Novel string field theory, Interactions Fake, p-adic Generalization(s)

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H.B. Nielsen presents the talk.

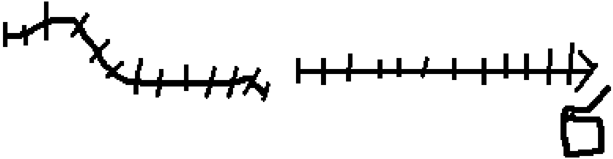
Abstract for Novel String Field Theory Interaction Fake, p-adic generalization

We have constructed a new formalism for describing a situation with several (dual) strings present at a time, a string field theory, by means of a constituent / a strings from a bits picture similar to, but importantly different from the “bits” by Charles Thorn. Ninomiya’s and mine ”objects” (essentially the bits) represent a latticification in the light cone varibles on the string rather. The remarkable feature and simplicity of our formalism is that the ”objects” do NOT interact, basically just run or sit trivially fixed. Scattering is a fake in our formalism.

Abstract for Novel String Field Theory Interaction Fake, p-adic generalization(continued)

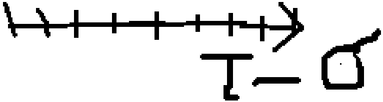
The actual non-interaction feature of our "Novel String Field Theory" puts string theory in the perspective of being a mathematical construction on top of a rather trivial quantum field theory with non-interacting 'objects"(=bits). This opens also up for hoping for generalizations inspired by hadrons with their partons all having all Bjorken $x = 0$, and thus infinitely many constituents. The p-adic string is an example.

Charles Thorn:

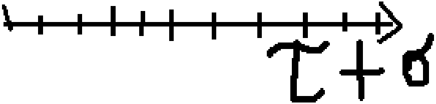


Ninomiya and I:

For $\dot{X}_R$:



For $\dot{X}_L$:



Major Achievement Anti-suggests putting it into Bits:

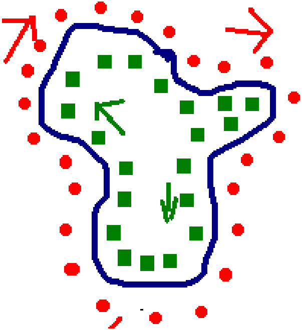
The most important gain of (super)string theory over ordinary quantum field theories as a theory of everything is:
QFT= Quantum field theories ONLY become non-divergent BY RENOMALIZATION; while the (even made a string field theory) STRING theory gives FINITE NUMBERS FROM THE START - Veneziano models.

The Wonderful Finiteeness of (Super)String-theory gets Spoiled, If Replaced by a Quantum Field Theory of "bits" (unless the bits are not normal particles)

- Thorns In Thorns the bit (= constituents) do interact, but in quite different way from ordinary quantum field theory particles.
- Ninomiya-Nielsen In ours it turs out that the "objects" (which is the name we use for our bits) do NOT interact. So the perturbation with the usual divergencies does not come up.

Overview Ignoring Tecnical Details:

Closed String : Two cyclically ordered sets of objects (~ bits),



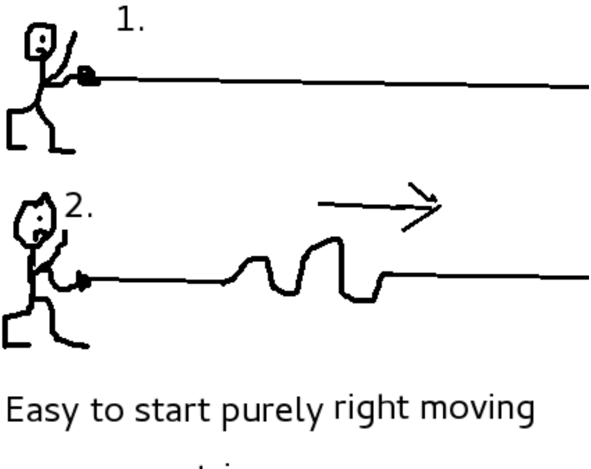
Notice Two objects to Each bit of String in Charles Thorns Sense

This "TWO OBJECTS at each point of the string" is to correspond to the wellknown formula for single string dynamics in the conformal gauge:

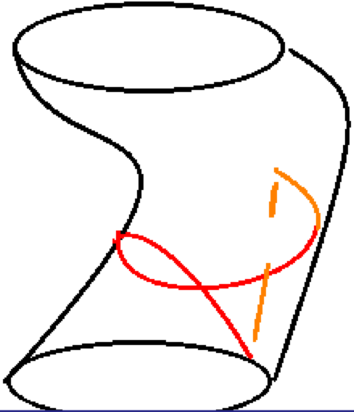
$$X^{\mu}(\sigma,\tau) = X^{\mu}_{R}(\tau-\sigma) + X^{\mu}_{L}(\tau+\sigma). \quad (1)$$

This means that the position and momentum of the string-bit sitting at a pair of objects - a rightmover and a left mover object - is given as the sum of the two object momenta and positions. This means that the objects, if they are considered to be anywhere at all, are at quite different places from the string itself, or the points they correspond to. Completely antiintuitive for constituents.

Think of Right- and Left mover as distingt degrees of freedom...?



A little Problem that say $X_R(\tau - \sigma)$ not periodic in $\tau - \sigma$ but only in σ.



Technical problem, because X_R^μ and X_L^μ not periodic:

We have to either:

- Declair that looking at these right mover and left mover variables X_L^μ and X_R^μ for the "objects" as *global* functions of $\tau + \sigma$ and $\tau - \sigma$ respectively is supposed to lead to ambiguities, so that we only care for local functions in the sense of only letting them be defined on smaller intervals. only piecewise functions.
- Or we identify only the derivatives of X_L^μ and X_R^μ, i.e.

$$\begin{aligned} J_R^\mu(I) &= X_R^\mu(\text{``}\tau - \sigma\text{''}(I) + \Delta/2) - X_R^\mu(\text{``}\tau - \sigma\text{''}(I) - \Delta/2) \\ J_L^\mu(I) &= X_L^\mu(\text{``}\tau - \sigma\text{''}(I) + \Delta/2) - X_L^\mu(\text{``}\tau - \sigma\text{''}(I) - \Delta/2) \\ \text{Here } I &= \ldots, -2, -1, 0, 1, 2 \ldots. \\ \text{and } \Delta &= \text{``}object/bit\text{''}\, distance. \end{aligned}$$

Want to Arrange: Each "object" a Full Physical System (a set of variables and their cononically conjugate)

But have in mind:
The right and left mover variables $\dot{X}_L^\mu$ and $\dot{X}_R^\mu$ have in string theory a derivative of delta function commutation rule with themselves:

$$\left[\dot{X}_L^\mu(\tau_{L1}), \dot{X}_L^\nu(\tau_{L2})\right] = -ig^{\mu\nu}\delta'(\tau_{L1}-\tau_{L2})$$
$$\left[\dot{X}_R^\mu(\tau_{R1}), \dot{X}_R^\nu(\tau_{R2})\right] = -ig^{\mu\nu}\delta'(\tau_{R1}-\tau_{R2})$$

where

$$\tau_R = \tau - \sigma$$
$$\tau_L = \tau + \sigma$$

So one object would at first not commute with its neighbors. ?

We move the Information on Oddly Numbered Objects to Neighboring Evenly Numbered Ones to make up Conjugate Variable to say $\dot{X}_R(I)$.

We found a way to achieve the following wishes before identifying (half) the objects with particles in a second quantized field theory. Think of at first having the objects be described just by $X_R(I)$ and $X_L(I)$, then modify them somehow to achieve:

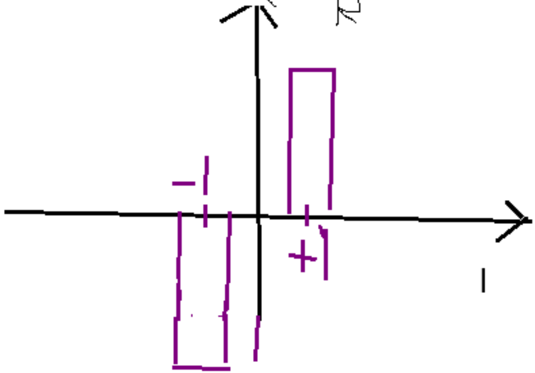
- Those objects, which we end up keeping in the formalism, shall if associated with one variable also be associated with its canonically conjugate one together with it. Objects have full sets of degrees of freedom.
- All variables associated with one object shall commute with those associated with an other object. Different objects commute.

Wishes about to Copnstruct Object-degrees of freedom:

- We select a subset of objects still so that all information in $X_R(\tau_R)$ is modulo the discretization in the "kept" "objects". The kept right objects carry all the right mover information; and the left carry the left mover information.

The Commutator of the $\dot{X}_R(l)$ of the δ' form.

Discretized $\delta'(\tau_R)$:



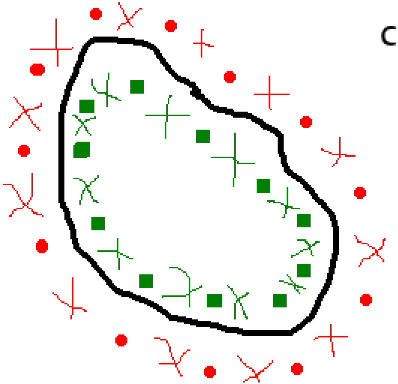
As function of integers it is only non-zero for l = +/-1.

Because the $\delta'(\tau_R)$ discretizes to a function only non-zero in two neighbtoring points to zero, we could achieve full commutation by leaving out all objects with an odd number.

So we shall seek to put in all information from X_R or from $\dot{X}_R$ in to only the even numbered objects. But the odd ones are essentially the conjugate conjugate of the even ones. In fact we can and shall choose the odd objects to be written as differences of the conjugate variables for the even neighbors.

Closed string described by two

chains.



We treat EVEN and ODDly numbered ``objects" in the cyclically ordered chains differently !

We achieve the wishes by the following ansatz:

We define for each *even numbered* (I even) object a variable set $J_R^\mu(I)$ and the cononically conjugate set $\Pi_R^\mu(I)$ (here leaving out a quite analogous left set with L instead of R). We call Δ or a the discretization step:

$$\begin{aligned} J_R^\mu(I) &= \dot{X}_R^\mu(I)\Delta = \\ = X_R^\mu(\tau_R(I+1/2) - X_R^\mu(\tau_R(I-1/2) & \quad \text{(for } I \text{ even);} \\ -\pi\Delta * (\Pi_R^\mu(I+1) - \Pi_R^\mu(I-1)) &= \dot{X}_R^\mu(I)\Delta = \\ = X_R^\mu(\tau_R(I+1/2) - X_R^\mu(\tau_R(I-1/2) & \quad \text{(for } I \text{ odd)} \end{aligned} \tag{2}$$

Note: We only use $\Pi_R^\mu(I)$ and $J_R^\mu(I)$ here for *EVEN I*.

We got a way to put the information of a free closed string solution of equations of motion into that two sets of (infinite) numbers of "even objects" with their $(J^{\mu}_{R}(I), \Pi^{\mu}_{R}(I))$ $(I = ..., -4, -2, 0, 2, 4, ...)$.

Summary: Can describe **one** closed string by two sets, R and L, of cyclically ordered "even numbered objects".
Each "object" (a bit taken after the splitting in $X_R + X_L$) has in the bosonic string theory one degree of freedom - a $J^{\mu}_{R}(I)$ and the canonically conjugate $\Pi^{\mu}_{R}(I)$ one - for each of the 25+1 dimensions. (modulo some troubles with gauge choosing ...)

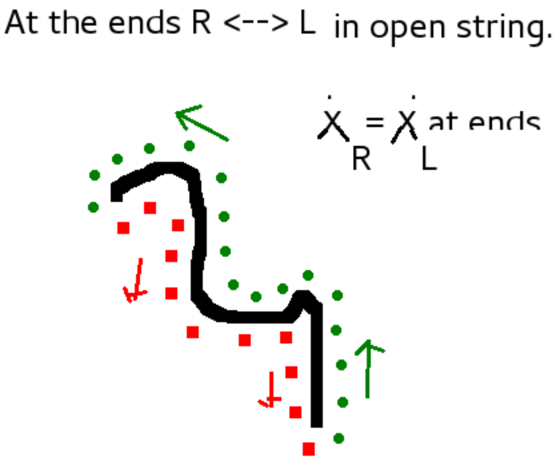
Main Point: Second Quantize the Objects; and There can be Many Strings in the Same Quantum Field Theory

- First describing **one** string you let i correspond to a quantum field theory in which you have the two cyclically ordered chains of "objects" (= the particles in the quantum field theory (with massless non-interacting particles)).
- This gives the obvious idea to describe several strings, namely by just putting more couples of cyclically ordered chains up in the same quantum field theory Hilbert space(s). i.e. you got a "string field theory" (= second quantized string theory like Kaku and Kikkawa or Witten...) for free!
- Except what about string-interactions ?

Scattering of Strings is a Fake.

We mannaged - though with some technical difficulties - to obtain string scattering as a fake, meaning that the objects themselves does **not** do anything during the scattering, but we/the physicists reclassify the objects into **new cyclically ordered chains**, and then we have a formal scattering, although in the physics of our model for non-interacting "objects" nothing can happen.

In String Theories with Open Strings Only One type of "Objects"; while only closed have R and L.



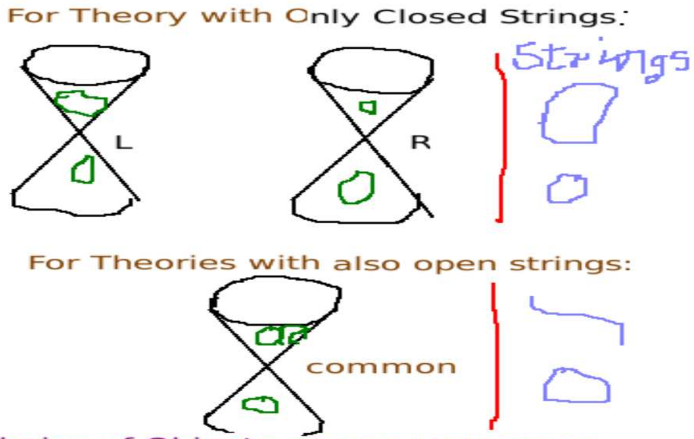
The Constraints $\dot{X}^2 + (X')^2 \approx 0$ and $\dot{X} \cdot X' \approx 0$ look nice in "objects".

The usual constraints that $\dot{X}^2 + (X')^2$ and $\dot{X} \cdot X'$ should be "weakly" 0 take a nice form in the variables used for our "objects":

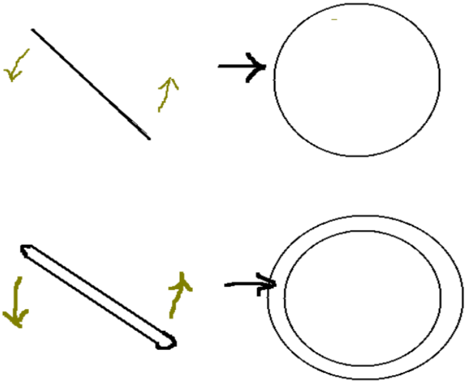
$$\begin{aligned} \dot{X}_R^2 &= \left(\dot{X}_R^\mu\right)^2 \approx 0 \\ \dot{X}_L^2 &= \left(\dot{X}_L^\mu\right)^2 \approx 0 \end{aligned} \quad (3)$$

Here we used $\approx$ to denote the "weak" equality.

Detail of Open Versus Closed Strings in Our Model



Translation from strings to ``Cyclic Chains"



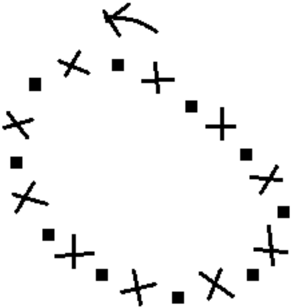
Note: Stringiness (one-dimensionaly touching of objects) is put in via the States of the Objects Used

Our “String Field Theory” model is basically the second quantized theory of the - by the constraints $\dot{X}^2 + (X')^2 \approx 0$ and $\dot{X} \cdot X' \approx 0$ - massless objects, behaving and described as particles (best in a timeless universe).

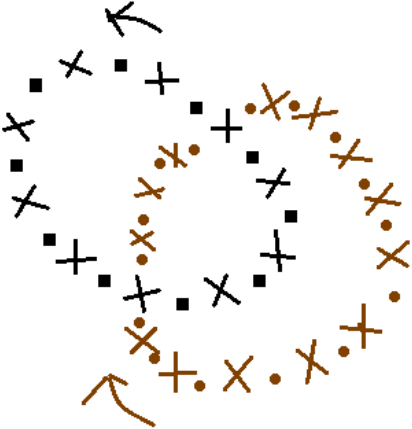
In that model, a quantum field theory of just non-interacting massless particles, there is no stringiness at all! It is only by the (initial) states of the objects **considered** that there is any allusion to the hanging together to one-dimensional chains. Something that at the edn leads to the stringy hanging together.

The string is in the initial - and also final conditions we need - conditions only!

A single Open String is described by just one Cyclically ordered chain of "even objects":



Now Add One more Open String described also as a Cyclically Oredered Chain of Objects.

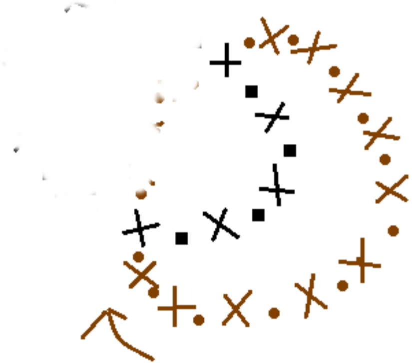


If the two cyclically ordered chains cross in two places, we can interprete it as corresponding to two open strings in different ways.

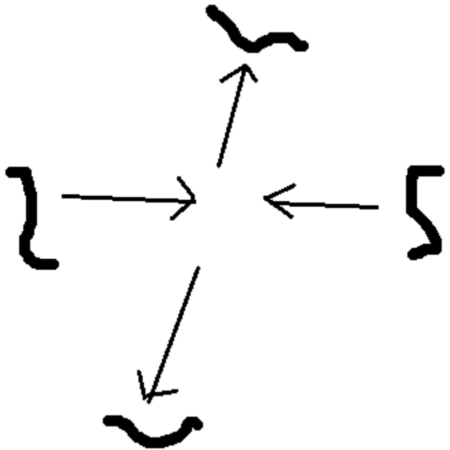
The idea of "faked scattering" now is that we split the combined sets of the two cyclically ordered chains into a couple of cyclically ordered chains in a new way! We take part of the chain corresponding to the first of the two initial strings and combine it with a part of the one that corresponds to the second string.

Find on the Foregoing Figure this Cyclically Oredered Chain → an Open String

The Rest of the Objects also form a Cyclically ordered chain menaning it gives a String.



Without Anything happening except in Phantasy two strings scattered to two other strings!

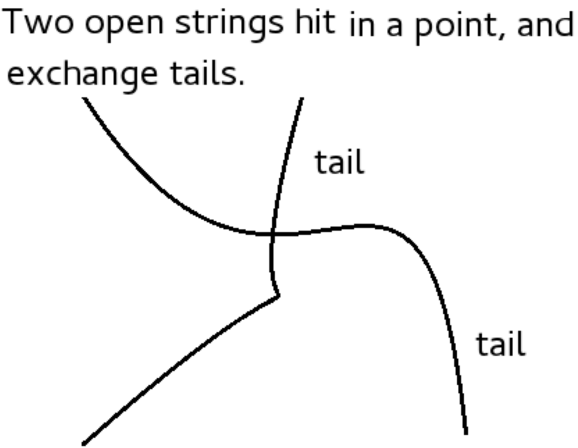


In principle we rewrote String Theory, but still would like to check if it is true.

To argue that our string-field-theory really is correct, one would first see that essentially from locallity one can see that indeed the system of "objects" will **not** change in a true scattering of dual strings.

Think say of a couple of strings scattering classically by "exchange of tails". Then the image of the $\dot{X}_R^\mu$ will only change on a nulset.

By locallity one argued the image of the $\dot{X}^{\mu}_{R/L}$ remain the same (mod nulset)



We calculated:

- Spectrum of a string using our String Field Theory Model.
- The (“faked”) scattering amplitude, expecting to get the Veneziano model; but got only one out of three terms in the infinite momentum frame gauge choise.
- Including the possibility of negative energies for the constituents(objects) - like in Nambu-Bethe-Salpeter equation - we at least glimps a way to get all three terms.

The Veneziano Model Derivation Quickly comes to Technical String Calculation:

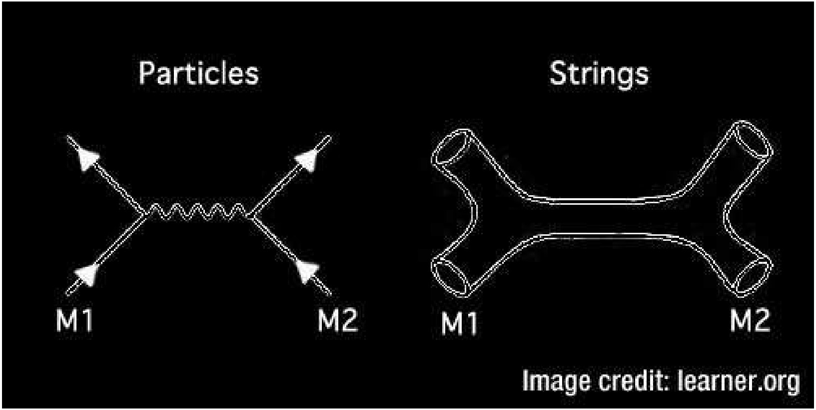
In spite of that our model being only a quantum field theory formalism having no stringiness proper in itself, but only in initial and final state input, the derivation of the Veneziano model from our model quickly goes into the track of string theory:

- We begin the calculation by representing the external string by wave functions in terms of "objects" being derived from a functional integral through an imagine time.
- Next we must take the overlap between the inital state - of some strings giving some cyclically ordered chains - and the final state.
- This leads to gluing together the space-time or rather (τ, σ) regions from the various imaginary time developments.

Contnuing Sketch of Veneziano-model derivation

- The glued together regions for definition of the functios over which to functionally integrate leads to complex surfaces which becomes just like the corresponding functional integral regions in usual string theory.
- The counting of the various ways to identify the systems of objects in initial and final states leads to precise integration measures for the Veneziano model integrals.

The "usual surfaces" in string theory.



The basic second quantized Hilbert space for our string field theory is only particle second quantized space $\mathcal{H}$.

On this ordinary particle free second quantized Hilbert space $\mathcal{H}$ one can create particles (free and massless) with creation operators denoted $a^\dagger(J^\mu)$, where we can think of the 26-vector J^μ (which is the main variable for one of our objects/bits) as say the 26-momentum (really we may only need 24 components in infinite momentum frame) for the free massless particle that can be created in our basic model.

Formulation of Second quantized "strings"

- The string states are created by acting on this space $\mathcal{H}$ with an in the limit infinite number of creation operators $a^\dagger(J^\mu)$ associated withe a series J^μ-values (26-vectors) as taken on by the "bits" of our type (="objects") and weighted with a wave function $\Psi(J_0^\mu, J_2^\mu, ..., J_{N-4}^\mu, J_{N-2}^\mu)$ for a single string described as consisting of a cyclically ordered chain of even numbered "objects":

$$
\begin{aligned}
& |string_\Psi >= \\
= \quad & \int \cdots \int \mathcal{D} J^\mu * \\
& *\Psi(J_0^\mu, J_2^\mu, ..., J_{N-4}^\mu, J_{N-2}^\mu) * \\
& *a^\dagger(J_0^\mu) a^\dagger(J_2^\mu) \cdots a^\dagger(J_{N-4}^\mu) a^\dagger(J_{N-2}^\mu) |``vac'' > .
\end{aligned}
$$

The state $|``vac'' > \in \mathcal{H}$ is a priori the empty state, meaning without any of the scalar free particles ($\sim$ our objects).

Really the vacuum $|``vac'' >$ should be Rough

We ran into troubles of only obtaining one out of three Euler Beta-functions for the scattering amplitude by using infinite momentum naturally combined with such a no particle vacuum used for $|``vac'' >$. This problem is supposed to be cured by a more complicated vacuum state (the rough Dirac sea), so that one can both add and subtract energy to the back ground state $|``vac'' >$ used.

Crux: We can make many string states trivially:

A single string creation operator in our scheme in terms of object-creation operators $a^\dagger(J^{mu})$ has the form

$$
\begin{aligned}
& string_\Psi = \\
= & \int \cdots \int \mathcal{D} J^\mu * \\
& *\Psi(J_0^\mu, J_2^\mu, ..., J_{N-4}^\mu, J_{N-2}^\mu) * \\
& *a^\dagger(J_0^\mu) a^\dagger(J_2^\mu) \cdots a^\dagger(J_{N-4}^\mu) a^\dagger(J_{N-2}^\mu).
\end{aligned}
$$

With that we can simple make a several string state by acting with several of these operators on a vacuum $|``vac'' >$:

$$
\begin{aligned}
& |1, 2, ..., n >= \quad (4) \\
= \quad & string_1^\dagger string_2^\dagger \cdots string_n^\dagger |``vac'' > \quad (5)
\end{aligned}
$$

Got Veneziano model from Fake scattering!

When we used infinite momentum frame (for gauge choise) we got, but interestingly enough only quite right for 25+1 dimensions, (for our bosonic string constituent SFT) for the scattering amplitude $A(s,t,u)$:

$$\begin{aligned} A(s,t,u) &= C * B(-\alpha(t), -\alpha(u)) \\ \text{where e. g. } \alpha(t) &= \alpha(0) + \alpha' * t \\ \text{and } \alpha(0) &= -(-1/\alpha') = 1/\alpha' \end{aligned}$$

We did not determine the overall coefficient C in the mentioned calculation.

Perspective: String theory a mathematical construction on a free quantum field theory (for massless particles)

Remarkable with our non-interacting consituents (=objects= our string bits) string field theory model:

- The basic SFT Hilbert space is just that of free massless **particles** and carries no signal of strings a priori in it. Rather **the strings come in only via the bits or objects being inserted in** (quantum fluctuating)**chains**!
- **Nothing happens to bits**(objects) under the scattering! It is **only**, that one has a **non-zero overlap between the object state corresponding to the strings in the "incomming" state of strings and in the "outgoing" one!** Rather as if the strings are just a clever($\sim$ **artificial**) construction in a fundamental world, most naturally interpreted as a particle theory

Generalization of non-interacting constituent idea

Let us suppose we **seek a theory that is finite** by looking e.g. at hadrons with their **rapidly falling off** amplitude for **large** transverse **momenta**.
If they really **fell off** exponentially they would in loops give rise to **convergent loop** corrections and there would be **no** ultravciolet **divergence propblem**; **but** we now know that the hadrons contain **partons** and because of that emit **less strongly falling off** particles (hadrons).
But if all the partons had Bjorken $x = 0$, then there would be no energy for the partons to scatter on each other and the exponential fall off would be preserved!

The Veneziano model soft/exponentil cut off in say $p_{transverse}$ come in our object-picture from the wave function of the string in terms of consituents.

Since the main thing - to get soft cut off to **avoid divergences** hopefully - comes from the wave function of the “string” in terms of our objects(=bits, but in X_R and X_L seperately), we could replace the ‘string” by thought upon structure provided we take its internal **wave function** in terms of the objects to **fall off** exponentially (as Gaussians)

"p-Adic, Adelic and Zeta Strings" Branko Dragovich, Institute of Physics, P.O. Box 57, 11001 Belgrade, SERBIA
The p-adic Veneziano amplitude $A_p(-\alpha(s), -\alpha(t), -\alpha(u))$(with all three terms):

$$A_p(-\alpha(s), -\alpha(t), -\alpha(u)) = g_p^2 \int_{\mathbf{Q}_p} |x|_p^{-\alpha(s)-1} |1-x|_p^{-\alpha(t)-1} d_p x$$

where p is a prime number, and $\mathbf{Q}_p$ the field obtained by ccompleting the field $\mathbf{Q}$ of rational mubers in the p-adic metric, which for a rationel $x \in \mathbf{Q}$ is defined as

$$\begin{aligned} |x|_p &= p^{-\nu_p(x)} \text{ for } x \neq 0 \\ \text{while we define:} |x|_p &= 0 \text{ for} x = 0 \end{aligned}$$

and extended by the completion.

p-adic integers Z_p and field Q_p.

- For any rational number $n/d \in \mathbf{Q}$ and any prime p define the p-adic order (or p-adic valuation)

$$\nu_p(n/d) \quad = \quad \nu_p(n) - \nu_p(d)$$

where for integers

$$\tag{6}$$

$$\nu_p(n) = \begin{cases} \{max\{v : \text{where } p^v|n\} \text{ if } n \neq 0 \\ \infty \text{ if } n = 0 \end{cases} \tag{7}$$

- Define a norm

$$|x| = p^{-\nu_p(x)}, \tag{8}$$

first for $x \in \mathbf{Q}$ but then by completion to the completion of $\mathbf{Q}$ in this $|x|$ used as norm.

The measure $\int ...d_p x$ to be used.

Theorem : There exists a unique Haar measure $\mu = \int ...d_p x$ on $\mathbf{Q}_p$ such that $\mu(\mathbf{Z}_p) = \int_{\mathbf{Z}_p} d_p x = 1$. If ν is a Haar measure on $\mathbf{Q}_p$, then there exists $c > 0$ such that $\nu = c\mu$.

That μ is a Haar measure means that the measure of a (measurable) subset $S \subset \mathbf{Q}_p$, $\mu(S) = \mu(S + a)$ for any $a \in \mathbf{Q}_p$.

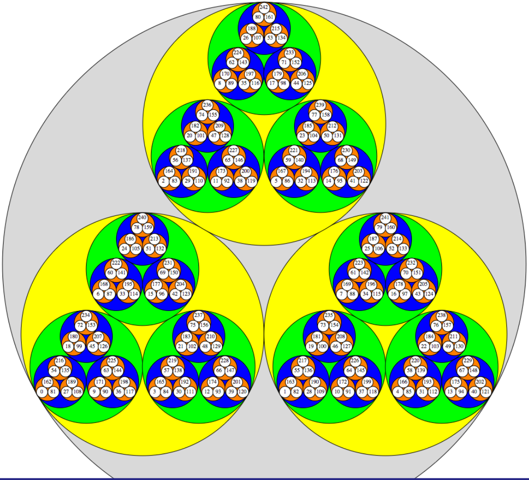
A single of the three Euler Beta-function Veneziano model contributions

The p-adic B-function of $(-\alpha(s), -\alpha(t))$

$$\begin{aligned} B(-\alpha(s), -\alpha(t)) &= g_p^2 \int_{\mathbf{Z}_p} |x|_p^{-\alpha(s)-1} |1-x|_p^{-\alpha(t)-1} d_p x \\ &= g_p\left(\frac{1}{1-p^{\alpha(s)}} + \frac{1}{1-p^{\alpha(t)}} - 1\right) \\ &= g_p^2 \frac{1-p^{\alpha(s)+\alpha(t)}}{(1-p^{\alpha(s)})(1-p^{\alpha(t)})} \\ &= g_p^2 \frac{1-p^{-\alpha(u)+1}}{(1-p^{\alpha(s)})(1-p^{\alpha(t)})} \end{aligned}$$

where we used the kinematical relation $\alpha(s) + \alpha(t) + \alpha(u) = -1$.

Metric arrangement of p-adic integer completion Z_3 for $p = 3$.

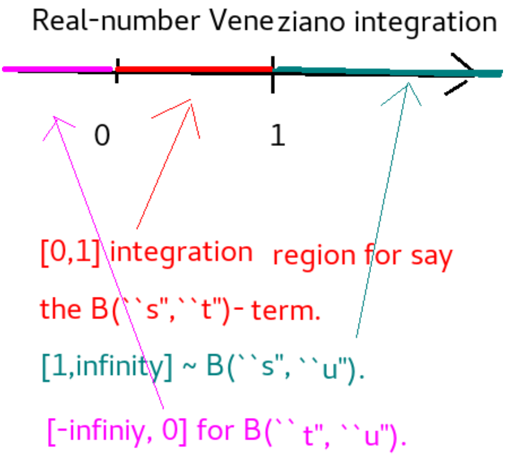


Base the proposal for wave function on the metric in p-adic integer completion Z_p (Gaussian correlations, strongest between nearest in p-adic $|x-y|_p$

We propose to replace our cyclically ordered chain of (even) "objects" to be replaced in the p-adic theory by the completion of the p-adic integers $\mathbf{Z}_p$ - which for p=3 looks like the picture with triangles in the corners of triangles in the corners of triangles ...

Really such "p-adic" reminiscent structure is not at all an unrealistic speculaton for a bound state of some objects.
Have in mind that the **number of elements in the completion of the p-adic integers$\mathbf{Z}_p$** has the **same** cardinal number as the **real** numbers.
Scattering shall go by exchange of parts of such completion set of p-adic integers.

The three B-functions from three intervals



p-adic (completion of) integers Z_p analogous $[0,1]$ integration region.

In the p-adic length/distance/norm

$$|x|_p = p^{-\nu_p(x)}; \nu_p(x) = \text{"number of p facors dividing into } x\text{"}$$

the completion $\mathbf{Z}_p$ of the integers $\mathbf{Z}$ in $\mathbf{Q}$ reminds of the real number interval $[0,1]$ by

$$\begin{aligned} \mathbf{Z}_p &= \{x|\ |x|_p \leq 1\} = \\ &= \{x|\ |1-x|_p \leq 1\} = \\ &= \{x|\ |x|_p \leq 1, \text{ and } |1-x|_p \leq 1\} \end{aligned} \tag{9}$$

Have in mind $|1-0|_p = |1|_p = 1$.

The p-adic Veneziano amplitude becomes ordinary powers

$$
\begin{aligned}
& A_p(-\alpha(s), -\alpha(t), -\alpha(u)) = \\
= \quad & g_p^2 \int_{\mathbf{Q}_p} |x|_p^{-\alpha(s)-1} |1-x|_p^{-\alpha(t)-1} d_p x \\
= \quad & g_p^2 \frac{1-p^{-\alpha(s)-1}}{1-p^{\alpha(s)}} * \frac{1-p^{-\alpha(t)-1}}{1-p^{\alpha(t)}} * \frac{1-p^{-\alpha(u)-1}}{1-p^{\alpha(u)}}
\end{aligned}
$$

Conclusion

We have presented a "novel string field theory" or perhaps better to say "A solution of Several-strings-string-theory":

- Our model is string-bit-theory deviating in important way from Charles Thorns one.
- It is a string field theory in the sense of describing possibly an arbitrary number of strings. But it is very different in the spirit of the formalism from usual string fild theories, such as Kaku and Kikkawa or Wittens string field theories.

Conclusion (continued)

- Our formulation can be considered a **solution** of string theory, in the sense that there is no more timedevelopment left in our object formulation, meaning that we solved the equations of motion.
- All the time development is **fake** especially the **scattering**.
- There is so little "string" in basic formulation only being a massless second quantized particle, that one would say: The string is a mathematical construction from rather trivial starting formalism.

Conclusion on Generalization to other Finite theories (hope)

Concerning the general looking for fite and therefore meaaningfull potential theories for all of physics:

- By analogy with a hadronic bound state, we argued that the ultraviolet causing high (transverse) momenta should be avoided by making the **Bjorken** x **for all constituent zero!** (then there would even be no enrgy for the partons to scatter at all.
- A model with only zero Bjorken $x = 0$ of course would need an infinite number of constituents (since the Bjorken x's must add up to unity.
- The string can with our objects=nits be considered such an infinite nummber of constituents model.

Conclusion on Generalization continued.

- Could one generalize the string to another pattern for the constituents (than our cyclically ordered sets the doubled strings ?
- The p-adic string the obvious candidate for such generalization.

$\epsilon\upsilon\xi\alpha\rho\iota\sigma\tau\omega$

Technical Resume Conclusion.

- The basic formalism is a massless quantum field theory without interactions.
- These particles are called “even objects” and are identified with the even numbered constituents/string-bits, when one first discretize the string after having divided it into right mover and left mover d.o.f.

Novel String Field Theory Solving String Theory Liberating Left and Right Movers

Work by :

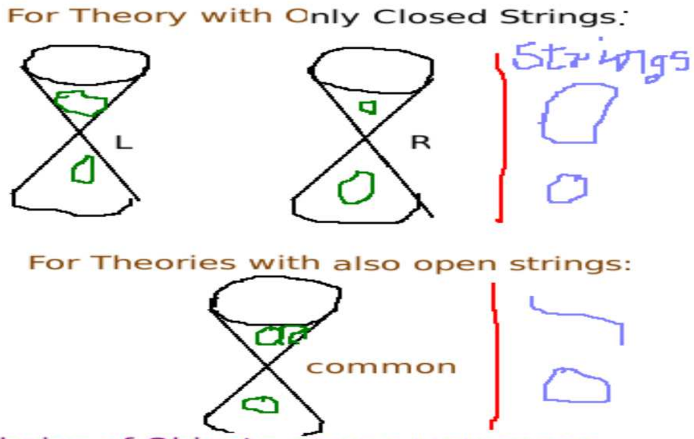
Holger Bech Nielsen

Masao Ninomiya

Main Points to Remember:

- We develop a formalism for description of an arbitrary number of strings (String Field Theory) by means of a Hilbert space formally with ``objects'' that are more like particles ( they are ``bits'' in a technically a little different way from Thorns).
- In terms of our ``objects'' (~ bits) the second quantized string world get totally **static, scattering becomes a fake, the scattering amplitude becomes just the overlap of the initial with final state!**
- In terminology of ``layers of degree of existence'' the **scattering does not belong to the layer of truly existing.**
- We get after some technical trouble the S-matrix = the overlap between initial and final string state to be the Veneziano amplitude, **but with the little need...**
- **That the objects must be able to have energy of both signs.**
- So one piece of a cyclic chain can **cancel another piece completely!**
- And thus pairs of compensating pieces of chains of objects may be **phantazised where-ever it may be.**
- `String'' comes ONLY in via the initial (and final state) conditions.

Detail of Open Versus Closed Strings in Our Model



Translation from strings to ``Cyclic Chains”

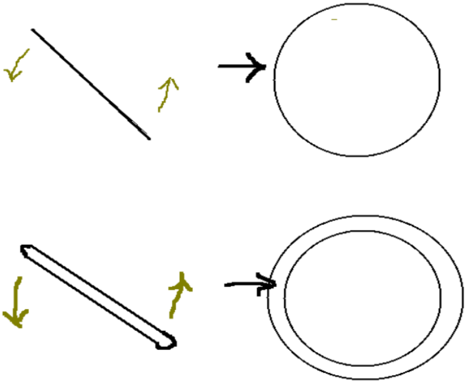
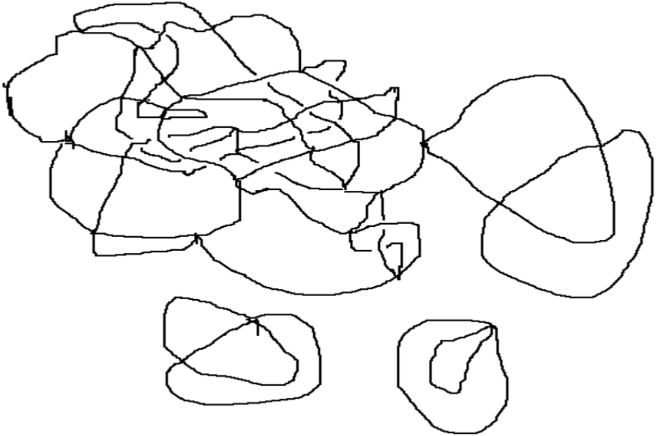
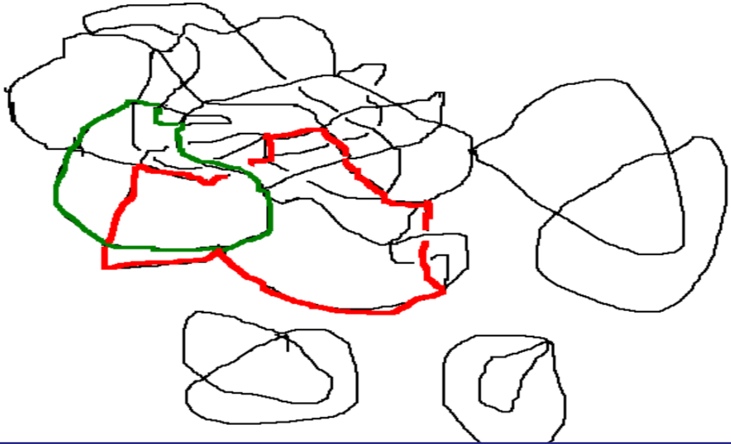


Image of all left and right mover X-derivatives for all strings:

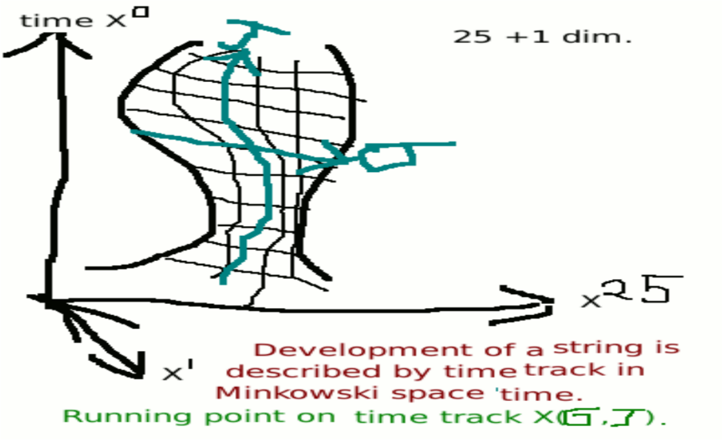


We Add one more – now red – Open string Contribution, a Cyclic Chain

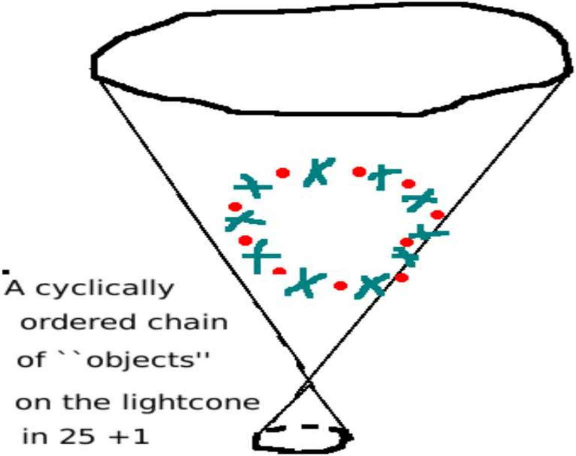


Whole Universe is Described by a Set of Strings in String (Field) Theory

Single String Description by Parametrized Surface in Minkowski Space

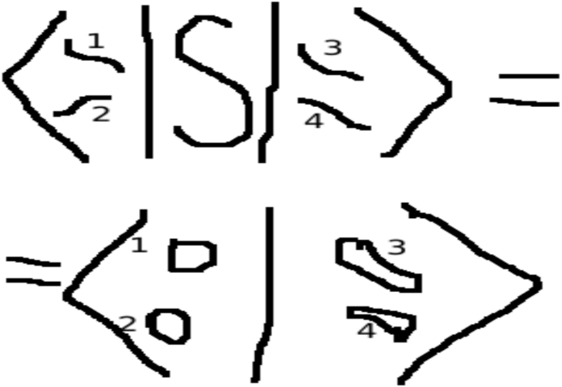


Picture of Chain of ``objects''

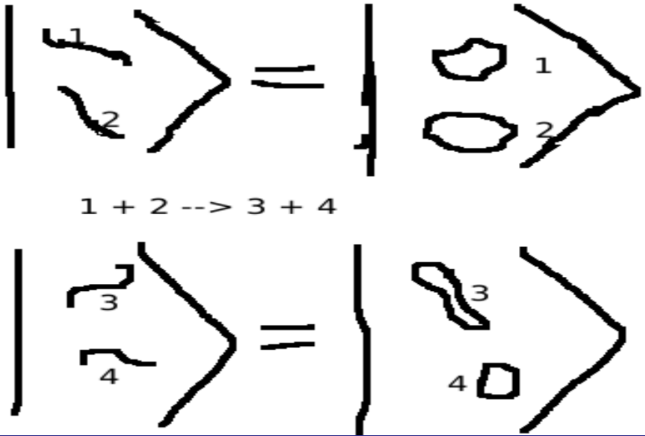


Our S-matrix is just overlap of states in our ``object'' describing (Fock) space

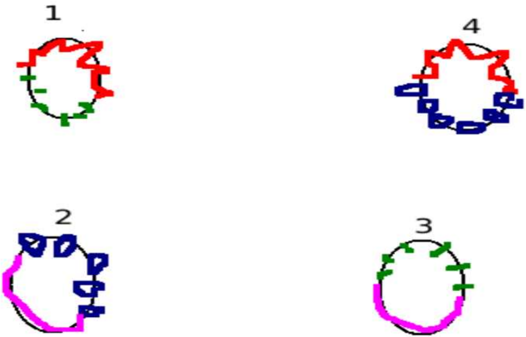
Calculate as if S-matrix were 1:



Representing states of several strings as cyclic chains of objects



Identifying ``Objects'' in Initial and Final Possibility



How different pieces of cyclically ordered chains of objects may get exchanged.