

**Thesis abstract**  
**Afnan SHATAT**  
**Charmonium photoproduction in Pb–Pb collisions with nuclear overlap  
measured with ALICE at the LHC**

Ultrarelativistic heavy-ion collisions are employed to investigate nuclear matter at high temperature and pressure, where Quantum Chromodynamics predicts the existence of a deconfined state of hadronic matter, the Quark Gluon Plasma (QGP). The ALICE experiment at the Large Hadron Collider is devoted to the QGP study. In the case of ultraperipheral collisions (UPC), in which the impact parameter between the two colliding nuclei is larger than twice the nuclear radius, hadronic interactions are suppressed. The strong electromagnetic fields emitted by ultrarelativistic heavy ions induce photonuclear reactions. These processes have been extensively studied in the context of ultraperipheral collisions. When a quasi-real photon interacts coherently with the nucleus, a charmonium can be produced. This process is called coherent photoproduction. It gives insight into the gluon distribution of the heavy nucleus and places stringent constraints on the hadron structure, including the poorly known regions of low Bjorken- $x$  values. In recent years, the coherent  $J/\psi$  photoproduction at very low transverse momentum has been observed in nucleus–nucleus collisions with nuclear overlap, based on the measurement of an excess in the  $J/\psi$  yield with respect to expectations from hadronic  $J/\psi$  production. Several theoretical models, initially developed to describe coherent  $J/\psi$  photoproduction in UPC, were extended to describe this mechanism in Pb–Pb collisions with nuclear overlap. The models predict different dependencies on rapidity and collision geometry. The coherent  $J/\psi$  photoproduction cross section was previously measured by ALICE in Pb–Pb collisions with nuclear overlap as a function of the collision geometry. Models were able to reproduce the measurement qualitatively. To impose further constraints on the models, this thesis studies the rapidity dependence of the coherent  $J/\psi$  photoproduction cross section using the Pb–Pb data collected in Run 2 (2015-2018), at  $\sqrt{s_{NN}} = 5.02$  TeV, with the ALICE experiment. The measurement performed in this thesis is also employed in conjunction with similar measurements in UPC to extract the photonuclear cross section as a function of the  $\gamma$ –Pb center-of-mass energy, corresponding to Bjorken- $x$  values from  $10^{-5}$  to  $3 \cdot 10^{-2}$ .