The Origin of the High-Mass Paired Dijet Resonances

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Abstract: Within the Scale-Symmetric Theory (SST) we obtain the three invariant masses on the tail of the distributions: the four-jet masses of 8.03 TeV and 7.79 TeV and a dijet mass of 1.95 TeV.

1. Introduction

The CMS team [1] discovered the highest mass event with a four-jet mass of M(Y) = 8 TeV or 7.9 TeV. Each pair of jets has a dijet mass of M(X) = 1.9 TeV or 2.0 TeV.

For the resonant production of pairs of dijet resonances in the proton-proton (pp) collisions we have [1]

$$p\ p \rightarrow Y \rightarrow X\ X \rightarrow (j\ j)\ (j\ j)\,, \qquad (1)$$

where j denotes a jet, $M(X) = m_{jj}$ is mass of dijet, and $M(Y) = m_{4j}$ is four-jet mass.

Here, within the Scale-Symmetric Theory (SST) [2], we described the origin of the high-mass paired dijet resonances.

2. Dijet mass M(X)

In the d = 0 state in nucleons/baryons (it is a state just above the equator of the core of baryons), mass of a strongly interacting particle (it can be a gluon loop or an association of entangled gluon loops) increases F = 9.0036 times (see formula (2.5.27) in [2]) and next it can transform into a spacetime condensate(s).

Consider a resonance with a mass equal to mass of the H^o Higgs boson (H^o = 125.25(17) GeV [3] or 125.0 GeV from SST [2]) and the Z boson (Z = 91.1876(21) GeV [3] or 91.1798 GeV from SST [2]). In the d = 0 state, the mass of such a resonance increases to

$$M(X) = m_{jj} = (H^o + Z)\ F = 1.95\ \textbf{TeV}\,. \qquad (2)$$

It can decay to a dijet.

3. Four-jet mass, M(Y), that decays on the edge of the nuclear strong field

For the spacetime condensates, to conserve the spin-zero, charge-zero, and the zero internal-helicity of the spacetime condensates/scalars, there is obligatory the four-object symmetry [2] so we should observe a pair of dijets ($Y \equiv ZZ + H^oH^o$) – its total mass in the d = 0 state is two times higher than the M(X) dijet but because it decays on the edge of the nuclear strong field of baryons, we must take into account the relativistic mass to calculate the invariant four-jet mass.

For a black hole (according to SST, the proton is a black hole not because of the gravitational interactions, but because of the nuclear strong interactions [2]) we have

$$(v_{spin} / c)^2 = A / R , \qquad (3)$$

where $A = 0.6974425$ **fm** is the equatorial radius (it is two times shorter than the Schwarzschild radius for the nuclear strong interactions), $c = 2.99792458 \cdot 10^8$ **m/s** is the spin speed on the equator, and v_{spin} is the spin speed in distance R from the centre of baryons [2].

Radius of the edge of the nuclear strong field in baryons, in the plane of the equator of the core of baryons, is $R_{edge} = 2.9582093$ **fm** [2] so from (3) we can calculate the spin speed on the edge

$$v_{spin,edge} = 0.4855565 \, c . \qquad (4)$$

According to SST, the partons/gluons in baryons are moving with the speed c so we have

$$v_{radial}{}^2 = c^2 - v_{spin}{}^2 , \qquad (5)$$

where v_{radial} is the radial speed of the partons.

From (5) we can calculate the radial speed of the partons on the edge just before the decay of $M(Y)$

$$v_{radial,edge} = 0.8742053 \, c . \qquad (6)$$

This value leads to the ratio of relativistic mass to rest mass in the radial direction ($M_{rel} / M_o = 1 / [1 - (v_{radial,edge} / c)^2]^{1/2}$)

$$f = M_{rel} / M_o = 2.0595 , \qquad (7)$$

i.e. the relativistic mass is f times higher than the rest mass M_o.

It leads to conclusion that the invariant mass of the four-jet resonance that decays on the edge of the nuclear strong interactions is

$$M(Y) = m_{4j} = 2 \, M(X) \, f = 8.03 \, \mathbf{TeV} . \qquad (8)$$

4. Four-jet mass, M*(Y), that results from the four-object symmetry

Notice that the mass $M(Y)$ is very close to $4M(X)$ so there just before the decay of $M(Y)$ can appear following transition/resonance

$$M(Y) = 8.03 \, \mathbf{TeV} \rightarrow M^*(Y) \equiv 4 \, M(X) = 7.79 \, \mathbf{TeV} . \qquad (9)$$

5. Full width of the spacetime condensates so also of the dijet and four-jet resonances

In SST, the full width is defined as follows [2]

$$\Gamma_{SST}\ [\mathrm{GeV}] = 2^{1/2}\ \alpha_{w(p)}\ M_C\ [\mathrm{GeV}]\ , \qquad (10)$$

where $\alpha_{w(p)} = 0.018722909$ is the coupling constant for the nuclear weak interactions of the spacetime condensates (see (2.2.27) in the book [2]), and M_C is the central mass of a spacetime condensate. For example, the SST full width of the $W^{\pm}$ boson should be ~2.13 GeV – we can compare it with the Particle-Data-Group (PDG) value 2.085(42) GeV [3].

6. Summary

Here, within the SST, we calculated the three invariant masses on the tail of the distributions: a four-jet mass of $m_{4j,SST} = 8.03$ **TeV** with a full width of 0.21 **TeV** (it follows from formula (9)), a four-jet mass of $m^*_{4j,SST} = 7.79$ **TeV** with a full width of 0.21 **TeV** and a dijet mass of $m_{jj,SST} = 1.95$ **TeV** with a full width of 0.05 **TeV**.

Our average ratios of dijet mass to four-jet mass are

$$\mathbf{Ratio_1} = m_{jj,SST} / m_{4j,SST} = M(X) / M(Y) = 0.243\ . \qquad (11a)$$

$$\mathbf{Ratio_2} = m_{jj,SST} / m^*_{4j,SST} = M(X) / M^*(Y) = 0.25\ . \qquad (11b)$$

Future more precise experimental data than the data presented in [1] will show whether our predictions are correct.

References

[1] CMS Collaboration (11 March 2022). “Search for paired dijet resonances”
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[3] P. A. Zyla, *et al.* (Particle Data Group)
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