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Photonuclear interactions in ultra-peripheral Pb+Pb collisions at the LHC

The strong electromagnetic fields present in ultra-peripheral Pb+Pb collisions at the CERN LHC accelerator lead to large cross sections for particle production in photonuclear interactions[1]. It will be shown that photonuclear processes may constitute a significant background to peripheral and semi-central hadronic nuclear collisions.

The cross sections for photonuclear interactions induced by photons from the electromagnetic fields of the nuclei have been calculated. The photon spectrum has been evaluated in impact parameter space. Thereby one can easily exclude collisions were the nuclei interact hadronically (b < 2R). For modelling the particle production, the DPMJET[2] Monte Carlo event generator has been used. Calculations have been done for photon energies from 6 GeV to 100 TeV in the rest frame of the target nucleus, which is the energy range contributing to particle production around mid-rapidity. The multiplicity, rapidity, and transverse momentum distributions of produced particles will be presented.

Two cases of photonuclear processes have been considered, single and double excitation. In the former case, one of the nuclei emits a photon which interacts with the other nucleus, whereas in the latter case both nuclei emit photons which interact with the other nucleus. The cross section for single excitation is much larger than that of double excitation. However, the topology of the double excitation events, where the rapidity distruction is more symmetrical, is simililar to that of hadronic interactions. Both processes may thus contribute significantly to the background of hadronic interactions, depending on the experimental event selection.

The photon-nucleon energies that can be reached in ultra-peripheral collisions at the LHC are higher than for any earlier gamma+A or gamma+p collisions. In addition to being a background for hadronic interactions, such events have a physics interest in themselves. Photoproduction of heavy quarks (e.g. cc-bar through gamma-gluon fusion) and jets have large cross sections and probe the nuclear parton distribution functions.

[1] O. Djuvsland, J. Nystrand, arXiv:1011.4908, to be published in Phys. Rev. C.

[2] S. Roesler, R. Engel, J. Ranft, Phys. Rev. D 57 (1998) 2889.

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