2.8 STUDYING GLUON JETS IN LARGE-p_T HADRON-NUCLEUS SCATTERING

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One of the most promising experiments at the Tevatron will be the study of particles produced at large transverse momentum in hadron-nucleus collisions. This study is of special interest since there is substantial good evidence that the nucleus acts like a gluon filter, and that the jets seen at large-p_T are predominantly gluon jets.[1] Furthermore, this experiment is ideally suited for the Tevatron since the requirement of a nuclear target rules out colliding-beam machines and the large incident hadron energy at the Tevatron will result in substantial gluon jet production. Thus, the properties of gluon jets can be conveniently studied and various questions about gluon fragmentation[2] can be experimentally answered. (e.g., Are gluon jets softer and broader than quark jets? Do they have a larger multiplicity at low energies, or is this only expected asymptotically? etc.)

The predominance of gluon jets at large p_T can be readily understood in the framework of perturbative QCD. In lowest order, the dominant amplitudes contributing to hard scattering of partons involve single gluon exchange. From these Born diagrams, it is very plausible that the ratio of hard gluon-nucleon cross sections to quark-nucleon cross sections is roughly the color factor 9/4, and a full calculation bears out this statement. Thus, as a direct consequence of the existence and strength of the triple gluon coupling, gluons interact more strongly with matter and hence there is an enchancement of gluon jets over quark jets at large-p_T. Clearly, this enhancement can be considerably increased by multiple scattering. Hence, hadron-nucleus scattering is a privileged place to study gluon jets, since the nucleus allows the possibility of multiple scattering and hence acts like a gluon filter. (On a lead target at p_T = 5 GeV/c, there are approximately 85% gluon jets.)

Quantitative studies[1] show that the A-dependence of large-p_T jet and specific particle production can be nicely explained in the above-described-framework. [In particular, the observation[3] of anomalous nuclear enhancement ($A^{n(p_T)}$ behavior with n>1) and its curious dependence on the trigger particle are natural consequences.]

References

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