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Bottomonia production and polarization in the NRQCD with kt-factorization

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The $\Upsilon(nS)$ production and polarization at high energies is studied in the framework of k_T-factorization approach. Our consideration is based on the non-relativistic QCD formalism for bound states formation and off-shell production amplitudes for hard partonic subprocesses. The direct production mechanism and feed-down contributions from radiative $\chi_b(mP)$ decays are taken into account. The transverse momentum dependent gluon densities in a proton were derived from the Ciafaloni–Catani–Fiorani–Marchesini evolution equation and Kimber-Martin-Ryskin prescription. Treating the non-perturbative color octet transitions in terms of the mulitpole radiation theory, we extract the corresponding non-perturbative matrix elements for $\Upsilon(nS)$ and $\chi_b(mP)$ mesons from a combined fit to $\Upsilon(nS)$ transverse momenta distributions measured by the CMS and ATLAS Collaborations at the LHC energies $\sqrt{s} = 7$ and 13 TeV and from the relative production rate $R^{\chi_b(nP)}_{\Upsilon(nS)}$ measured by the LHCb Collaboration at $\sqrt{s} = 7$ and 8 TeV. Then we apply the extracted values to investigate the polarization parameters λ_θ, λ_ϕ and $\lambda_{\theta\phi}$, which determine the $\Upsilon(nS)$ spin density matrix. Our predictions have a good agreement with the currently available data within the theoretical and experimental uncertainties.

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