. Marzucca, G. Papathanasiou and B. Verbeek, *All-order amplitudes at any multiplicity in the multi-Regge limit*, Phys. Rev. Lett. **124** (2020) 16.

2. V. Del Duca, C. Duhr, R. Haindl, A. Lazopoulos and M. Michel, *Tree-level splitting amplitudes for a gluon into four collinear partons*, JHEP **2010** (2020) 093.

3. M. Becchetti, R. Bonciani, V. Del Duca, V. Hirschi and F. Moriello, *NLO Corrections to Light-Quark Mixed QCD-EW Contributions to Higgs Production*, e-Print: 2010.09451 [hep-ph].

4. G. Pancheri, L. Bonolis, *Bruno Touschek in Glasgow. The making of a theoretical physicist*, arXiv:2005.04942 [physics.hist-ph].

5. G. Pancheri, Y. Srivastava, *About soft-photon resummation*, arXiv:2011.05865 [physics.hist-ph].