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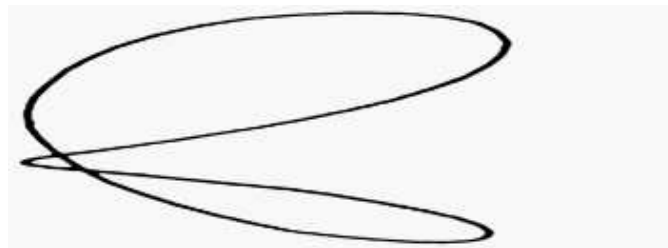
Title
The Single Thread

Abstract
This short paper explores intriguing analogies between helical structures of electron and elementary particles and circular supercoiled DNA. I propose a strong relation between the dispositions Lk=Tw+Wr (Lk=const., changing Twist and Writhe) and the quark compositions Q=I3+Y/2 (examples: Q=const., varying Isospin an Hypercharge; or Strangeness S or Y=const. varying Charge and Isospin).

THE SINGLE THREAD

I was deeply impressed by two things, the paper of Qiu Hong Hu on Hubius Helix [1] I was reported by Riccardo Rauber [2], and the matter of circular DNA [3], linked with my previous work [4].

I was very impressed from the paper of Qiu on Hubius Helix because it reproduces almost exactly my model with the Moebius strip [4]. It cited a particular helix, *a closed two-turns helix, a so called Hubius Helix*, but rapidly recognized as the edge of a Moebius strip *("the edge of a Mobius strip is a Hubius Helix ")*. Here's a drawing.

The properties of electron are generated by the *circulatory motion of a mass-less particle at a speed of light on helix*. Many other data, including numeric, coincide with the model [4] proposed to me. Perhaps the main difference lies in the mass-less particle running at a speed of light on helix. This work struck me, I was very impressed, because the model of Qiu Hong Hu is basically identical to mine, also in numbers. Also, something I was very impressed, neither was aware of the work of the other.

But the issue of the circular DNA is more complex and requires two more words.

I must first tell what and why I was impressed, and finally what I understand.
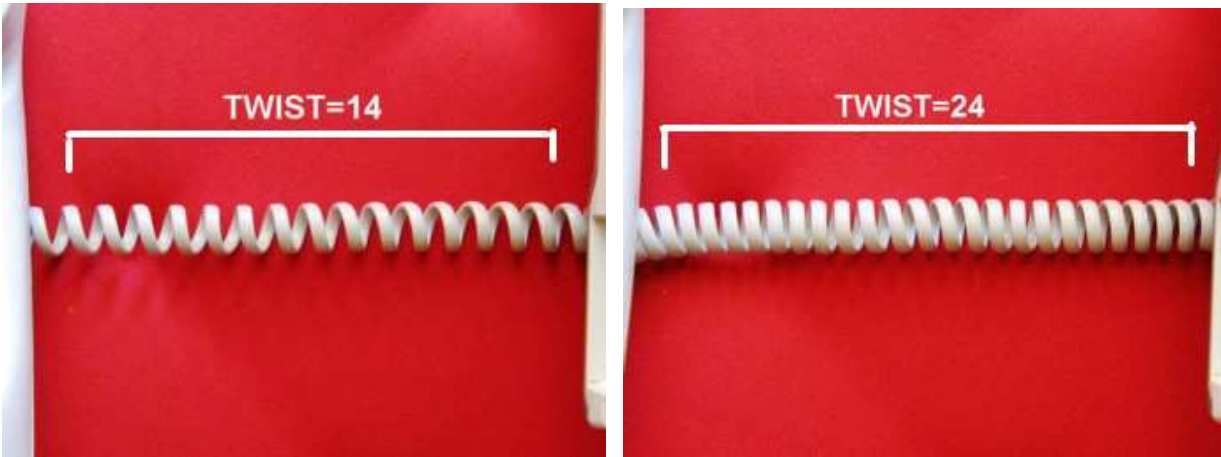
The first thing that struck me was the "circular DNA". But I would say, if you wish, also the other "single-stranded DNA". I knew neither one nor the other. Put together, the two things made me remind my concept of elementary particles with a single closed wire [4].

I do not say then my next interest when I read that many recent studies have addressed on methods of DNA supercoiling in relation to circular DNA in the bacterial chromosome.

How does what?

Summarize: I introduce with my own words.

Consider a helix. Consider indeed a piece of helix between two points A and B. We call Tw the number of twists of this piece of helix around its axis.

It may happen that instead the helix axis wraps around an imaginary axis.
The number of turns made by the helix axis around an imaginary axis is called Writhe (Wr).

The helix is said "supercoiled". The form that is born is also called "supercoil".

Twist and Writhe are convertible into each other. Compared with a "relaxed" helix a twist (Tw) causes a winding (Wr) or a supercoil. A positive twist causes a (positive)

supercoiling, on the contrary a negative twist (eg elimination of some pitch of helix) results in a negative supercoiling.

The equation holds:

Lk=Tw+Wr

Lk is called "linking number" and is a topological property of the curve.

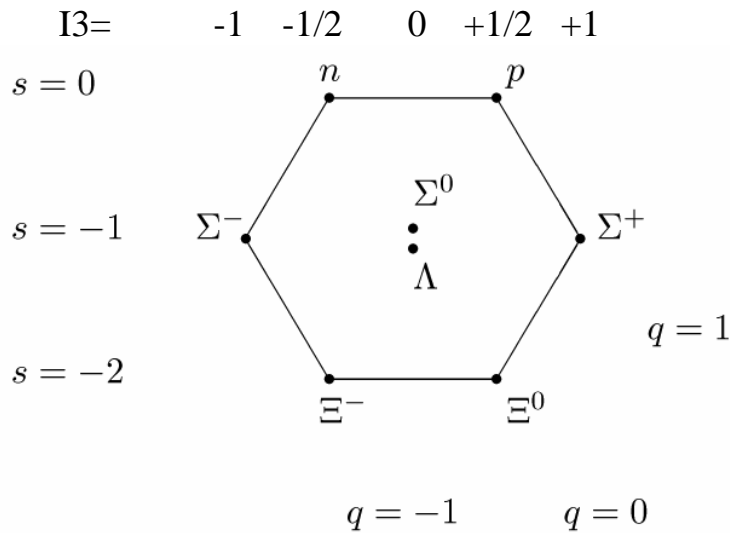If a helix is closed in a circle (or, if its ends are blocked) Lk can not vary.

Tw and Wr individually may change.

So summing up what has impressed me and why? I was impressed with these "similarities" between circular supercoiled DNA and particles as I supposed in [4].
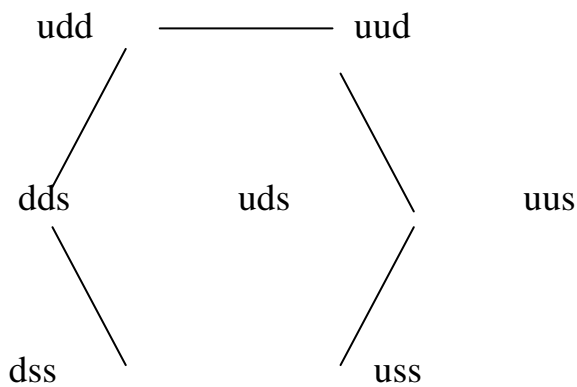
I try to continue. In particular take into account the baryon octet.

Horizontally the same strangeness S (or hypercharge Y = S + b), diagonally the same electric charge Q.

We have $Q=I3+Y/2$ or $Q=I3+S/2+b/2$ (for the baryons b=1)

The quark compositions of the octet of baryons are these:

Consider the particles on a diagonal, constant charge Q, Y and I3 are arranged to give constant charge (while the mass - energy - varies).

We now consider the formula

$Q=I3+Y/2$

and say that **an alteration of the charge Q can be absorbed as Y or I3.**

(and the mass varies)

This fact, together with the spatial arrangement of the windings, reminds me very strongly to recent studies on the circular bacterial DNA.

I quote few words from an Internet forum [5]:

Question

Good evening (.......).

When we speak of supercoiling in prokaryotes I'm always a little bit confused because I have many doubts that assail me.

From what I understand (correct me if I'm wrong) the bacterial chromosome (eg prokaryotic DNA) is a circular molecule (when relaxed) consists of the DNA double helix (coil). But it may also be a SUPERCOILED form, a structure called the SUPERHELIX, the degree of supercoiling is controlled by the topoisomerase, specific enzymes capable of modifying DNA topology going to act on so-called linking number (Lk) (....). Topoisomerase I: enzyme capable of modifying, etc. .... (omissis).
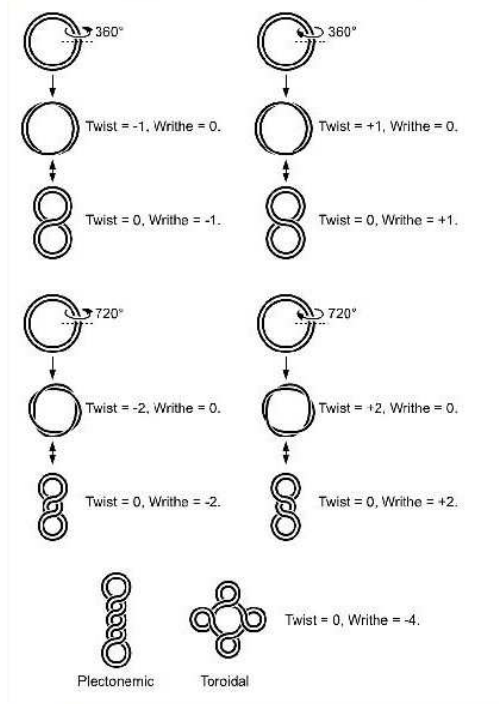

Answer

hello, I try to answer (but I'm pretty sure having to undergo corrections)

Meanwhile, the bacterial chromosome is normally circular.

You should imagine the double helix wraps around itself.

(.....) now I use this picture to support the rest of the explanation

(Note that helical nature of DNA is omitted for clarity)

If you take a pretty long stretch, open it and add a twist (right or left) and then closes it, you'll see this spring that it distributes torque across its body in circle (second row in the image, that is positive or negative depends on the direction of the twist, ie whether left or right) (....)
but may also occur in another form and download this tension by creating a wrapping around itself (the third row of the image).
(....) Therefore, these twists can be absorbed in either form.

An alteration of the linking number Lk can be absorbed as twist or writhe.

the formula of the linking number is in fact Lk = Wr + Tw
The difference between the two topoisomerase lies in the mechanism.
Topoisomerase I is able to introduce a cut in only one of two strands, allowing the intact strand to pass (..... etc.)

In Appendix I reproduce the experiment, inspired by [6].

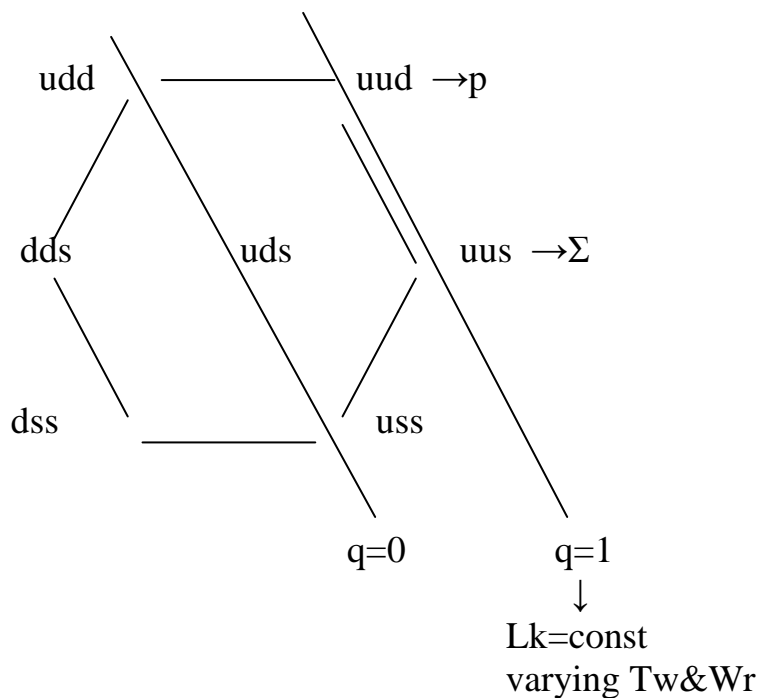We can then compare the two formulas
Q=I3+Y/2
Lk=Tw+Wr
The striking similarity (also considering the spatial arrangements they entail) is this:

an alteration of the charge Q can be absorbed as Y or I3;
an alteration of the linking number Lk can be absorbed as twist or writhe.

The different spatial arrangements are under constant Q but with different state of stored energy (mass).

Then you can draw a formal parallel, probably not random, between a circular strand - DNA - to Lk constant (and Tw, Wr variables) and a closed filament - particle - at constant Q and Y, I3 variables. This is for example the sequence at constant charge that we find on any diagonal of the octet
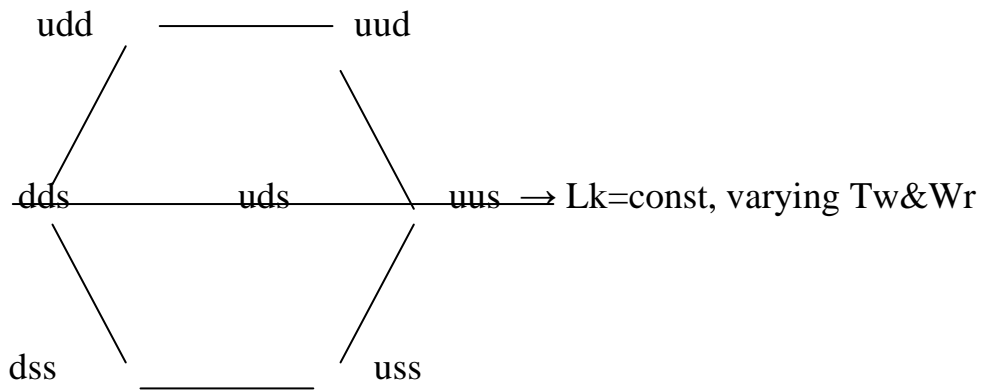
udd   uud →p

dds   uds   uus →Σ

dss   uss

q=0   q=1
                        ↓
                   Lk=const
                   varying Tw&Wr

Consider for example the sequence uud uus or p, Σ at charge Q =1.
To this sequence we can at least formally associate the classification
"linking number Lk=1"
and a change of Twist and Writhe from Tw=1 Wr =0 to state Tw=0 Wr =1.
The appearance of a loop Writhe Wr =1 could be associated with the emergence of a quark "s" instead of "d".

This is obviously not the only way to read the relation Q=I3+Y/2.
You can think of relating the linking number Lk, constant, to a quantum number other than the charge Q but instead, for example, the strangeness S or hypercharge Y, the horizontal line dds, uds, uus. In this case the variation 1 of charge might be associated with a change 1 of Tw and the appearance of a quark "u" instead of "d". This would be consistent with a rotation of 360° from d (+120°) to u (-240°) as I suggested in [4].
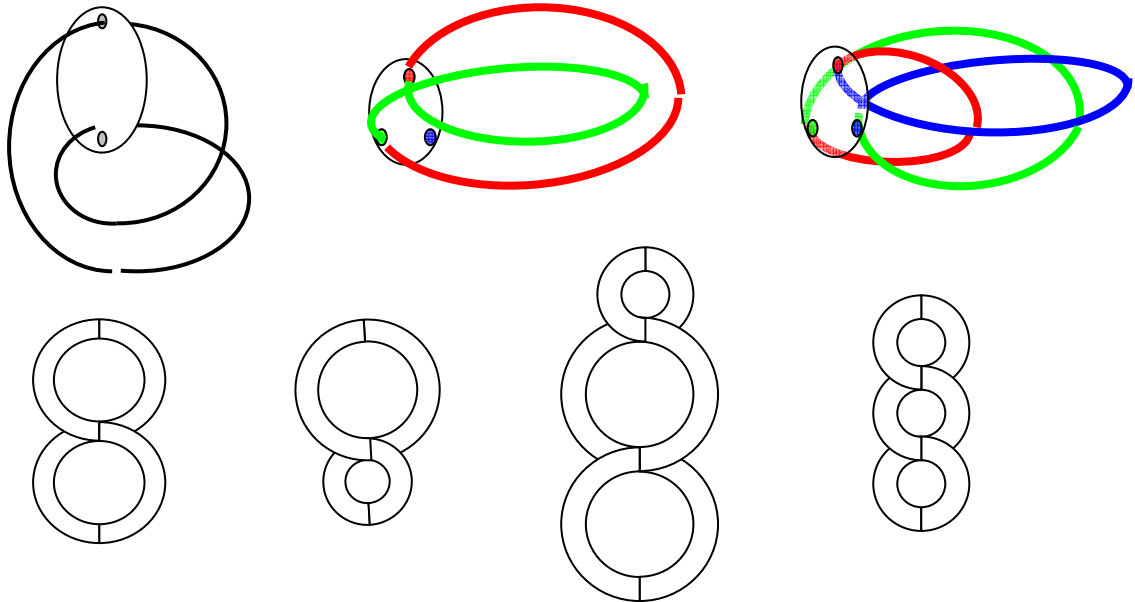Would now be the different spatial arrangements to Y (or S) constant, Q and I3 variables, to have different mass, this time smaller.
A clue to choose the most promising formal analogy is then given, among other things, how big or small the differences of energy states of DNA, Lk constant, Tw, Wr variables.

udd ——————— uud

dds —————— uds —————— uus $\Rightarrow$ Lk=const, varying Tw&Wr
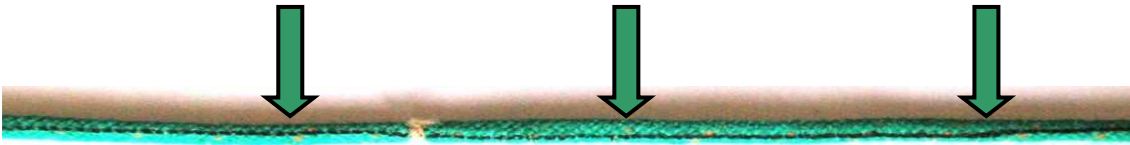
dss ——————— uss

CONCLUSIONS

I can not go beyond the observation of similarities, but it is inconceivable that nature changes its behavior between objects in much the same scale size, creating completely different branches of science. It is <u>we who change the names</u>, to please different academic disciplines. So it strikes me and I'm not surprised (I should not wonder), these similarities in behavior. Unfortunately I do not know enough. Most of these studies on behavior of DNA in more and more elementary bodies have just begun. I can only end with drawings that suggest ideas.

Twist and Writhe are convertible into each other. Compared with a "relaxed" helix a twist (Tw) causes a winding (Wr) or a supercoil. A positive twist causes a (positive) supercoiling, on the contrary a negative twist (eg elimination of some pitch of helix) results in a negative supercoiling. The equation holds Lk=Tw+Wr but the filament chooses a new equilibrium in which individual Tw and Wr have changed.

APPENDIX

Reproduce the experiment using a piece of rope that can absorb torsional energy. On this rope as a reference trace a black line. Do I put at rest then, straight in a relaxed condition. The black line shows that there are no twists

Tw=0. Wr=0 (Lk=0)

I can now close in a circle, locking the ends in position with a clip. If the rope is long enough, you have certainly a relaxed state at rest.

Tw=0. Wr=0 (Lk=0)

At this point I do a twist on the rope, by turning one end of 360°. I must take it blocked the extremes that retains its twist. The black line makes us still evident the internal twist (Tw=1).

Tw=1. Wr=0 (Lk=1)

The rope can still be arranged in a circle. I take the ends blocked with a clip. The black line makes us still evident the twist.

Tw=1. Wr=0 (Lk=1)

But I realize that the rope can also take quite a different natural equilibrium. Internal twist disappears and forms supercoiling (Wr=1).
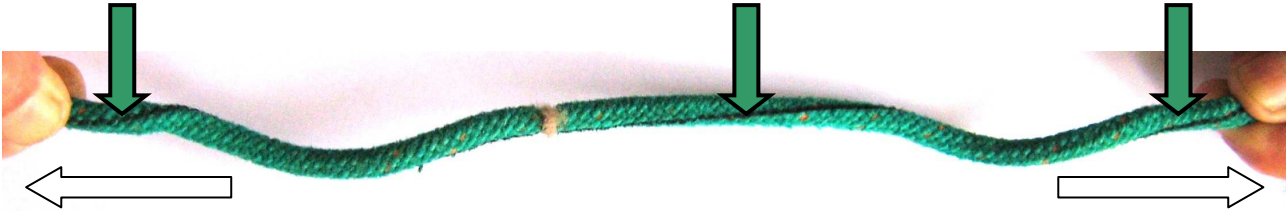

Tw=0. Wr=1 (Lk=1)

then **an alteration of the linking number Lk can be absorbed as twist or writhe.**

Even more interesting is the experiment that follows. We have the usual rope in a "relaxed" state on a plane, so that it forms two loops (Wr =2).

Tw=0. Wr=2 (Lk=2)

Now firmly locked into the extreme stretch the rope forced to assume a straight position and eliminating the two loops (Wr =0).

Tw=2. Wr=0 (Lk=2)

The black line drawn on the rope shows that you have created two internal twist (Tw =2).

REFERENCES

[1] Qiu-Hong Hu, "The nature of the electron", arXiv:physics/0512265v1, (2005)

[2] R.Rauber, personal communication

[3] "DNA Supercoil", Wikipedia, (2010)

[4] G. Bettini, "The Moebius Strip: a Biology of Elementary Particles", viXra:1004.0035 , (2010)

[5] Forum: MolecularLab.it, (2010)

[6] G. Rhodes, "Using Rubber Tubing to Demonstrate DNA Supercoiling and the Action of Topoisomerases", Springer-Verlag, (1997)