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Exclusive processes in hadronic collisions at the LHC: Improving our understanding of the Standard Model and opening a portal for New Physics

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The LHC experiments have focused part of its physics goals into the particle production in exclusive processes in order to improve our understanding of the Standard Model (SM) and search for signals of New Physics. Exclusive production means that the final state is composed only by the centrally produced particle X , with large rapidity gaps with no tracks between the particle, detected by the central detectors, and the beam line direction. Such a signature differs from the usual QCD production by the absence of particle (gluon) radiation that populates the detector, destroying the gap and making it very difficult to be observed. The basic idea in exclusive processes is that the incident hadrons (protons or nuclei) emit a color singlet object, which can be a quasi-real photon γ or a Pomeron IP, remain intact and scatter with some energy loss ξ in a very small angle from the beam pipe. One has that the final state X can be produced by $\gamma\gamma$, γIP or IPIP interactions depending on its quantum numbers. In this contribution we will present our recent results for the exclusive production of top pairs in pp collisions and for the exclusive vector meson production in heavy ion collisions. We will demonstrate that the discovery of the elastic production of top pairs is feasible considering the tagging of both protons in the final state using forward proton detectors at the LHC as e.g. the AFP and PPS detectors. In addition, we will demonstrate that the study of the coherent and incoherent vector meson photoproduction in pA and AA collisions by the CMS and LHCb detectors can be useful to constrain the description of the QCD dynamics at high energies. Finally, we will comment on the possibility of searching for axion like particles in heavy - ion collisions.

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