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Antihyrogen production at RHIC and LHC energies

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Colliding beams of heavy ions at energies per nucleon in the
range 10^2 - 10^4 GeV, corresponding to experiments RHIC at Brookhaven, and LHC at CERN, suggested that intense electromagnetic fields of these ions can produce relatively large fluxes of electron and heavy lepton pairs. The bound-free pair production (BFPP) is one of the processes that restrict the luminosity of the ion beams. In this process, the charge of the ion decreases and it is depleted out of the beam. For this reason, the calculation of the exact bound-free electron-positron pair production cross section is important for deciding the stability of the beam.

Another important application of this calculation is for producing anti-hydrogen. Anti-hydrogen is the simplest bound state of antimatter and may be produced with the collision of anti-protons with ions. They were first produced and observed at CERN Low Energy Antiproton Ring (LEAR) in 1995. In this process (anti(p)+Z -> anti(H)+e(-)+Z), Xenon(Z=54) has been used. This process was first proposed by Munger et al. and they studied for the calculation of antihydrogen production cross section by the equivalent photon approximation (EPA). The cross section calculation of antihydrogen production is important, because as being BFPP, antihydrogen production mechanism also leads to a beam loss.

In this work, we have calculated the BFPP and relativistic antihydrogen production with Monte Carlo integration techniques by computing the Feynman diagrams. The calculation shows that for large energies and charges, the antihydogen production cross section is quite large.

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