Studies of azimuthal decorrelation of dijets with a jet veto with ATLAS

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1 Open problems

The next-to-leading-order QCD predictions provide a good description of the inclusive jet cross sections up to the highest reached jet energies [1, 2]. For certain observables and in some regions of phase space higher-order contributions are important and must be resummed to all orders. This is the case for dijet events with large rapidity separation of the two jets, \( \Delta y \), and/or when a veto is applied on additional jets with \( p_T > Q_0 \) produced in the rapidity interval between them; \( Q_0 \) is called a veto scale. There are two available resummation approaches, BFKL and DGLAP. BFKL resums the higher orders in terms of \( \ln(1/x) \) while DGLAP does it in terms of \( \ln(Q^2) \). The goal of the presented measurement [3] is to test theoretical predictions inspired by the above two approaches. The DGLAP inspired procedure is implemented in POWHEG+PYTHIA 8 and POWHEG+HERWIG 6.5 Monte Carlo generators. POWHEG [4, 5, 6] provides a full NLO dijet calculation. It is interfaced to PYTHIA 8 [7] or HERWIG 6.5 [8] to provide the parton shower. The predictions based on BFKL are generated with HEJ [9, 10] and HEJ+ARIADNE. HEJ resums leading-logarithms relevant in the Mueller-Navelet limit. ARIADNE [11] provides parton showers based on the colour-dipole cascade model. The uncertainty of the HEJ+ARIADNE prediction is not available and only the statistical uncertainty is shown.

The described theoretical predictions are tested by ATLAS [12]. Several observables are measured with the data samples recorded in 2010 and 2011 in proton-proton collisions at 7 TeV centre-of-mass energy. The 2010 data sample corresponds to 36.1 \( \pm \) 1.3 pb\(^{-1}\) and was taken under low pile-up conditions. The veto scale \( Q_0 \) is set to 20 GeV and jets are accepted in the region \( |y| < 4.4 \). The 2011 sample represents 4.5 \( \pm \) 0.1 fb\(^{-1}\) and it is more affected by pile-up. In this case \( Q_0 \) is set to 30 GeV and jets are accepted if \( |y| < 2.4 \). An additional requirement of \( \Delta y > 1 \) was used on the 2011 sample to enhance the events of interest.

Dijet events were selected if the (sub)leading jet \( p_T \) was higher than 60 (50) GeV. The events were classified into two categories: the inclusive and gap dijet events. An event contributes to the gap sample if there is no jet with \( p_T > Q_0 \) in the rapidity interval between the two leading-\( p_T \) jets.

An interesting observable is the gap fraction, the ratio of the dijet cross sections measured using the gap and the inclusive samples. It is exponentially suppressed as a function of \( \Delta y \) and \( \log(p_T/Q_0) \) where \( \bar{p}_T \) is the average \( p_T \) of the two leading jets. There is a plateau at high \( \Delta y \) and high \( \bar{p}_T \) that can be explained as an effect of steeply falling parton distribution functions and/or as a consequence of colour-singlet exchange processes. A complementary observable...
is the mean multiplicity of jets with $p_T > Q_0$ in the rapidity interval between the two jets. POWHEG+PYTHIA 8 and HEJ+ARIADNE provide good description of both variables. The prediction obtained with POWHEG+HERWIG 6.5 does not describe data very well.

The studied observable with the highest discrimination power between different predictions is the ratio of the first two angular moments: $\langle \cos(2\Delta \phi) \rangle / \langle \cos(\pi - \Delta \phi) \rangle$ where $\Delta \phi$ is the azimuthal separation of the two jets. It is shown in Fig. 1. This observable is especially sensitive to the theoretical differences in the regions of low $\bar{p}_T$ and high $\Delta y$. HEJ+ARIADNE provides the best description of the ratio for the inclusive dijet sample; its performance is a bit poorer for the gap sample. The double differential dijet cross section $d^2\sigma / d\Delta \phi d\Delta y$ is not well described by the predictions using HEJ. It is quite well described by POWHEG+PYTHIA 8.

2 Outlook

No theoretical prediction describes data over the full phase space and for all observables. Data can constrain parton-shower models because the experimental uncertainty is generally lower than the spread of the different predictions. Theoretical predictions should be improved to decide about the presence or absence of BFKL effects or colour-singlet exchange processes.

References


