Baryonium Dark Matter states as progenitors for hadron generations

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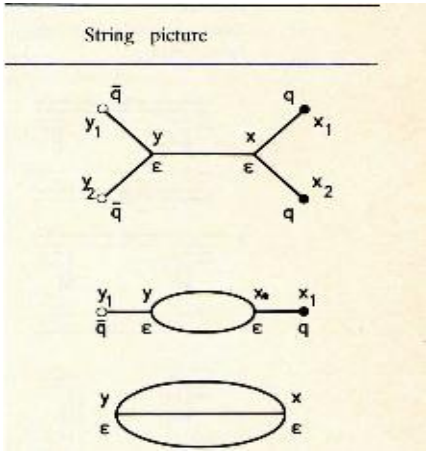
Abstract

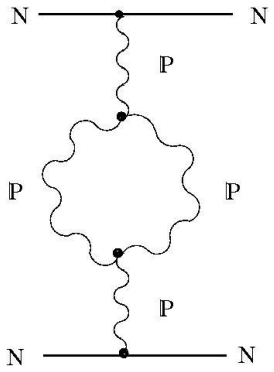
Quark-less baryonium resonance has been expected in the old paper on string QCD phenomenology (Veneziano et al. 1980). This idea can be expanded to the multi baryon-antibaryon states of Baryonium Dark Matter (BDM), (Piskounova, 2017). The structure of BDM conglomerates and their masses are investigated on the basis of achievements of QCD string phenomenology. The masses of expected BDM states go with exponential sequence (me 2016) and correspond to the medial mass of each hadron generation. If take into account the hidden mass of BDM, it is suggested that heavy neutral BDM state is progenitor of mesons, baryons and resonances of corresponding generation. This assumption has been checked up on charmed generation of hadrons. In space, the heavy Baryonium Dark Matter conglomerates should be stable and fulfill important functions in the Universe.

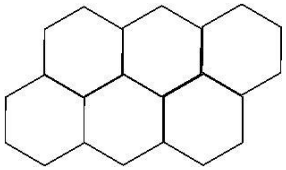
Introduction into BDM

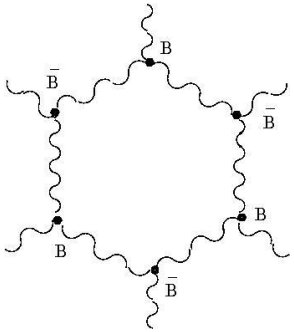
Baryonium Dark Matter is possible because of quark-less baryonium resonance that has been invented in L. Montanet, G.C. Rossi and G. Veneziano, *Baryonium Physics*, Phys. Rep. 63 (1980) 153. It is multi-quark resonance, like tetraquark, quark-antiquark loop or quark-less. All of them are decaying in two baryons. The quark-less diagram is actually the first lightest state of Baryonium Dark Matter.

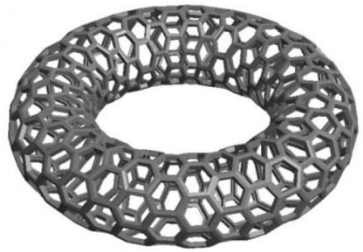


BDM has been built with the same principles: multiple String junctions are self connected on the surface of torus with no quarks and zero baryon charge.



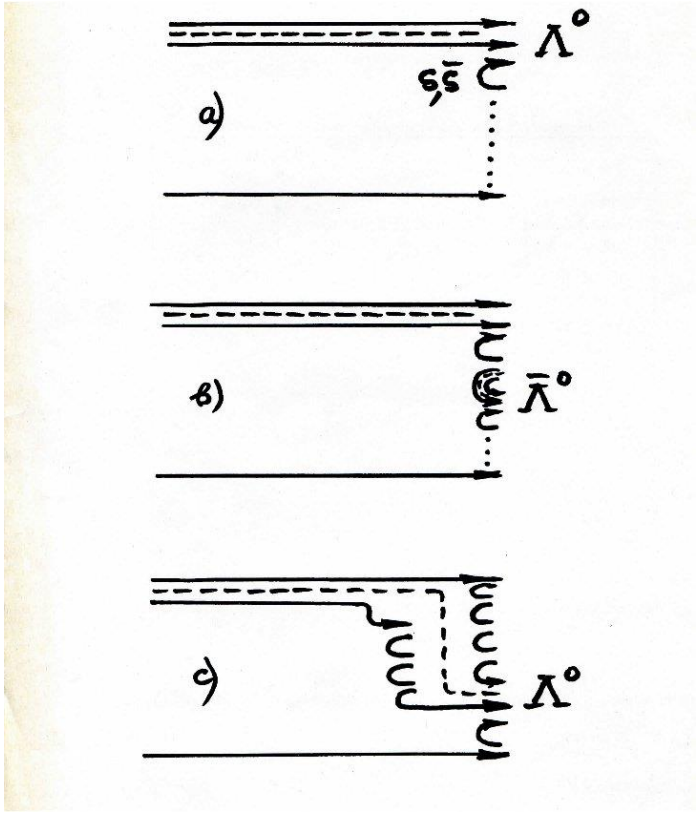






Baryon string junction

Baryonic string junctions bring asymmetry into the central rapidity baryon-antibaryon production rate at the high energies.



Leading production brings asymmetry in forward region of spectra

Baryon-antibaryon production in central region is symmetrical

Extra baryon production is brought to Central region by proton String Junction

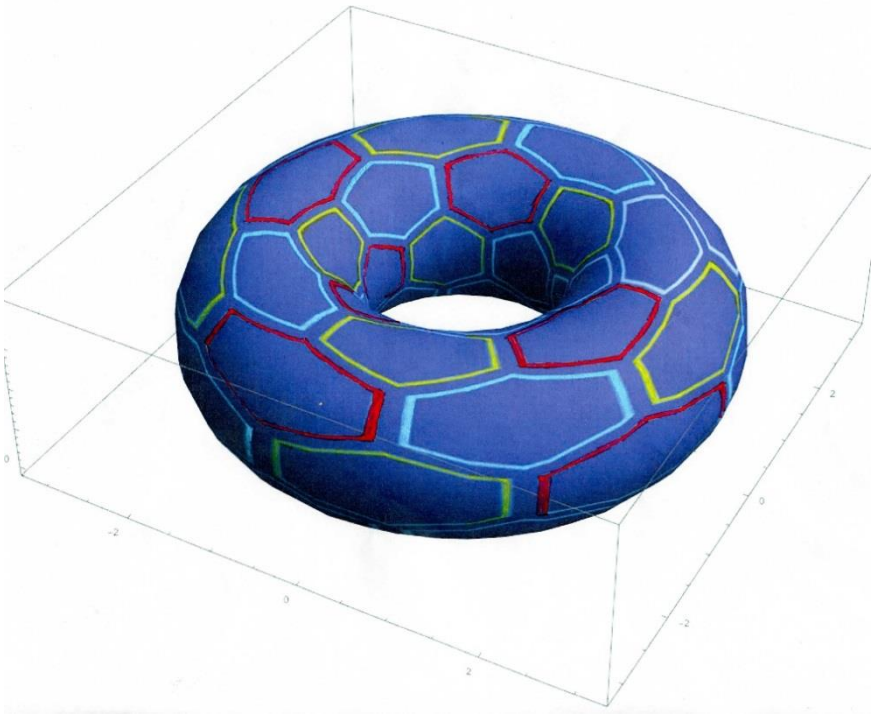
Discrete masses of BDM

Since the BDM particles are the objects of QCD, they should obey to symmetry rules. This rules are manifested in SJ anti-SJ hexagons and QCD color confinement in each hexagon. Colored gluon exchanges are to be enclosed by each hexagon. It leads to the following sequence of the number of hexagons along the

big radius R of torus: 3, 6, 12, 24, 48…,

while the number of hexagons around small radius r of torus has to be even.

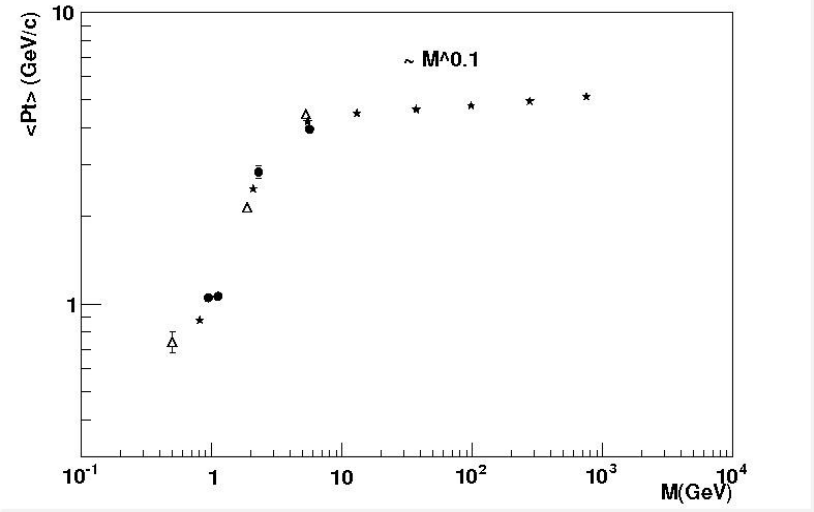
It is shown in the picture that 7 hexagons around radius R don't allow to close the hexagon net with color confinement.



Suggestion about mass values of BDM

In QGSM it was expected that hadrons are results of the disintegration of quark-gluon string. The Pomeron exchange is only string which is working with high energy QCD phenomena. As it was shown in previous slide, torus is third order of pomeron exchange expansion. In the paper on mass dependence of average transverse momenta of hadrons the hadron generations are shown on logarithmic scale of mass. It is seen that generations go with exponent, which
is natural for QCD variables.

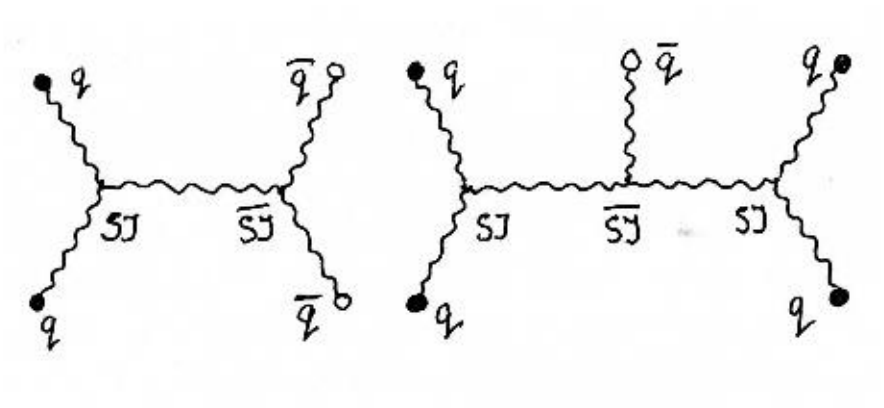
If we suggest that
hadrons are the results of BDM states disintegration, the BDM masses can be described with expression $M_n = 0{,}25*\exp(n-1)$ (GeV).
The sequence is able to be extrapolated to the giant mass. The slope of average Pt vs M will be also work for the detailed investigation of BDM disintegration.



* Important notice: the lowest mass BDM state is 8 times less massive than p+anti-p

Tetraquarks and pentaquarks as baryon-antibaryon string objects

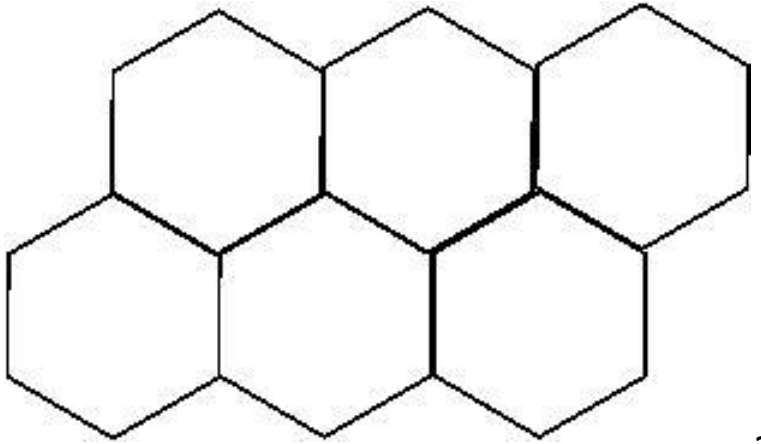
The BDM structure is seen in the diagrams of multi quarks QCD conglomerates: tetraquarks and pentaquarks. We see the obvious presence of baryon antimatter: the anti-baryon anti-String Junction is included into the both diagrams. These states are the debris of BDM.



Tetraquark **Pentaquarks**

Charmed resonances as offspring from third-order 3x2 BDM state

If we pull gluon line in the 3x2 diagram, the cut line gives two heavy quarks (c, anti-c) that are connected to baryon SJ and antibaryon anti-SJ. That are two charmed resonances. Deconstruction of other hexagons has to be resulted with more light baryons and mesons. For charm production it is necessary to have enough mass and energy concentrated in one gluon string. There are 6 protons and 6 antiprotons on the torus, that means that the mass of BDM conglomerate is less than included baryons by 6.5 times. Hidden mass gives the possibility to produce c-anti c quark pair. There could be two baryon resonance or two charmed pentaquarks plus few light baryons and antibaryons plus dozens of pions and photons.



Experimental achievements give the charmed resonances with masses: 1835, 1851 and 1859 MeV. The mass of third order BDM is 1855+-15 MeV, see Piskounova, arXiv: 1908.10759.

More expectations on Baryonium Dark Matter

Concept of Dark Matter is changing. Dark Matter particles used to be imagined as mysterious species of light exotic undiscovered particles that are just hanging around in the Universe and somehow capturing the most of mass of the Universe. DM even was recently suggested to be studied in the interactions with primordial Black Holes (see Cuadrat-Grzybowski et al, Phys. Rev. D 110 (2024) 06029) that are also hanging around in space.

But Dark Matter particles, first of all, must be functional constituents of Universe. Starting from fundamental features of living nature to expand and to propagate itself as more as possible, it may be approved that Baryonium Dark Matter should exist in order to stockpile condensed baryon-antibaryon matter, to transport materials into empty places of Universe, and to multiply new stars and galaxies. It is also nutrition for Super Massive Black Holes (SMBH). In our Galaxy the waves of BDM from central SMBH may transfer the energy and matter to the periphery. In such a way, BDM particles are very busy matter constituents of the Universe.

Conclusions

Baryonium Dark Matter is long-living constituent of Universe, whose functional role begins to be more and more appreciated. It should be called the fundamental state of matter in the Universe. BDM conglomerates are condensed quark-less QCD states which can be originated in ultra-high energy events like Big Bang, Supernova explosions or relativistic jet eruption from Super Massive Black Holes.

Heavy neutral BDM conglomerates have multiple states of discrete masses and can fulfil the following important functions in the Universe.

a) They keep the stock of matter provision for the Super Massive Black Holes.

b) BDM states even make up an interior of SMBHs.

c) BDM conglomerates are being erupted into the space with the relativistic jets from SMBH and give the acceleration to protons and antiprotons as soon as BDM happen disintegrated into lighter states.

d) They are bringing the matter for new stars and galaxies and helping the Universe to expand.

e) BDM waves may deliver heat and matter up to Solar system too.

f) The sequence of masses of BDM states correspond to the masses of hadron generations. It means that BDM states are progenitors to the generations of hadrons.

As it was analyzed in recent preprint (Piskounova, arXiv:2309.14933, Baryonium Dark Matter could as well bring water to Earth, while it is being burned in the oxygen atmosphere.

!! It should be noticed that BDM conglomerates can also bringing disasters to Earth: the dinosaur catastrophe on Yucatan peninsula (66 millions of years ago) and world flood (10600 years BC).

The question arises: how does the baryon-antibaryon asymmetry can appear in the frameworks of this scheme? The baryon-antibaryon Dark Matter do solve this problem partially: the Universe is mostly symmetrical. The difference between proton and antiproton may be only in their functional roles: antiprotons participate in the stocking the matter at low energies near SMBH, while high energy protons go far to propagate the new galaxies.

Some evidence from cosmological news

The circles of baryonic matter appear from Dark Matter clumps