SCALED CHARGED PARTICLE MOMENTUM DISTRIBUTIONS AT HIGH Q^2 AT HERA

DANIEL TRAYNOR
Queen Mary, University of London
Mile End Road,
London E1 4NS, UK
d.traynor@qmul.ac.uk

The cross-section normalised scaled momentum distribution (x_p) of charged final state hadrons has been measured in DIS ep collisions by H1 at High Q^2 in the Breit frame of reference. Compared with previous results presented by HERA experiments this analysis has significantly higher statistics, extends to higher Q^2, and to the full range of x_p. The results are compared with different models of the fragmentation process as implemented in leading order Monte Carlo models with either parton showers or the colour dipole model of higher order QCD radiation and the string or cluster model for the hadronisation.

1. Introduction

In this paper the process of parton fragmentation and hadronisation is studied using the inclusive charged particle spectrum in the current region of the Breit frame of reference in Deep Inelastic Scattering (DIS) data. In the current region of the Breit frame a comparison with one hemisphere of an e^+e^- annihilation, taking $E^* = Q$, is possible, directly testing quark fragmentation universality.

In the Breit frame the scaled momentum variable x_p is thus defined to be $2p_h^{\pm}/Q$ where $p_h^{\pm}$ is the momentum of a charged track in the current region of the Breit frame. In e^+e^- annihilation events the equivalent variable is $2p_h^{\pm}/E^*$. In this analysis the use of much higher statistics now available at high Q compared to previous studies[1,2] and an improved understanding of the H1 detector and associated systematics provide a much improved measurement of the scaled momenta spectra. Results are now available to $< Q >\sim 100$ GeV, close to the LEP1 centre of mass energy, and to the full range of x_p (nominally, $0 < x_p < 1$).

2. Data Selection

Events are selected if the scattered positron is detected in the acceptance of the LAr calorimeter ($10° < \theta_e < 150°$) with an energy greater than 11 GeV. The kinematic phase space is required to be in the range $100 < Q^2 < 20\,000$ GeV^2 and $0.05 < y < 0.6$. The polar scattering angle for a massless parton, calculated from the positron in the QPM approximation, is required to be in the range $30° < \theta_q < 150°$,

Only primary vertex fitted tracks from the central jet chamber are used in this analysis which has good acceptance from 20° to 160° for transverse momenta above 120 MeV. In addition a variety of quality cuts are applied to remove badly measured tracks in a clean and well-modelled manner.

Data are corrected for detector acceptance and resolution effects

3. DIS Scaled Momenta Spectra

In figure [1] the inclusive, event normalised, charged track scaled momentum spectrum, is shown as a function of Q for nine different intervals of x_p. Also shown is a comparison to results from e^+e^- annihilation events[3].

Moving from low to high Q the spectra becomes softer, i.e. there is a dramatic increase in the number of hadrons with a small share of the initial parton's momentum and a decrease in those hadrons with a large share. The cause of these scaling violations (parton splitting in QCD) is the same as for the scaling violations observed for the deep inelastic structure functions. The e^+e^- data show the same behaviour as the ep data. The agreement shown here provides a good demonstration of quark fragmentation universality.

In figure [2] the data is compared with Leading Order Matrix Element Monte-Carlos that then implement different models to describe higher orders and the hadronisation process. The data clearly show a preference for string hadronisation models (RAPGAP[4], DJANGO[5]) predictions over the HERWIG[6] predictions (cluster hadronisation). At high x_p the HERWIG predictions even fail to show scale breaking producing a flat spectrum.

Figure [2] shows that the colour dipole model, CDM[?], (DJANGO) and parton shower model, PS, (RAPGAP) provide a good description of the data. The CDM model provides a slightly harder description of the data but within the errors of the data neither model is favored. Both models overestimate the multiplicity at higher Q but the statistical precision of the data prevents any stronger statement from being made. The soft colour interaction model, SCI[8], however, is much "softer" than the other two models

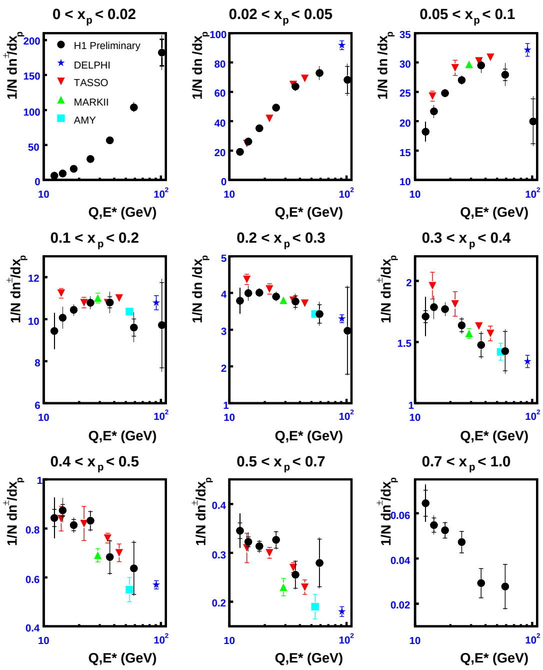

Figure 1. H1 data for the event normalised inclusive scaled momentum spectrum. In addition there is a further scale uncertainty of 3% (5% in the lowest Q interval). Also shown are data from various e$^+$e$^-$ experiments (taking $Q = E^*$). Note the suppressed zeros and large change in scale moving to higher values of x_p

and disfavoured by the data at low x_p but appears to give a better description at high x_p. This could be due to the additional gluon interactions in the SCI model which soften the spectra produced by the parton shower.

4. Conclusions

The results support the concept of quark fragmentation universality in ep collisions and e$^+$e$^-$ annihilation. The Monte Carlo which model the parton cascade by implementing either the colour dipole model or parton showers describe the data. The string model of hadronisation provides a better description of the data than the cluster model as implemented in HERWIG.

References

1. H1 collaboration, S. Aid *et al.*, Nucl. Phys. B445 (1995) 3; H1 collaboration, C. Adloff *et al.*, Nucl. Phys. B504 (1997) 3; H1 collaboration, C. Adloff *et al.*;

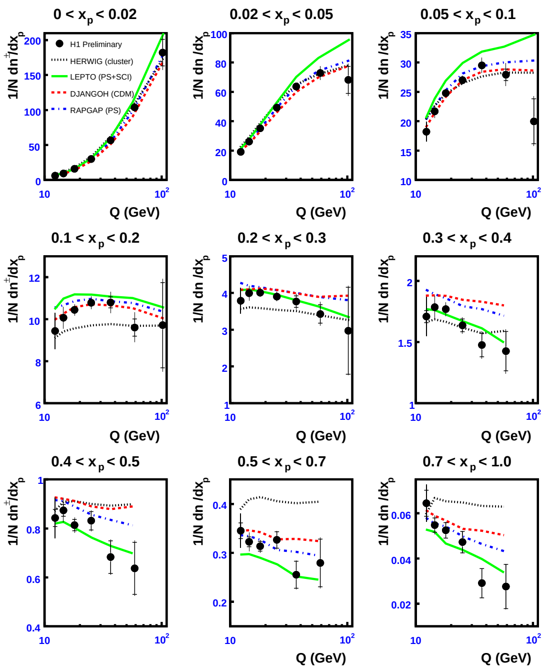

Figure 2. H1 data for the event normalised inclusive scaled momentum spectrum. In addition there is a further scale uncertainty of 3% (5% in the lowest Q interval). Also shown are predictions from different Monte-Carlo programs

ICHEP98: 29th Int. Conf . on High Energy Physics (Vancover, Canada) July 1998 p531.
2. ZEUS Collaboration, M. Derrick *et al.*, Z. Phys. C67 (1995) 93; ZEUS Collaboration, M. Derrick *et al.*, Phys. Lett. B414 (1997) 428; ZEUS Collaboration, J. Breitweg *et al.*, Eur. Phys. J. C11 (1999) 251.
3. TASSO Collaboration, W. Braunschweig *et al.*, Z. Phys. C47 (1990) 187-198; MARK II Collaboration, A. Petersen *et al.*, Phys. Rev. D37 (1988) 1-27; AMY Collaboration, Y. K. Li. *et al.*, Phys. Rev. D41 (1990) 2675-2688; DELPHI Collaboration, P. Abreu *et al.*, Phys. Lett. B311, (1993) 408.
4. H. Jung, Computer Phys. Comm. 86 (1995) 147-161.
5. A. Kwiatkowski, H. Spiesberger, and H.-J. Mohring, Computer Phys. Comm. 69 (1992) 155; K. Charchula, G.A. Schuler, and H. Spiesberger, Computer Phys. Comm. 81 (1994) 381.
6. G. Marchesini *et al.*, Computer Phys. Comm. 67 (1992) 465-508.
7. L. Lönnblad, Computer Phys. Comm. 71 (1992) 15.
8. A. Edin, G. Ingelman and J. Rathsman, Phys. Lett. B366 (1996) 371.