

Top-Quark Pair Production in Heavy-Ion Collisions in the ATLAS Experiment

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Top-quark pair production in heavy-ion collisions provides a unique opportunity to probe nuclear parton distribution functions and study the time evolution of strongly interacting matter, including the quark-gluon plasma. This work presents the observation and measurement of top-quark pair production in both proton-lead (p+Pb) and lead-lead (Pb+Pb) collisions using the ATLAS experiment at the Large Hadron Collider (LHC). In p+Pb collisions at a centre-of-mass energy of 8.16 TeV, top-quark pair production is observed in the lepton+jets and dilepton channels, with significances exceeding 5 standard deviations in each channel. The nuclear modification factor, $\langle R_{pA} \rangle$, is measured for the first time in this process, providing new insights into nuclear parton distribution functions. In Pb+Pb collisions at a centre-of-mass energy of 5.02 TeV, top-quark pair production is studied in the $(e\mu)$ final state, using datasets recorded in 2015 and 2018 with an integrated luminosity of 1.9 nb^{-1} . The measurement achieves a significance of 5.0 standard deviations and is compared to theoretical predictions based on various nuclear PDF sets. These measurements establish top-quark pairs as valuable tools for investigating heavy-ion collisions, offering novel insights into the dynamics of the quark-gluon plasma and nuclear matter.

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