Baryon charge asymmetry at LHC , String Junction transfer in proton reactions and SJ torus as baryonium, B=0, DM candidate.

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- Toroidal structures at space observations near SMBH
- Conclusions

Introduction I : baryonium and strong interaction approaches of 70th

I. Quark-diquark model of baryon interactions was proposed in: M. Ida and R. Kobayashi, Prog. Theor. Phys. 36(1966)846 ; D.B. Lichtenberg and I.J. Tassie, Phys. Rev. 155 (1967) 1601.

II. J.L. Rosner "Possibility of baryon-antibaryon enhancements with unusual quantum numbers." Phys. Rev. Lett. 21 (1968) 950

III. Carl Rosenzweig: "Implication of Duality, Unitarity and SU6 symmetry for baryons and baryonium" (1977) :

In order to understand baryons, we must understand baryonium. The most striking property of baryonium states is the existence of selection rules, which forbids baryonium decay into purely mesonic states.

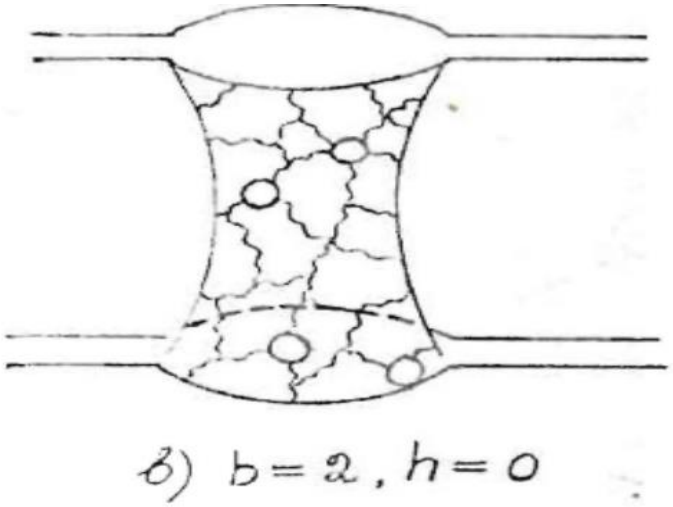
IV. G. Chew and C. Rosenzweig, "Dual Topological Unitarization: an Ordered Approach to Hadron Theory", Phys. Rep. 41C (1978) 263.

It was quickly realized by J. Rosner, that duality for baryons implies new particles family – combination of two quarks with two antiquarks. Assuming these new states to be the long-sought Rosner exotics, they have tentatively dubbed "baryonium".

V. G. Veneziano, Some Aspects of a Unified approach to gauge, dual and Gribov theories, Nucl. Phys. B117(1976) 519 :

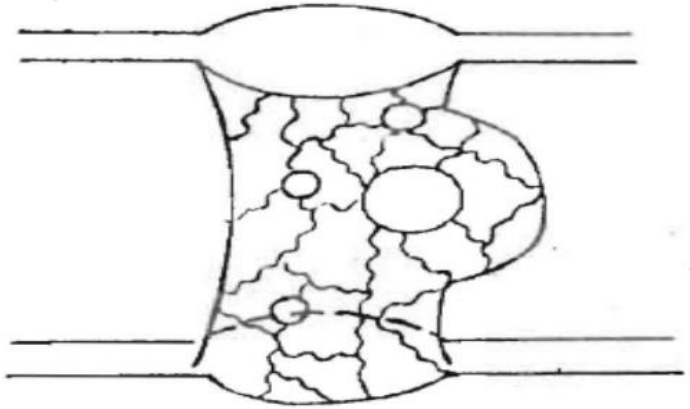
Existing dual models with their string interpretation could play an important role by showing what type of properties one should expect from QCD in two dimension planar approximation. The challenging problem now to generalize such analogy to the four - dimentional case.

Quark-Gluon String model with SJ torus as second order pomeron diagram: topological expansion 1975



в) $b=2, h=0$

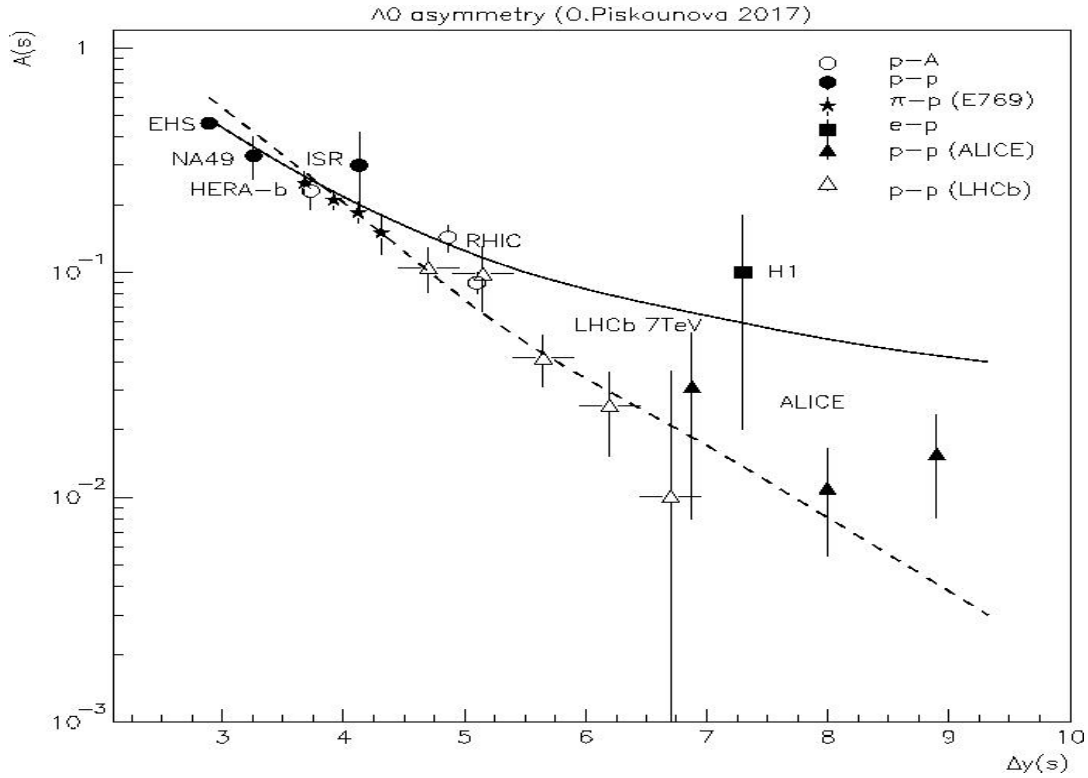
б) $b=1, h=1$



г) $b=2, h=1$

M.Giafaloni, G.Machesini, G. Veneziano, Nucl. Phys. B98 (1975), 472

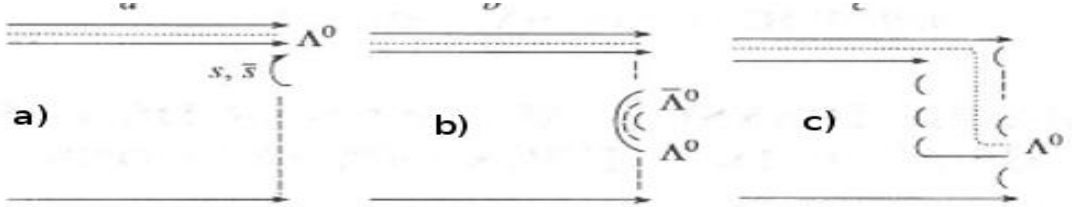
Baryon/antibaryon production at proton colliders: baryon charge transfer with SJ



The asymmetry of baryon/antibaryon production has been measured in many proton-proton, pion-proton and electron-proton experiments.

SJ transfers the baryon charge from proton projectile into the central rapidity region at high energy proton interactions, while the diquark used to bring positive baryons to Y=0 point in the reactions at $\sqrt{s} < 200$ GeV. QGSM calculations have been done at $0.5<\alpha_{SJ}(0)<0.9$ (O.I. Piskounova, Phys. Atom. Nucl. 70 (2007) 1107-1109).

SJ fragmentation function and intercept, $\alpha_{SJ}(0)$



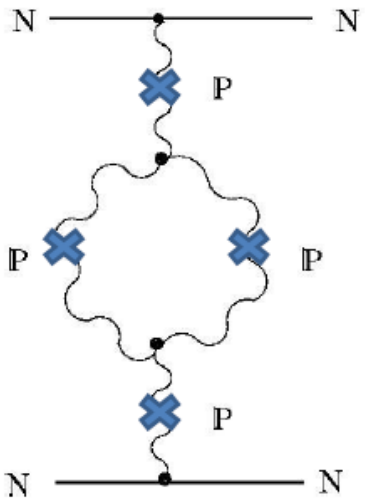
The fragmentation of diquark chain: (*a*) leading fragmentation into Λ^0, (*b*) central and (c) fragmentation by string junction.

$$D_{SJ}^{\Lambda^0}(z) = \frac{a_f^{\Lambda^0}}{a_0^{\bar{\Lambda}_c} z} z^{1-\alpha_{SJ}(0)} \times (1-z)^{-\alpha_\phi(0)+\lambda+2(1-\alpha_R(0))}$$

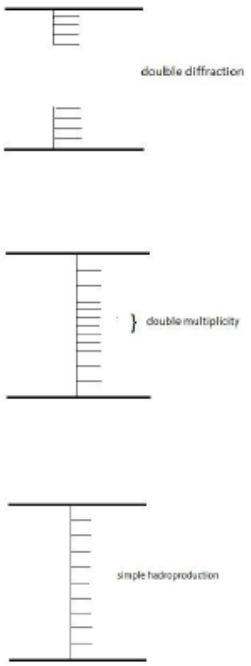
SJ fragmentation function depends on the intercept of SJ trajectory, $\alpha_{SJ}(0)$

Experimental expectations for the SJ torus in multi particle production and in Double Diffraction

Pomeron "loop" corresponds to the pomeron with handle

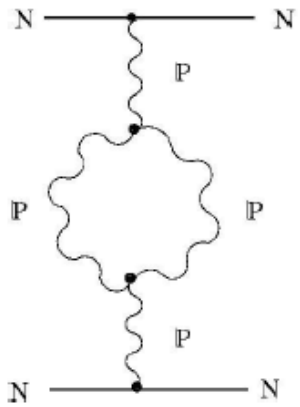


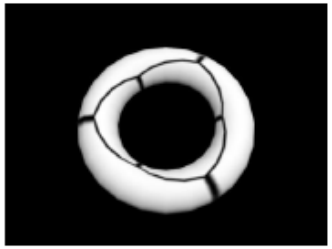
$A \sim (1/Nc)^4$



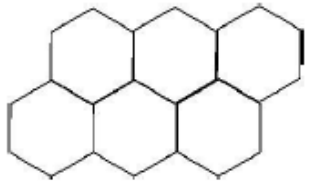
Baryon/antibaryon junction hexagon and hexagon net on the torus

Pomeron torus is covered with gluon exchange net





3D view of pomeron loop covered with the gluon net

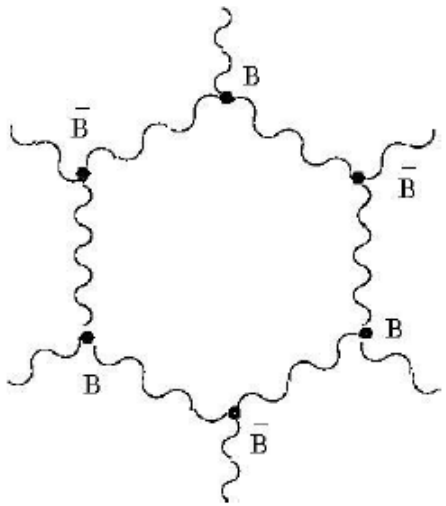


6 - minimal set of hexagon gluon cells to cover the pomeron torus (6 ,16, 30 ...)

Why hexagons?

Baryon/antibaryon junction hexagon

The only way to cover the torus with the SJ (string junctions) net is hexagon (honey comb).



String junction brings the baryon/antibaryon charge

String junction is responsible for baryon/antybaryon asymmetry in spectra at LHC

It seems that string junction can not annihilate or disappear (??)

At fixed energy we can cover the pomeron torus with discrete numbers of hexagons

The gap in the pomeron exchange with loop may be of discrete values

We can insert quark-antiquark loops on every side or leg of SJ hexagon

Experimental possibilities at colliders and in CRs

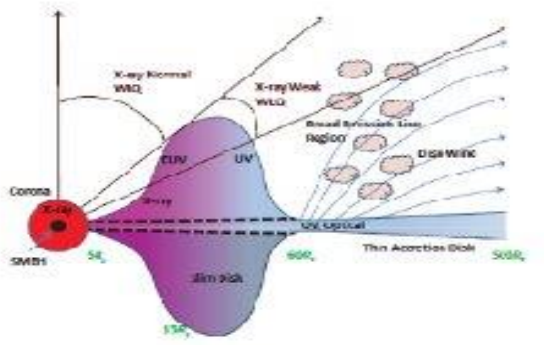
- Precise DD rapidity gap distributions in the big gaps region
- The intervals with doubled multiplicity in multi particle production
- Rapidity distributions in VHE cosmic ray first interaction with atmosphere, arXiv.org:**1907.00176**

SJ torus as baryonium Dark Matter

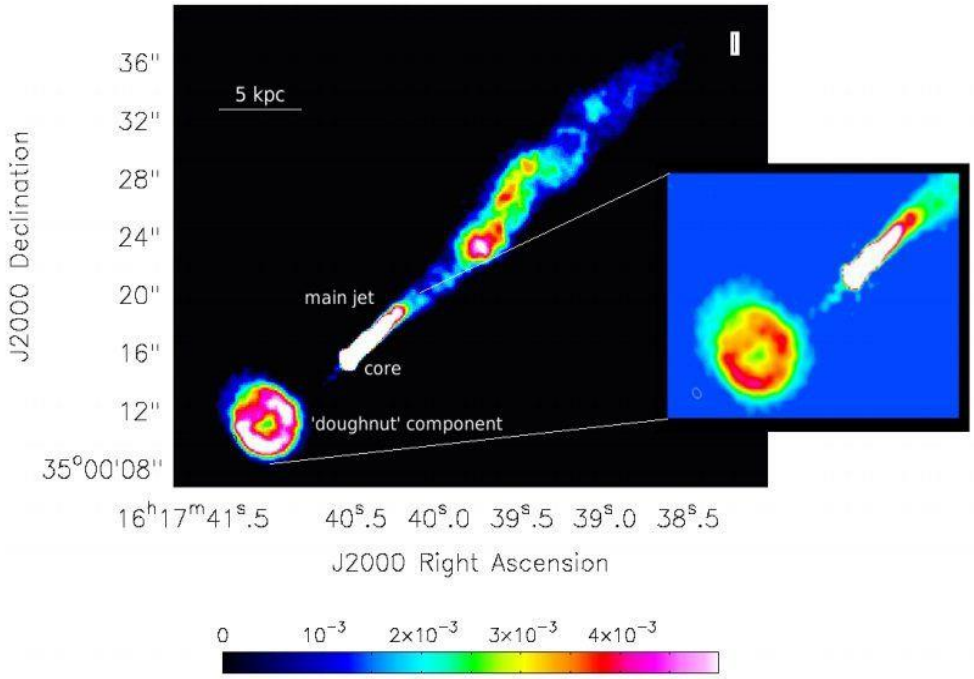
- Can obtain great mass
- No charge, B=0
- As more heavy, as more stable
- Appears in high energy baryon interactions
- Lightest baryonium seems absorbable into proton
- DM consists of baryon-antibaryon matter in the similar way as the diamond is made from carbon
- Exists at SMBH under huge gravitational pressure
- Can be injected to space with Relativistic Jets

Toroid structures at space observations near SMBH

Torus configuration of QCD matter, what has been revealed by Chandra (arxiv:1503.02085) at the event horizon of SMBH , must be such dense "doughnut" that roentgen radiation is screened on 40%)

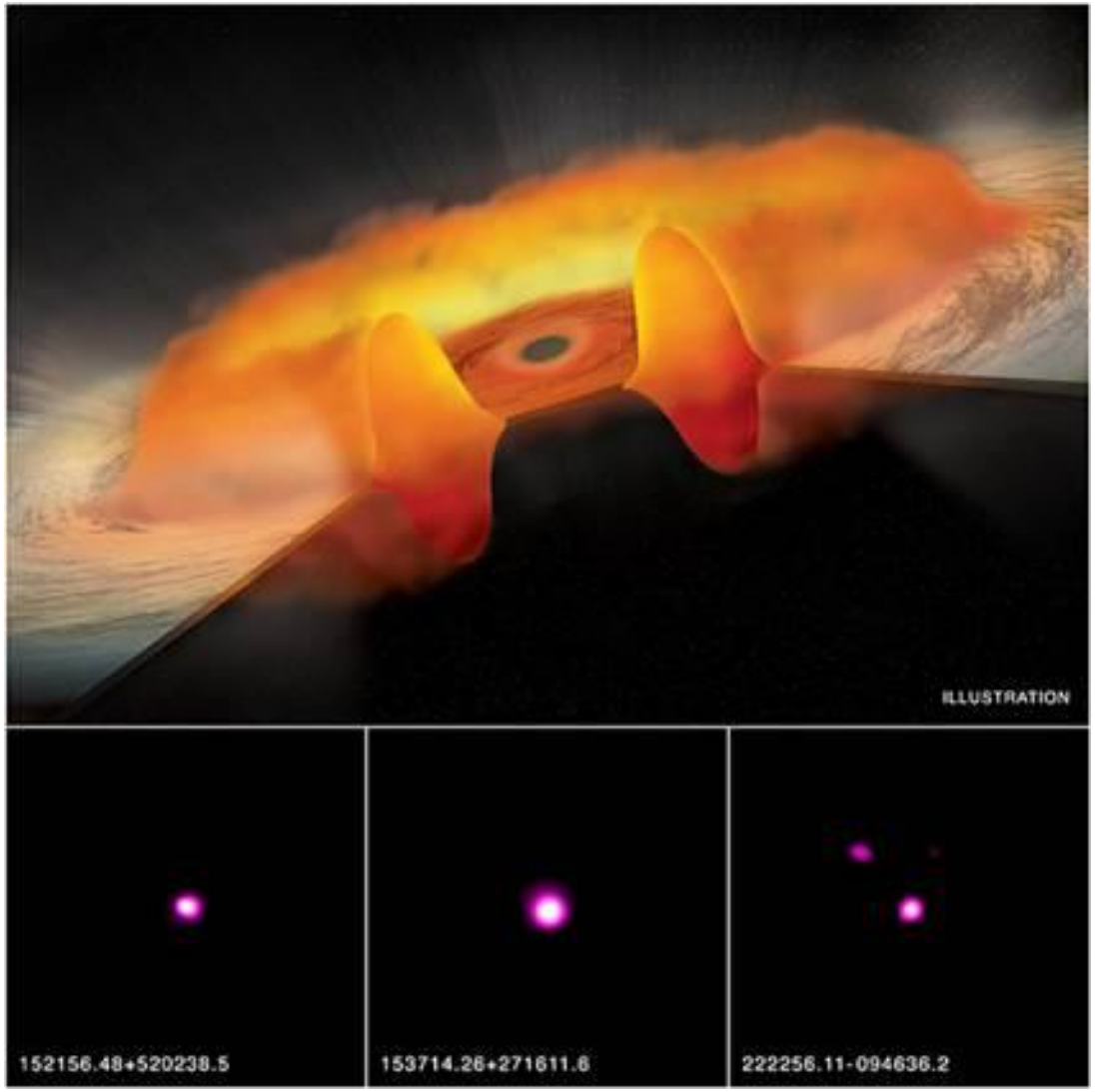


Toroidal structure of jet from radio galaxy NGC6109 (arXiv: 1808.019670) is recent observation of baryon matter in the extremal conditions .



Baryon matter falling under BH horizon should be symmetric, or in other words, has no charge information.

Super Massive Black hole s are throwing out 1/3 of their mass with the jets.



With “doughnut” structure SMBH mass grows more rapidly

Conclusions

- String Junction brings baryon charge at LHC nucleon-nucleon collisions
- SJ can be organized with anti SJ in the neutral structures (hexagons) and build SJ torus with the zero baryon charge that behaves as DM particle with B=0 (baryonium)
- SJ torus has discrete levels of energy (mass)
- Multiple states of baryonium DM helps to adjust model parameters to the known features of DM
- Giant massive toroid structures are observed near SMBHs
- Massive SJ torus can be “squashed” due to the gravity pressure and return to lower mass level with the valuable baryonic mass radiation as relativistic jets
- Look to **1812.02691** and **1909.08536** for updates