

**Question 8.****Expectation 9.**

Is there a direct quantum field theory derivation of  $\theta$ ? Perhaps using the  $\epsilon$ -expansion (at constant  $k!$ ) of Chern-Simons-Witten theory with gauge group  $\mathfrak{g}_+^{\epsilon} := \mathcal{D}(\mathfrak{b}, b, \epsilon\delta)$  with some Seifert-surface-dependent gauge fixing?

There are many further invariants like  $\theta$ , given by Green function formulas and/or Gaussian integration formulas. One or two of them may be stronger than  $\theta$  and as computable.

**Dream 10.****Dream 11.**

These invariants can be explained by something less foreign than semisimple Lie algebras.

$\theta$  will have something to say about ribbon knots.

Thank You!

**References.**

- [Jo] V. F. R. Jones, Hecke Algebra Representations of Braid Groups and Link Polynomials, *Annals Math.*, **126** (1987) 335–388.
- [Kri] A. Kricker, The Lines of the Kontsevich Integral and Rozansky's Rationality Conjecture, [arXiv:math/0005284](https://arxiv.org/abs/math/0005284).
- [LTW] X-S. Lin, F. Tian, Z. Wang, Bureau Representation and Random Walk on String Links, *Pac. J. Math.*, **182-2** (1998) 289–302, [arXiv:q-alg/9605023](https://arxiv.org/abs/q-alg/9605023).
- [Oht] T. Ohtsuki, On the 2-loop Polynomial of Knots, *Geom. Top.* **11** (2007) 1357–1475.
- [Ov] A. Overbay, Perturbative Expansion of the Colored Jones Polynomial, Ph.D. thesis, University of North Carolina, Aug. 2013, [weβ/Ov](#).
- [Ro1] L. Rozansky, A Contribution of the Trivial Flat Connection to the Jones Polynomial and Witten's Invariant of 3D Manifolds, I, *Comm. Math. Phys.* **175-2** (1996) 275–296, [arXiv:hep-th/9401061](https://arxiv.org/abs/hep-th/9401061).
- [Ro2] —, The Universal  $R$ -Matrix, Bureau Representation and the Melvin-Morton Expansion of the Colored Jones Polynomial, *Adv. Math.* **134-1** (1998) 1–31, [arXiv:q-alg/9604005](https://arxiv.org/abs/q-alg/9604005).
- [Ro3] —, A Universal  $U(1)$ -RCC Invariant of Links and Rationality Conjecture, [arXiv:math/0201139](https://arxiv.org/abs/math/0201139).

[BN1] D. Bar-Natan, Everything around  $sl_{2+}^{\epsilon}$  is DoPeGDO. So what?, talk in Da Nang, May 2019. Handout and video at [weβ/DPG](#).

[BN2] —, Knot Invariants from Finite Dimensional Integration, talks in Beijing (July 2024, [weβ/icbs24](#)) and in Geneva (August 2024, [weβ/ge24](#)).

[BV1] —, R. van der Veen, A Perturbed-Alexander Invariant, *Quantum Topology* **15** (2024) 449–472, [weβ/APA1](#).

[BV2] —, —, Perturbed Gaussian Generating Functions for Universal Knot Invariants, [arXiv:2109.02057](https://arxiv.org/abs/2109.02057).

[DHOEBL] N. Dunfield, A. Hirani, M. Obeidin, A. Ehrenberg, S. Bhattacharyya, D. Lei, and others, Random Knots: A Preliminary Report, lecture notes at [weβ/DHOEBL](#). Also a data file at [weβ/DD](#).

[GK] S. Garoufalidis, R. Kashaev, Multivariable Knot Polynomials from Braided Hopf Algebras with Automorphisms, [arXiv:2311.11528](https://arxiv.org/abs/2311.11528).

[GL] —, S. Y. Li, Patterns of the  $V_2$ -polynomial of knots, [arXiv:2409.03557](https://arxiv.org/abs/2409.03557).

[GR] —, L. Rozansky, The Loop Expansion of the Kontsevich Integral, the Null-Move, and  $S$ -Equivalence, [arXiv:math.GT/0003187](https://arxiv.org/abs/math.GT/0003187).

[Sch] S. Schaveling, Expansions of Quantum Group Invariants, Ph.D. thesis, Universiteit Leiden, September 2020, [weβ/Scha](#).