HADRONIZATION OF QUARK GLUON PLASMA (AND GLUON JETS)
AND THE ROLE OF THE 0++ GLUEBALL AS PRIMARY HADRON
PRODUCTS

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Signatures of dominant and central production of glueballs (binary gluonic mesons) in heavy ion and
hadronic collisions are discussed. Search strategies are proposed.

1 Introduction

The three sequences of binary gluonic mesons (gb) are reviewed, represented by the respective gb resonances with lowest mass and $J^{PC}$ quantum numbers: $0^{++}$, $0^{-+}$ and $2^{++}$. While the $2^{++}$ sequence is associated through Regge analytic continuation in angular momentum of two body elastic amplitudes to the Pomeron trajectory, the triple Pomeron vertex is thought to be responsible for the multiparticle production of mainly $0^{++}$ glueballs. We discuss search strategies for the main $0^{++}$ component and also for the heavier $2^{++}$ state in heavy ion and hadronic inelastic scattering at high energy and high (initial) energy density under the hypothesis that they become the dominant primary systems of multiparticle production in this environment. We propose in particular to impose centrality selections also in hadronic reactions, e.g. $p\bar{p}$ collisions at the Tevatron, in order to discover eventual transitory behaviour bearing a similarity to kaon distributions in PbPb collisions at the SPS as analyzed in ref. [4, 5].

2 Discussion

The three $J^{PC}$ series of binary gluonic mesons are

\[ 0^{++} \quad 0^{++} \quad 2^{++} \quad 4^{++} \quad \ldots \] (1)

\[ 2^{++} \quad 2^{++} \quad 3^{++} \quad 4^{++} \quad 5^{++} \quad \ldots \]

\[ 0^{-+} \quad 0^{-+} \quad 2^{-+} \quad 4^{-+} \quad \ldots \]

We envisage two temporal developments of a collision:

a) quark gluon plasma formation
initial thermal equilibrium as appropriate for an expanding medium within the quark gluon plasma phase. In the further development the hadronisation pro-
cess from within the plasma phase coincides closely in time with chemical freezout.

b) no quark gluon plasma formation

initial thermal equilibrium occurs within the hadronic phase with subsequent chemical freezout.

It is conceivable, that for a given centre of mass collision energy both phases a) and b) above occur depending on the centrality of the collision. Then phase a) is distinguished by the independence of the thermodynamic intensive variables, mainly temperature and chemical potentials for baryon number and strangeness $T \sim T_{cr}, \mu_b$ and $\mu_s$ from the initial energy density, prior to thermalization $\varepsilon_0$.

It is for the case of phase a) that we expect dominant production of $gb$ ($0^{++}$) to occur upon chemical freezout. We discuss the possibility of characteristic $\pi^+\pi^-$ as well as $K\overline{K}$ invariant mass and relative momentum distributions to remain observable notwithstanding further hadronic collisions before final thermal freezout.

The following properties appear characteristic:

a1) dipion invariant mass distribution:

Ordering all pions produced in rapidity and relative momentum the invariant mass spectrum corresponding to $gb$ ($0^{++}$) production should show the interference pattern first observed in central production in p p collisions at $\sqrt{s} = 63 GeV$ by the AFS collaboration.

a2) $K\overline{K}$ invariant mass distribution:

The high mass tail of $gb$ ($0^{++}$) as well as a separate peak from production of $gb$ ($2^{++}$) can be observed in the invariant mass distribution of $K\overline{K}$ pairs.

Figure 1. Invariant mass distribution of pion pairs centrally produced in pp collisions at ISR energies.
We further propose to look for similar invariant mass distribution in multijet dominated collisions.

Conclusions

We have presented search strategies for dominant production of binary gluonic mesons, mainly $g(b) (0^{++})$ and to a lesser extent $g(b) (2^{++})$ in high energy and high initial energy density heavy ion as well as hadronic collisions, whence a transition through the equilibrated quark gluon phase takes place. If these strategies prove successful, dominant glueball production may constitute a direct and clear signature of the quark gluon phase and its hadronic transition.

References

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