Looking For the Classical (2,0)-Theory

Christian Sämann

School of Mathematical and Computer Sciences
Heriot-Watt University, Edinburgh

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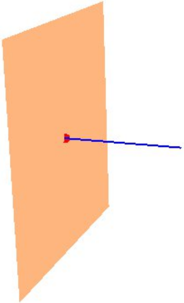
Based on work w. S Palmer, G Demessie, B Jurčo, M Wolf, P Ritter, L Schmidt:

- Higher Gauge Theory: 1203.5757, 1308.2622, 1311.1977, 1406.5342, 1512.07554, 1602.03441, 1604.?????
- Integrability: 1105.3904, 1205.3108, 1305.4870, 1312.5644, 1403.7185

Motivation: The Dynamics of Multiple M5-Branes

To understand M-theory, an effective description of M5-branes would be very useful.

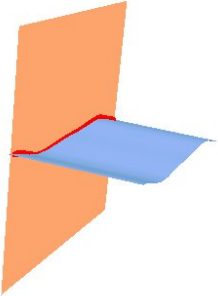


D-branes

- D-branes interact via strings.
- Effective description: theory of endpoints
- Parallel transport of these: Gauge theory
- Study string theory via gauge theory

M5-branes

- M5-branes interact via M2-branes.
- Eff. description: theory of self-dual strings
- Parallel transport: Higher gauge theory
- Can we study M-theory via HGT?



What we know

Multiple M5-branes are described by a $\mathcal{N} = (2,0)$ superconformal field theory.

What we know:

- String theory considerations: conformal fixed point in 6d
  Witten, Strominger 1995
- Field content: $\mathcal{N} = (2,0)$ supermultiplet in 6d:
  - a self-dual 3-form field strength
  - five (Goldstone) scalars
  - fermionic partners
- A theory of essentially tensionless light strings
- Supergravity decouples, so study string dynamics separately
- Observables: Wilson surfaces, i.e. parallel transport of strings
- No Lagrangian description known
- As important as $\mathcal{N} = 4$ super Yang-Mills for string theory
- Huge interest in string theory: AGT, AdS$_7$-CFT$_6$, S-duality, ...
- Mathematics: Geom. Langlands, Khovanov Homology, ...

Parallel Transport of Strings is Problematic

The lack of surface ordering renders a parallel transport of strings problematic.

Parallel transport of particles in representation of gauge group G:

- holonomy functor hol : path $\gamma \mapsto \mathsf{hol}(\gamma) \in \mathsf{G}$
- $\mathsf{hol}(\gamma) = P\exp(\int_\gamma A)$, P: path ordering, trivial for $\mathsf{U}(1)$.

Parallel transport of strings with gauge group $\mathsf{U}(1)$:

- map hol : surface $\sigma \mapsto \mathsf{hol}(\sigma) \in \mathsf{U}(1)$
- $\mathsf{hol}(\sigma) = \exp(\int_\sigma B)$, B: connective structure on gerbe.

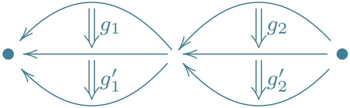
Nonabelian case:

- much more involved!
- no straightforward definition of surface ordering

Naïve no-go theorem

Naively, there is no non-abelian parallel transport of strings.

Imagine parallel transport of string with gauge degrees in Lie(G):



Consistency of parallel transport requires:

$$(g_1' g_2')(g_1 g_2) = (g_1' g_1)(g_2' g_2)$$

This renders group G abelian.

Eckmann and Hilton, 1962
Physicists 80'ies and 90'ies

Way out: 2-categories, Higher Gauge Theory.

Two operations $\circ$ and $\otimes$ satisfying Interchange Law:

$$(g_1' \otimes g_2') \circ (g_1 \otimes g_2) = (g_1' \circ g_1) \otimes (g_2' \circ g_2) \ .$$

Objection to a classical (2,0)-theory

Without coupling constant, there shouldn't be classical effective descriptions in M-theory.

Standard objection beyond the previous no-go theorem:

- theory at conformal fixed points ⇒ no dimensionful parameter
- fixed points are isolated ⇒ no dimensionless parameter
- "No parameters ⇒ no classical limit ⇒ no Lagrangian."

Answers:

- Same arguments for M2-brane Schwarz, 2004
- There, integer parameters arose from orbifold $\mathbb{R}^8/\mathbb{Z}_k$
- Same should happen for M5-branes
- Even if no Lagrangian, BPS-states may exist classically
- Even if not, study quantum features of related theories.

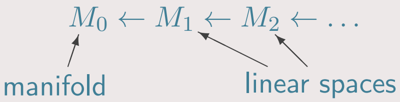
4-Slide Crash Course on Higher Gauge Theory

Fastest Route to Higher Gauge Theory

One easily constructs local higher gauge theory using NQ-manifolds.

N-manifolds, NQ-manifold

- $\mathbb{N}$-graded manifold with coordinates of degree $0, 1, 2, \dots$



$$M_0 \leftarrow M_1 \leftarrow M_2 \leftarrow \dots$$

manifold

linear spaces

- Morphisms $\phi : M \to N$ are maps $\phi^* : \mathcal{C}^\infty(N) \to \mathcal{C}^\infty(M)$
- NQ-manifold: vector field Q of degree 1, $Q^2 = 0$
- Physicists: think ghost numbers, BRST charge, SFT

Examples:

- Tangent algebroid $T[1]M$, $\mathcal{C}^\infty(T[1]M) \cong \Omega^\bullet(M)$, $Q = \mathrm{d}$
- Lie algebra $\mathfrak{g}[1]$, coordinates ξ^a of degree 1:

$$Q = -\tfrac{1}{2} f^c_{ab} \xi^a \xi^b \frac{\partial}{\partial \xi^c}$$

Condition $Q^2 = 0$ is equivalent to Jacobi identity for f^c_{ab}

L_∞-Algebras, Lie 2-Algebras

NQ-manifolds provide an easy definition of L_∞-algebras.

Lie n-algebroid or n-term L_∞-algebroid:

$$M_0 \leftarrow M_1 \leftarrow M_2 \leftarrow \ldots \leftarrow M_n \leftarrow * \leftarrow * \leftarrow \ldots$$

Lie n-algebra, n-term L_∞-algebra or Lie n-algebra:

$$* \leftarrow M_1 \leftarrow M_2 \leftarrow \ldots \leftarrow M_n \leftarrow * \leftarrow * \leftarrow \ldots$$

Example: Lie 2-algebra

- NQ-manifold: $* \leftarrow W[1] \leftarrow V[2] \leftarrow * \leftarrow \ldots$, coords. w^a, v^i
- Homological vector field:

$$Q = -m_i^a v^i \frac{\partial}{\partial w^a} - \tfrac{1}{2} m_{ab}^c w^a w^b \frac{\partial}{\partial w^c} - m_{ai}^j w^a v^i \frac{\partial}{\partial v^j} - \tfrac{1}{3!} m_{abc}^i w^a w^b w^c \frac{\partial}{\partial v^i}$$

- Structure constants: higher products μ_i on $W \leftarrow V[1]$

$$\mu_1(\tau_i) = m_i^a \tau_a \ , \quad \mu_2(\tau_a, \tau_b) = m_{ab}^c \tau_c \ , \quad \ldots \ , \quad \mu_3(\tau_a, \tau_b, \tau_c) = m_{abc}^i \tau_i$$

- $Q^2 = 0$: Higher or homotopy Jacobi identity, e.g.

$$\mu_2(w_1, \mu_2(w_2, w_3)) + \text{cycl.} = \mu_1(\mu_3(w_1, w_2, w_3))$$

Local Higher Gauge Theory via NQ-Manifolds

One easily constructs local higher gauge theory using NQ-manifolds.

Ordinary gauge theory:

- Gauge potential from morphism of N-manifolds:

$$a : T[1]M \to \mathfrak{g}[1] \quad \longrightarrow \quad A^a_\mu \mathrm{d}x^\mu := a^*(\xi^a)$$

- Curvature: failure of a to be morphism of NQ-manifold:

$$F^a := (\mathrm{d} \circ a^* - a^* \circ Q)(\xi^a) = \mathrm{d}A^a + \tfrac{1}{2} f^a_{bc} A^b \wedge A^c$$

- Gauge transformations: flat homotopies between morphisms.

Higher gauge theory:

- Gauge potentials $T[1]M \to (W[1] \leftarrow V[2])$:

$$A^a_\mu \mathrm{d}x^\mu := a^*(w^a) \quad \text{and} \quad B^i_{\mu\nu} \mathrm{d}x^\mu \wedge \mathrm{d}x^\nu = a^*(v^i)$$

- Curvature: failure of a to be morphism of NQ-manifold:

$$\mathcal{F} := \mathrm{d}A + \tfrac{1}{2}\mu_2(A, A) + \mu_1(B)$$

$$\mathcal{H} := \mathrm{d}B + \mu_2(A, B) + \tfrac{1}{3!}\mu_3(A, A, A)$$

Local Higher Gauge Theories

The most interesting higher gauge theories for us live in 6 and 4 dimensions.

- "Fake curvature": $\mathcal{F} = \mathrm{d}A + \frac{1}{2}\mu_2(A,A) - \mu_1(B) = 0$
  Vanishing makes parallel transport reparam. invariant.
- 3-form curvature: $\mathcal{H} = \mathrm{d}B + \mu_2(A,B) + \frac{1}{3!}\mu_3(A,A,A)$

Gauge part of (2,0) theory

If (2,0) theory on $\mathbb{R}^{1,5}$ is a higher gauge theory, then gauge part is:

$$\mathcal{H} = *\mathcal{H}~,\qquad \mathcal{F} = 0~.$$

Non-Abelian Self-Dual Strings

BPS equation for (2,0) theory on $\mathbb{R}^4$ ($\sim$ monopoles in 4d SYM)

$$\mathcal{H} = *\left(\mathrm{d}\Phi + \mu_2(A,\Phi)\right)~,\qquad \mathcal{F} = 0~.$$

The Global Picture: Categorification

> *We will need to use some very simple notions of category theory, an esoteric subject noted for its difficulty and irrelevance.*
> G. Moore and N. Seiberg, 1989

What does categorification mean?
One of Jeff Harvey's questions to identify
the "generation PhD>1999" at Strings 2013.

Categorification

Categorification provides some guidelines in the construction of higher objects.

Category theory: excellent tool for deformations/generalizations.

Notions used: categorification, internalization and enrichment.

Idea: Mathematical objects are stuff, structures, structure eqns.

Translate as follows:

- stuff (sets) becomes categories
- structures (functions) become functors
- structure equations become structure isomorphisms

Example: 2-Groups

Categorifying a group, we arrive at the notion of a 2-group.

Group:

- Stuff: Underlying set G, unit $\mathbb{1}$
- Structure: Multiplication, inverse
- Structure equations: associativity, $g^{-1}g = \mathbb{1}$, $\mathbb{1}g = g\mathbb{1} = g$

2-Group:

- Stuff: A category $\mathscr{C}$, unit object $\mathbb{1}$
- Structure: Multiplication bifunctor $\otimes$, inverse functor inv
- Structure isomorphisms:
  - $\mathsf{a}_{x,y,z} : (x \otimes y) \otimes z \Rightarrow x \otimes (y \otimes z)$
  - $\mathsf{l}_x : x \otimes \mathbb{1} \Rightarrow x$, $\mathsf{r}_x : \mathbb{1} \otimes x \Rightarrow x$
  - $\mathsf{inv}(x) \otimes x \Rightarrow \mathbb{1} \Leftarrow x \otimes \mathsf{inv}(x)$

Example: Strict 2-Group $\mathsf{G} \ltimes \mathsf{H} \rightrightarrows \mathsf{G}$,

- a, l, r all trivial, $\mathsf{inv}(x) \otimes x = \mathbb{1} = x \otimes \mathsf{inv}(x)$
- $\mathrm{id}(g) = (g, \mathbb{1}_{\mathsf{H}})$, $(g_1, h_1) \otimes (g_2, h_2) = (g_1 g_2, h_1(g_1 \rhd h_2))$, etc.

Categorical Description of Principal Bundles

Descent data for principal bundles is encoded in a functor.

The cover $\sqcup_a U_a$ of a manifold M encoded in the Čech groupoid:

$$\check{\mathscr{C}}(U)\ :\quad \bigsqcup_{a,b} U_{ab} \rightrightarrows \bigsqcup_{a} U_a\ ,\quad U_{ab}\circ U_{bc}=U_{ac}\ .$$

Principal G-bundle

Transition functions are nothing but a functor $g:\check{\mathscr{C}}(U)\rightarrow(\mathsf{G}\rightrightarrows *)$

$$\begin{tikzcd}
\sqcup U_{ab} \arrow[r, "g_{ab}"] \arrow[d, shift left] \arrow[d, shift right] & \mathsf{G} \arrow[d, shift left] \arrow[d, shift right] \\
\sqcup U_a \arrow[r, "*"] & *
\end{tikzcd}$$

$$g_{ab}g_{bc}=g_{ac}$$

Equivalence relations: natural isomorphisms.

Use higher categories: Higher bundles including gerbes

Connections and Finite Gauge Transformations

Higher connections and finite gauge transformations are readily derived.

First option: Integrate infinitesimal description from above

- Procedure rather involved
- Result usually only categorically equivalent to expected one

Second option: Differentiate gauge 2-group Ševera

- Functors from manifolds to transition functions of principal G-bundles over $M \times \mathbb{R}^{0|1} \to M$
- Moduli space is N-manifold $\mathsf{Lie}(\mathsf{G})[1]$
- Induced action of $\mathsf{Hom}(\mathbb{R}^{0|1}, \mathbb{R}^{0|1})$ on moduli space yields Q.
- Directly generalizes to L_∞- and quasi-groupoids

Finite gauge transformations: B Jurčo, CS & M Wolf

- Natural transformations yield Maurer-Cartan forms etc.
- Readily read off gauge transformations

Summary of our construction

Input:

- some higher Lie groupoid as higher space-time
- some higher Lie groupoid as higher gauge group

Output:

- higher principal bundle
- higher curvatures
- finite gauge transformations

Context:

Many Suggested Models are Higher Gauge Theories

M2-Brane Models as Higher Gauge Theories

The ABJM model can be completed to a higher gauge theory.

- Most dualities in string theory between Yang-Mills theories.
- And in M-theory? M2-branes: Chern-Simons-matter theories
  M5-branes: Tensor-multiplet theories
- These can be put on equal footing. S Palmer&CS, 1311.1997
- Note: The ABJM gauge structures form strict Lie 2-algebras.
- Here: need Lie 3-algebra:

$$\begin{pmatrix} 0 & \mathfrak{gl}(N,\mathbb{C}) \\ 0 & 0 \end{pmatrix} \xrightarrow{\mu_1} \begin{pmatrix} \mathfrak{u}(N) & \mathfrak{gl}(N,\mathbb{C}) \\ 0 & \mathfrak{u}(N) \end{pmatrix} \xrightarrow{\mu_1} \begin{pmatrix} \mathfrak{u}(N) & 0 \\ 0 & \mathfrak{u}(N) \end{pmatrix}$$

- Action implementing fake curvature conditions:

$$S_{\text{ABJM}} = \int_{\mathbb{R}^{1,2}} \text{tr}\left(\tfrac{k}{4\pi}\eta \; A \wedge (\text{d}A + \tfrac{1}{3}[A,A]) \right.$$
$$\left. - \nabla Z^\dagger_A \wedge * \nabla Z^A - * \text{i} \bar{\psi}^A \wedge \not{\nabla} \psi_A \right) + V$$

$$S_{\text{HGT}} = S_{\text{ABJM}} + \int_{\mathbb{R}^{1,2}} \text{tr}\left(\lambda_1^\dagger \wedge (F - \mu_1(B)) \right.$$
$$\left. + \lambda_2^\dagger (H - \mu_1(C)) + \lambda_3^\dagger \mu_1(\lambda_2) \right)$$

Tensor Hierarchy Models are Higher Gauge Theories

There is much more evidence for using higher structures in M-theory.

Proposal for 6d (1,0) models from tensor hierarchies

Samtleben et al., 1108.4060, also 1108.5131

Gauge structure:

- Graded vector space: $\mathfrak{g} \xleftarrow{\mathsf{h}} \mathfrak{h} \xleftarrow{\mathsf{g}} \mathfrak{l}$
- Maps with structure relations:

$$\begin{aligned}
\mathsf{h}(\mathsf{g}(\lambda)) &= 0\\
\mathsf{f}(\mathsf{h}(\chi),\gamma)-\mathsf{h}(\mathsf{d}(\mathsf{h}(\chi),\gamma)) &= 0\\
\mathsf{f}(\gamma_{[1},\mathsf{f}(\gamma_2,\gamma_{3]}))-\tfrac{1}{3}\mathsf{h}(\mathsf{d}(\mathsf{f}(\gamma_{[1},\gamma_2),\gamma_{3]})) &= 0\\
\mathsf{g}(\mathsf{b}(\chi_1,\mathsf{h}(\chi_2)))-2\mathsf{d}(\mathsf{h}(\chi_1),\mathsf{h}(\chi_2)) &= 0\\
\mathsf{g}(\mathsf{f}^*(\gamma,\lambda)-\mathsf{d}^*(\mathsf{h}^*(\lambda),\gamma)+\mathsf{b}(\mathsf{g}(\lambda),\gamma)) &= 0
\end{aligned}$$

- Relations for a symplectic NQ-manifold in degrees $1,2,3$
- Their model is a higher gauge theory.
- No fake curvature condition is imposed.

How to construct (2,0)-theories systematically

Twistor Description of Higher Gauge Fields

Using twistor spaces, one can map holomorphic data to solutions to field equations.

Recall the principle of the Penrose-Ward transform:

- We construct a double fibration

$$\begin{tikzcd} & F \arrow[dl] \arrow[dr] & \\ P & & M \end{tikzcd}$$

  P: twistor space, F: correspondence space
- $H^n(P, \mathfrak{S})$ (e.g. vector bundles) $\xleftrightarrow{1:1}$ sols. to field equations.
- Works for
  - instantons, monopoles, ...
  - solutions to $\mathcal{N} = 4$ super Yang-Mills theory
- Idea: use this to construct 6d (2,0) superconformal eoms

Known Examples of Twistor Descriptions

For Yang-Mills theories and its BPS subsectors, there is a wealth of twistor descriptions.

$$\begin{tikzcd} & \mathbb{C}^4 \times \mathbb{C}P^1 \arrow[dl] \arrow[dr] & \\ \mathbb{C}P^3_\circ & & \mathbb{C}^4 \end{tikzcd}$$

Instantons
hol. vector bundle

$$\begin{tikzcd} & \mathbb{C}^3 \times \mathbb{C}P^1 \arrow[dl] \arrow[dr] & \\ T\mathbb{C}P^1 & & \mathbb{C}^3 \end{tikzcd}$$

Monopoles
hol. vector bundle

$$\begin{tikzcd} & \mathbb{C}^{4|12} \times \mathbb{C}P^1 \times \mathbb{C}P^1 \arrow[dl] \arrow[dr] & \\ P^{5|6} & & \mathbb{C}^{4|12} \end{tikzcd}$$

Super Yang-Mills
hol. vector bundle

$$\begin{tikzcd} & \mathbb{C}^6 \times \mathbb{C}P^3 \arrow[dl] \arrow[dr] & \\ P^6 & & \mathbb{C}^6 \end{tikzcd}$$

abelian $\mathcal{H} = *\mathcal{H}$
hol. gerbe

Hughston, Murray, Eastwood, CS & M Wolf, Mason et al.

Note: last twistor space reduces nicely to the above ones.

Constructing (2,0)-theories

Penrose-Ward transform for non-abelian self-dual tensor multiplet.

$$\begin{tikzcd} & \mathbb{C}^{6|16} \times \mathbb{C}P^3 \arrow[dl] \arrow[dr] & \\ P^{6|4} & & \mathbb{C}^{6|16} \end{tikzcd}$$

non-abelian self-dual tensor multiplet
hol. principal 2-bundle
also: semistrict, simplicial, 3-bundles, . . .

B Jurčo, CS & M Wolf

Note:

- $P^{6|4}$ is a straightforward SUSY generalization of P^6
- EOMs, abelian: $\mathcal{H} = \star\mathcal{H}$, $\mathcal{F} = 0$, $\not{\nabla}\psi = 0$, $\Box\phi = 0$
- $\mathcal{N} = (2, 0)$ SC non-abelian tensor multiplet EOMs!
- Reduces search for (2,0)-theory to search for gauge structure
- Similarly: Twistor description of self-dual strings.

You may be talking about the empty set,
I want to see some examples...

A Categorified Nahm Transform

Many ingredients are still missing, more work needs to be done.

- Usually, we wouldn't use twistors to construct solutions
- Instead: ADHM- and AHDMN-constructions
- Equations explicitly solvable, moduli space under control, etc.
- No higher Nahm transform so far
- Substantially more ingredients than twistor construction:
  - associated 2-vector bundle
  - Stringor bundle (categorified Spinor bundle)
  - categorified Dirac operator
- Solutions to these problems: Major mathematical progress
- More work is needed...

Review: The 't Hooft-Polyakov Monopole

The 't Hooft-Polyakov Monopole is a non-singular solution with charge 1.

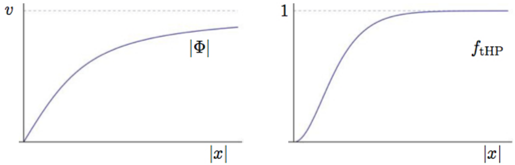
Recall 't Hooft-Polyakov monopole (e_i generate $\mathfrak{su}(2)$, $\xi = v|x|$):

$$\Phi = \frac{e_i x^i}{|x|^2}(\xi \coth(\xi) - 1)~, \qquad A = \varepsilon_{ijk}\frac{e_i x^j}{|x|^2}\left(1 - \frac{\xi}{\sinh(\xi)}\right)\, \mathrm{d}x^k$$

- At S^2_∞: $\Phi \sim g(\theta) e_3 g(\theta)^{-1}$.
  $g(\theta) : S^2_\infty \to \mathsf{SU}(2)/\mathsf{U}(1)$: winding 1
- Charge $q = 1$ with

$$2\pi q = \tfrac{1}{2}\int_{S^2_\infty} \frac{\mathrm{tr}\,(F^\dagger \Phi)}{||\Phi||} \quad \text{with} \quad ||\Phi|| := \sqrt{\tfrac{1}{2}\,\mathrm{tr}\,(\Phi^\dagger\Phi)}$$

- Higgs field non-singular:



Elementary Solutions: A Non-Abelian Self-Dual String

We can write down a non-abelian self-dual string with winding number 1.

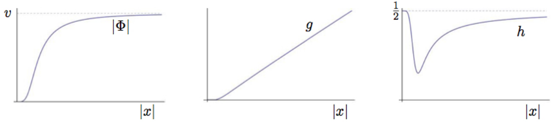
Self-Dual String (Lie 2-algebra $\mathfrak{su}(2) \times \mathfrak{su}(2) \xleftarrow{\mu_1} \mathbb{R}^4$, $\xi = v|x|^2$):

$$\Phi = \frac{e_\mu x^\mu}{|x|^3}\, f(\xi)\ , \quad B_{\mu\nu} = \varepsilon_{\mu\nu\kappa\lambda} \frac{e_\kappa x^\lambda}{|x|^3}\, g(\xi)\ , \quad A_\mu = \varepsilon_{\mu\nu\kappa\lambda} D(e_\nu, e_\kappa)\, \frac{x^\lambda}{|x|^2}\, h(\xi)$$

- Solves indeed $H = \star \nabla \Phi$ for right $f(\xi)$, $g(\xi)$, $h(\xi)$
- At S^∞_3: $\Phi \sim g(\theta) \triangleright e_4$. $g(\theta) : S^3_\infty \to \mathsf{SU}(2)$ has winding 1.
- Charge $q = 1$:

$$(2\pi)^3 q = \tfrac{1}{2} \int_{S^3_\infty} \frac{(H, \Phi)}{||\Phi||} \quad \text{with} \quad ||\Phi|| := \sqrt{\tfrac{1}{2}(\Phi, \Phi)}\ ,$$

- Higgs field non-singular:

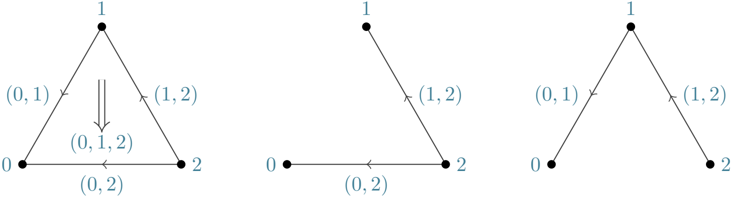


Extensions: Quasi-Categories

Most general, currently available approach: quasi-categories

- Quasi- or ∞-categories: models for $(\infty, 1)$-categories.

  Boardman, Vogt, Joyal
- Example: the nerve of a category
- Simplicial sets, which are Kan complexes: Horns can be filled:



- Functors: simplicial maps
- Natural transformations: simplicial homotopies
- Ševera's differentiation: yields corresponding L_∞-algebra.
- Higher gauge theory: 1604.????, B Jurčo, CS and M. Wolf

The String Group

A very interesting case: The string group.

- Monopole/instanton solutions: gauge group from spin group
  $\mathsf{Spin}(3) \cong \mathsf{SU}(2)$, $\mathsf{Spin}(4) \cong \mathsf{SU}(2) \times \mathsf{SU}(2)$
- Higher analogue of the spin group: String group
  Stolz, Teichner, Witten, ...
- Def. via Whitehead tower (iteratively delete homotopy groups)

$$\ldots \to \mathsf{String}(n) \to \mathsf{Spin}(n) \to \mathsf{Spin}(n) \to \mathsf{SO}(n) \to \mathsf{O}(n)$$

- Definition only up to homotopy, as a group: ∞-dimensional
- 2-group models:
  - ∞-dimensional strict 2-group Baez et al., Nikolaus et al.
  - finite-dimensional quasi 2-group Schommer-Pries
- Higher gauge theory 1602.03441, G A Demessie and CS
- Conjecture: Gauge 2-group for M5-branes is $\mathsf{String}(E_8)$

Generalized Higher Gauge Theory

Replacing spacetime by a categorified space yields interesting features.

Return to picture from beginning:

Gauge theory	$a : T[1]M \rightarrow \text{Lie algebra}[1]$
Higher gauge theory	$a : T[1]M \rightarrow L_\infty\text{-algebra}[1]$

Generalize this:

Generalized higher gauge theory	$a : T^*[2]T[1]M \rightarrow L_\infty\text{-algebra}[1]$

Generalized higher gauge theory: P Ritter, CS and L Schmidt

- $T[1]M$ replaced by exact Courant algebroid $T^*M \oplus TM$
- relation to generalized geometry/double field theory
- M is replaced by a categorified space $T^*M \rightrightarrows M$
- Gauge connection contains a cov. constant vector field
- Lambert & Papageorgakis suggested eoms for 3-Lie algebra valued tensor multiplet
- Naturally interpreted in generalized higher gauge theory

Conclusions

Summary and Outlook.

Summary:

- ✓ Clear physical and mathematical motivation to study HGT
- ✓ Many suggested models are HGT or GHGT
- ✓ Explicit higher monopole and instanton solutions
- ✓ Various twistor constructions with principal 2-bundles
- ✓ 6d superconformal tensor multiplet equations
- ✓ Higher groupoid gauge theories on higher groupoids

Future directions:

- ▷ Study more general higher groups
- ▷ Extend and study twistor constructions
- ▷ Find more solutions
- ▷ Continue translation of higher ADHM-constructions

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Christian Sämann

School of Mathematical and Computer Sciences
Heriot-Watt University, Edinburgh

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