IL NUOVO CIMENTO **41 C** (2018) 14
DOI 10.1393/ncc/i2018-18014-y

COLLOQUIA: IFAE 2017

Measurements of quarkonium production in p-Pb and Pb-Pb collisions with ALICE at LHC

G. G. FRONZÉ (1)(2)(3)

(1) *INFN, Sezione di Torino - Torino, Italy*
(2) *Dipartimento di Fisica, Università di Torino - Torino, Italy*
(3) *Subatech, IMT Atlantique - Nantes, France*

received 21 April 2018

Summary. — ALICE (A Large Ion Collider Experiment) is devoted to the study of heavy-ion collisions at LHC energies. In such collisions a deconfined state of hadronic matter, the Quark-Gluon Plasma (QGP), is formed. Quarkonium states are important probes to study the QGP evolution since their formation happens early during the collision and their production rate is modified in the interaction with the medium. The latest ALICE results on quarkonium production in Pb-Pb and p-Pb collisions will be presented and discussed.

1. – Motivations to study quarkonium production

Colour screening effects and regeneration phenomena are mechanisms affecting quarkonium production in ultra-relativistic heavy-ion collisions, where a Quark-Gluon Plasma (QGP) is created [1-3]. While the presence of free colour charges weakens the nuclear potential between quarks (Debye screening) melting bound states and leading to a suppression effect, it is foreseen that the abundance of heavy quarks enhances the statistical recombination during the QGP evolution or at the phase boundary. Charmonium and bottomonium (bound states of $c\bar{c}$ and $b\bar{b}$ quarks) are studied in ALICE through their decay into pairs of electrons or muons. The study of bottomonium is complementary to the study of charmonium states since a lower production of heavier quarks is expected to limit regeneration effects. The modification of quarkonium production yields in heavy-ion collisions is evaluated through the nuclear modification factor R_{AA}. Besides Pb-Pb collisions, quarkonium production is studied by ALICE in pp and p-Pb collisions. The pp collisions allow one to measure the reference cross-section which the quarkonium yields in AA will be compared to, while p-Pb collisions provide a reference on Cold Nuclear Matter (CNM) effects affecting quarkonia production without the presence of QGP.

ALICE is composed by two groups of detectors. The central barrel is delimited by a solenoidal magnet and surrounds the interaction point, while the muon spectrometer

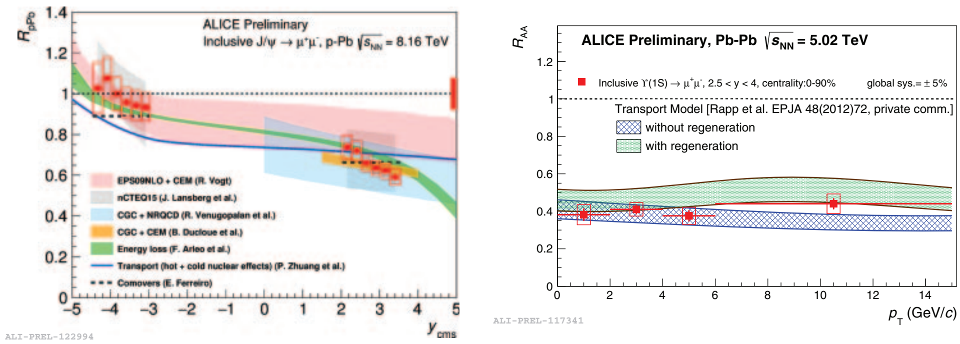

Fig. 1. – J/ψ R_{AA} (left) in six rapidity bins both at forward and at backward rapidity in p-Pb at $\sqrt{s_{\mathrm{NN}}} = 8.16\,\mathrm{TeV}$ compared to theory. R_{AA} of inclusive $\Upsilon(1S)$ (right) in Pb-Pb at $\sqrt{s_{\mathrm{NN}}} = 5.02\,\mathrm{TeV}$ as a function of p_{T} and compared to theoretical calculations

extends at high rapidities and is focused on the reconstruction and identification of forward-emitted muons. For a detailed description refer to [4, 5].

2. – p-Pb collisions

In p-Pb collisions, ALICE is able to study the electron-positron decay channel at $-1.37 < y_{cms} < 0.43$ and the muon decay channel in the ranges $-4.46 < y_{cms} < -2.96$ and $2.03 < y_{cms} < 3.53$. Previous results at $\sqrt{s_{\mathrm{NN}}} = 5.02\,\mathrm{TeV}$ showed a nuclear modification factor compatible with no suppression at negative rapidity both for J/ψ [6] and Υ [7]. At forward rapidity a suppression is clearly observed for J/ψ. A similar trend is observed for the Υ production, although the measurement is also compatible with no suppression within the experimental uncertainties. From the comparison of J/ψ results with models, with the addition of data relative to the decay channel $J/\psi \rightarrow e^+e^-$ measured at mid-rapidity, a good agreement with models including energy loss and nuclear modification of PDFs has been found. The latest results at $\sqrt{s_{\mathrm{NN}}} = 8.16\,\mathrm{TeV}$

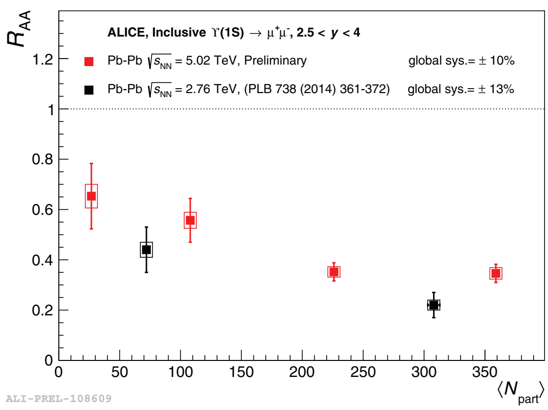

Fig. 2. – Υ R_{AA} measured as a function of centrality in Pb-Pb collisions at $\sqrt{s_{\mathrm{NN}}} = 2.76\,\mathrm{TeV}$ and $5.02\,\mathrm{TeV}$

present a similar trend. Compatibility has been found comparing J/ψ data at $\sqrt{s_{\rm NN}} =$ 5.02 TeV and 8.16 TeV, showing no clear energy dependence. A suppression can be observed at forward rapidity, fig. 1 (left). The differential study with respect to the transverse momentum of J/ψ ($p_{\rm T}$), in y bins, shows a suppression at low $p_{\rm T}$ and forward rapidity.

3. – Pb-Pb collisions

From the comparison of ALICE and PHENIX data, respectively collected in Pb-Pb at $\sqrt{s_{\rm NN}} = 2.76$ TeV and Au-Au at $\sqrt{s_{\rm NN}} = 200$ GeV, an enhancement of the J/ψ production at low $p_{\rm T}$ can be observed in the most central collisions in both electron- and muon-pair decay channels [8, 9]. ALICE data at $\sqrt{s_{\rm NN}} = 5.02$ TeV shows compatibility with data at $\sqrt{s_{\rm NN}} = 2.76$ TeV, even if the higher-energy measurements are systematically above the lower-energy ones. Compatibility can be observed between data and models which include regeneration phenomena [10]. Measurements of the Υ production at $\sqrt{s_{\rm NN}} = 5.02$ TeV are compatible with measurements at $\sqrt{s_{\rm NN}} = 2.76$ TeV within uncertainties. At both energies a clear suppression over all centrality classes is observed (fig. 2). As already observed for the J/ψ production, the higher-energy measurements are systematically above the lower-energy ones. Good agreement can be found between data and models both including and not including regeneration, as can be seen in fig. 1 (right).

4. – Conclusions

ALICE measurements of the J/ψ production in p-Pb have highlighted a trend which presents agreement with theoretical models based on CNM effects. The J/ψ production in Pb-Pb collisions at $\sqrt{s_{\rm NN}} = 2.76$ TeV and 5.02 TeV presents good agreement with models including regeneration. Measurement of the Υ production at $\sqrt{s_{\rm NN}} = 2.76$ TeV and 5.02 TeV presents a clear suppression with respect to pp. The Υ measurements can also be used as a cross-check of models including or not regeneration effects, even if the present uncertainties are not yet tight enough to discriminate between models.

REFERENCES

[1] Matsui T. and Satz H., *Phys. Lett. B*, **178** (1986) 416.
[2] Brambilla N. *et al.*, *Eur. Phys. J. C*, **71** (2011) 1534.
[3] Cacciari M. *et al.*, *JHEP*, **10** (2012) 137.
[4] Aamodt K. *et al.*, *JINST*, **3** (2008) S08002.
[5] Abelev B. B. *et al.*, *Int. J. Mod. Phys. A*, **29** (2014) 1430044.
[6] Adam J. *et al.*, *JHEP*, **11** (2015) 127.
[7] Abelev B. B. *et al.*, *Phys. Lett. B*, **740** (2015) 105.
[8] Adam J. *et al.*, *JHEP*, **07** (2015) 051.
[9] Adam J. *et al.*, *JHEP*, **05** (2016) 179.
[10] Adam J. *et al.*, *Phys. Lett. B*, **766** (2017) 212.