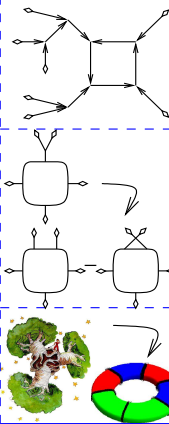
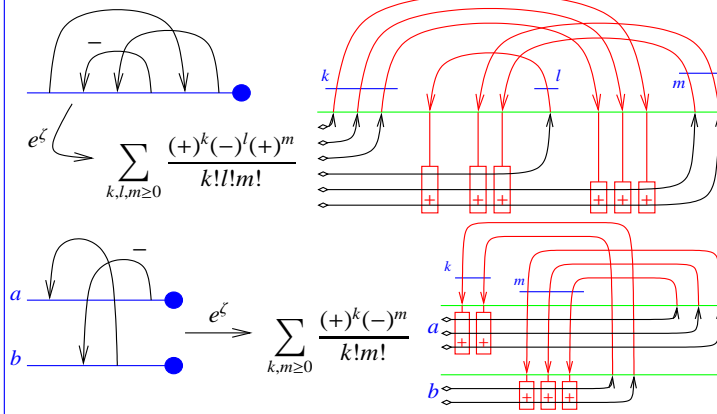
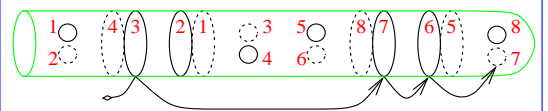


A Partial Reduction of BF Theory to Combinatorics, 2

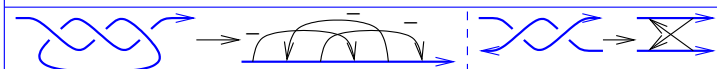
Theorem 1 (with Cattaneo, Dalvit (credit, no blame)). In the ribbon case, e^{ζ} can be computed as follows:



Sketch of Proof. In 4D axial gauge, only “drop down” red propagators, hence in the ribbon case, no M -trivalent vertices. S integrals are ± 1 iff “ground pieces” run on nested curves as below, and exponentials arise when several propagators compete for the same double curve. And then the combinatorics is obvious...



Musings



Theorem 2. Using Gauss diagrams to represent knots and T -component pure tangles, the above formulas define an invariant in $CW(FL(T)) \rightarrow CW(T)$, “cyclic words in T ”.

- Agrees with BN-Dancso [BND] and with [BN2].
- In-practice computable!
- Vanishes on braids.
- Extends to w.
- Contains Alexander.
- The “missing factor” in Levine’s factorization [Le] (the rest of [Le] also fits, hence contains the MVA).
- Related to / extends Farber’s [Fa]?
- Should be summed and categorified.

References.

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[BN2] D. Bar-Natan, *Balloons and Hoops and their Universal Finite Type Invariant, BF Theory, and an Ultimate Alexander Invariant*, <http://www.math.toronto.edu/~drorbn/papers/KBH/>, [arXiv:1308.1721](http://arxiv.org/abs/1308.1721).

[BND] D. Bar-Natan and Z. Dancso, *Finite Type Invariants of W-Knotted Objects: From Alexander to Kashiwara and Vergne*, <http://www.math.toronto.edu/~drorbn/papers/WKO/>.

[CKS] J. S. Carter, S. Kamada, and M. Saito, *Diagrammatic Computations for Quandles and Cocycle Knot Invariants*, *Contemp. Math.* **318** (2003) 51–74.

[CS] J. S. Carter and M. Saito, *Knotted surfaces and their diagrams*, *Mathematical Surveys and Monographs* **55**, American Mathematical Society, Providence 1998.

[Da] E. Dalvit, <http://science.unitn.it/~dalvit/>.

[CR] A. S. Cattaneo and C. A. Rossi, *Wilson Surfaces and Higher Dimensional Knot Invariants*, *Commun. in Math. Phys.* **256-3** (2005) 513–537, [arXiv:math-ph/0210037](http://arxiv.org/abs/math-ph/0210037).

[Fa] M. Farber, *Noncommutative Rational Functions and Boundary Links*, *Math. Ann.* **293** (1992) 543–568.

[Le] J. Levine, *A Factorization of the Conway Polynomial*, *Comment. Math. Helv.* **74** (1999) 27–53, [arXiv:q-alg/9711007](http://arxiv.org/abs/q-alg/9711007).

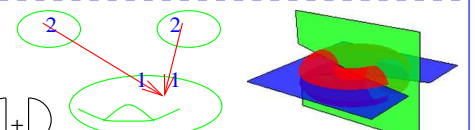
[Ro] D. Roseman, *Reidemeister-Type Moves for Surfaces in Four-Dimensional Space*, *Knot Theory*, Banach Center Publications **42** (1998) 347–380.

[Wa] T. Watanabe, *Configuration Space Integrals for Long n -Knots, the Alexander Polynomial and Knot Space Cohomology*, *Alg. and Geom. Top.* **7** (2007) 47–92, [arXiv:math/0609742](http://arxiv.org/abs/math/0609742).

Chern-Simons. When the domain of BF is restricted to ribbon knots, and the target of Chern-Simons is restricted to trees and wheels, they agree. Why?

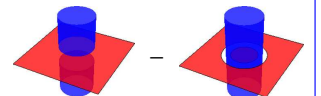
Is this all? What about the ν -invariant?

(the “true” triple linking number)



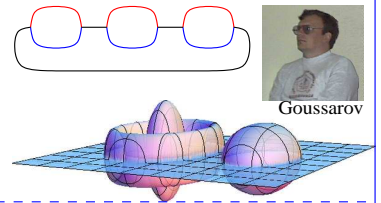
Gnots. In 3D, a generic immersion of S^1 is an embedding, a knot. In 4D, a generic immersion of a surface has finitely-many double points (a gnot?). Perhaps we should be studying these?

Finite type. What are finite-type invariants for 2-knots? What would be “chord diagrams”?



Bubble-wrap-finite-type.

There’s an alternative definition of finite type in 3D, due to Goussarov (see [BN1]). The obvious parallel in 4D involves “bubble wraps”. Is it any good?

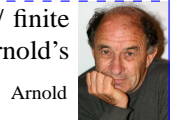


Shielded tangles. In 3D, one can’t zoom in and compute “the Chern-Simons invariant of a tangle”. Yet there are well-defined invariants of “shielded tangles”, and rules for their compositions. What would the 4D analog be?



Will the relationship with the Kashiwara-Vergne problem [BND] necessarily arise here?

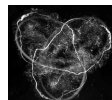
Plane curves. Shouldn’t we understand integral / finite type invariants of plane curves, in the style of Arnold’s J^+ , J^- , and St [Ar], a bit better?



	$a(\times)$	$a(\times)$	$a(\times)$	∞	\circ	\circ	\circ	\circ	\dots
St	1	0	0	0	0	1	2	3	\dots
J^+	0	2	0	0	0	-2	-4	-6	\dots
J^-	0	0	-2	-1	0	-3	-6	-9	\dots

Continuing Joost Slingerland...

<http://youtu.be/YCA0VIExVhge>



<http://youtu.be/mHyT0cfF990>



“God created the knots, all else in topology is the work of mortals.”

Leopold Kronecker (modified)

www.katlas.org

