Upsilon Production in p-Pb Collisions at Forward Rapidity with ALICE at the LHC

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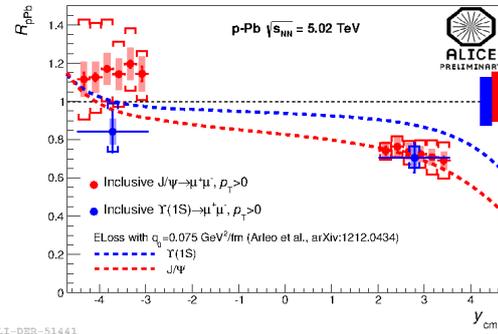*Kolkata - 700064, INDIA*

1. Introduction

The Parton Distribution Functions (PDF) of nuclei differ from those for free protons due to several nuclear effects, such as shadowing at small values of x, anti-shadowing at intermediate x, the EMC effect and Fermi motion at large x. Thus, interpretation of the Pb-Pb data not only requires the study of pp collisions but also p-Pb collisons to understand the cold nuclear matter effects.

With this goal in mind, the ALICE experiment has measured the $\Upsilon(1S)$ production in the p-Pb collisions at $\sqrt{s_{\mathrm{NN}}} = 5.02$ TeV . The measurement is performed at forward rapidity ($2.04 < y_{cms} < 3.54$) and backward rapidity ($-4.46 < y_{cms} < -2.96$) and down to $p_{\mathrm{T}} = 0$ via the dimuon decay channel. The $\Upsilon(1S)$ R_{pPb} has been measured as a function of rapidity (y_{cms}) of the center of mass of the nucleon-nucleon collisions. The ratio of the nuclear modification factors R_{pPb} at forward rapidity and backward rapidity and forward to backward yield ratio (R_{FB}) has also been studied. Results are discussed and compared with the ALICE J/ψ data at forward and backward rapidity and with the available theoretical predictions.

2. Data and Event Selection

A data sample of integrated luminosity of $L_{int} = 5.3 \ nb^{-1}$ (for p-Pb), $6.1 \ nb^{-1}$ (for Pb-p) have been collected. The minimum bias (MB) trigger is defined as the coincidence of a signal in both the VZERO-A and the VZERO-

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FIG. 1: Comparison of the inclusive $\Upsilon(1S)$ R_{pPb} with inclusive J/ψ data and Arleo et al. model [2].

C detectors synchronized with the passage of two colliding lead bunches.

3. Results

The suppression of quarkonia can be quantified by measuring the nuclear modification factor R_{pPb}, which is the ratio of production in proton-lead collisions to the production in proton-proton collisions scaled by the number of binary collisions.

$$ R_{\mathrm{pPb}} = \frac{N_{\mathrm{pPb}}^{\Upsilon(1S)}}{\langle N_{\mathrm{coll}} \rangle_{\mathrm{pPb}} \times N_{\mathrm{pp}}^{\Upsilon(1S)}} \qquad (1) $$

The inclusive $\Upsilon(1S)$ R_{pPb} was measured at forward ($2.04 < y_{cms} < 3.54$) and backward rapidity ($-4.46 < y_{cms} < -2.96$) down to zero p_{T}. Data were compared to that of the J/ψ in the same kinematic range. The observed suppression for the $\Upsilon(1S)$ is comparable with the J/ψ one within the present uncertainties (FIG. 1).
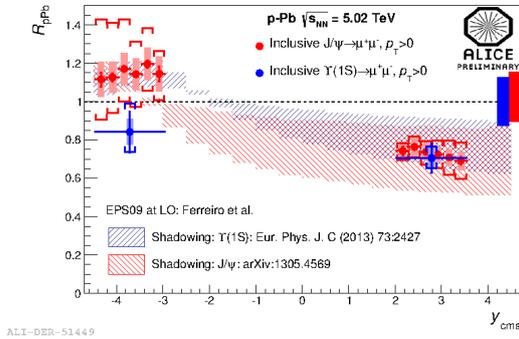
FIG. 2: Comparison of the inclusive $\Upsilon(1S)$ R_{pPb} with inclusive J/ψ data and Ferreiro et al. model [3].
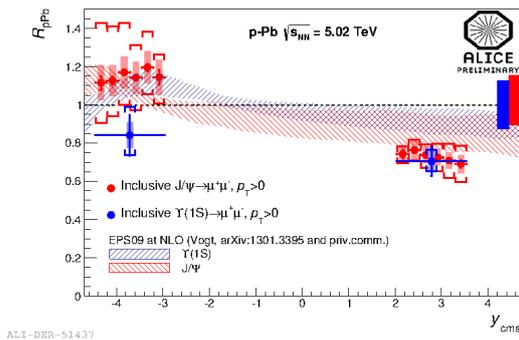

FIG. 3: Comparison of the inclusive $\Upsilon(1S)$ R_{pPb} with inclusive J/ψ data and Vogt et al. model.
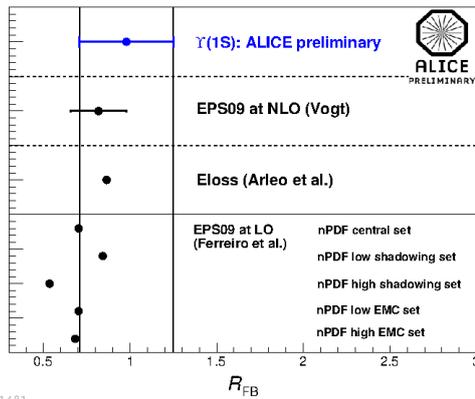

FIG. 4: Comparison of the inclusive $\Upsilon(1S)$ R_{FB} with various models.

Data were also compared with various models. The Coherent Parton Energy Loss [2] and the EPS09 Shadowing calculation at NLO [1] tend to overestimate the $\Upsilon(1S)$ suppression at backward rapidity (FIG. 1, 3). The inclusive $\Upsilon(1S)$ R_{pPb} as a function of the rapidity was also compared to EPS09 Shadowing calculation at LO where uncertainties were computed in order to highlight the respective contributions of shadowing and EMC effects [3]. Within the present uncertainties, neither of the effects can be favoured by the data (FIG. 2).

The integrated R_{FB} of inclusive $\Upsilon(1S)$ was measured in the commom rapidity region ($2.96 < |y_{cms}| < 3.54$) of p-Pb and Pb-p. The $\Upsilon(1S)$ R_{FB} is found to be larger that of the J/ψ measured in the same kinematic window and the difference is 3σ. EPS09 Shadowing calculation at NLO and Coherent Parton Energy Loss model predicts $\Upsilon(1S)$ data within the current uncertainties (FIG. 1). The comparison of the measured R_{FB} with EPS09 Shadowing calculation at LO [3] indicates a reasonably good agreement, but does not favour the large shadowing contribution.

Acknowledgments

References

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