A RESEARCH STATEMENT

MIHAI MARIAN

1. Introduction

I work with two theories: Khovanov homology [Kho00] and Heegaard Floer homology [OS04b], and in particular with their bordered incarnations [BN05, LOT18]. The original theories take topological objects (knots, 3-manifolds) and output graded groups, and their bordered versions take in bordered objects (tangles, manifolds with boundary) and output more sophisticated algebraic objects: “type D structures” over bigraded algebras. Both bordered theories, in the simplest non-trivial cases (manifolds with torus boundary, 4-ended tangles), admit symplectic interpretations in certain Fukaya categories of surfaces [HRW23, KWZ19]. These combinatorial-symplectic theories are the ones I study most closely, so my work belongs simultaneously to low-dimensional topology and a corner of symplectic topology. For instance, the following figure illustrates my most recent work [Mar25a], in which I study an operator induced by cabling:

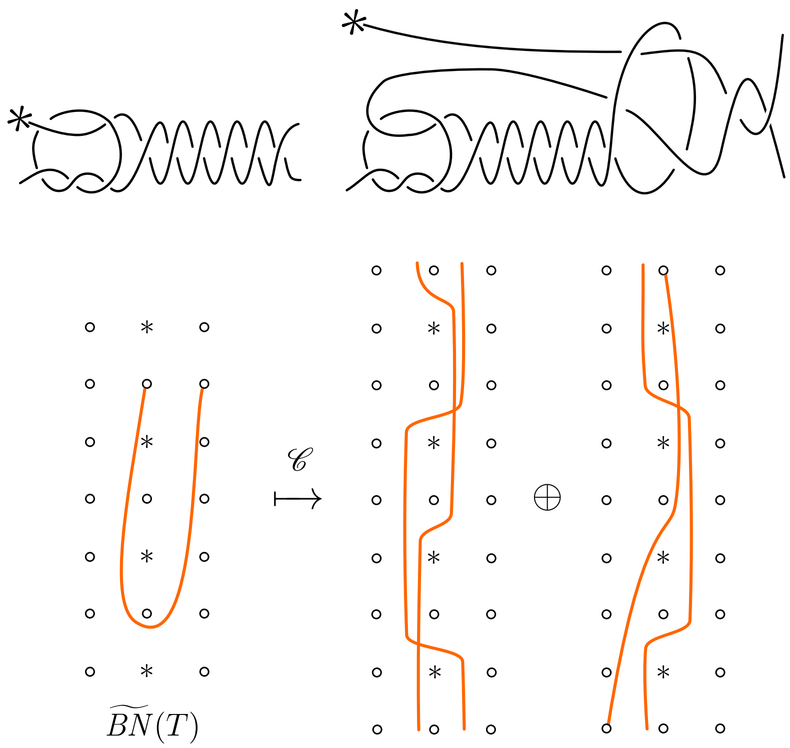


Figure 1. Bordered Khovanov invariants associated with the Seifert-framed right-handed trefoil knot and its Seifert-framed $(2,1)$-cable. The left curve is the Bar-Natan invariant $\widetilde{BN}(T)$ of a tangle canonically associated with the trefoil. The operator $\mathscr{C}$ takes this into the 4-component curve on the right. The invariants are valued in $\mathcal{W}(S^2_{4,*})$, a Fukaya category of the 4-punctured sphere, and lifted to a covering space by $\mathbb{R}^2 \setminus \mathbb{Z}^2$.

The project that the figure belongs to is inspired by similar work in Heegaard Floer theory, where the effect of cabling on the bordered invariant of a knot complement is well-understood [HW23]; cf. also §2.3. My work is likely the first meaningful study of bimodules associated with tangle operators and, as I will explain below, the result is both algebraically rich and surprising when compared with the story in Heegaard Floer theory.

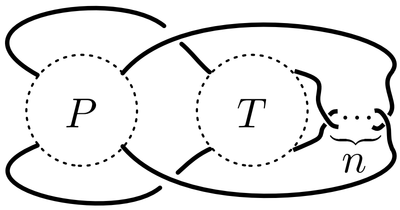
Khovanov homology and knot Floer homology, which is the knot invariant coming from Heegaard Floer theory [OS04a, Ras03], are fundamentally different. At the same time, they have strong structural similarities, and my research is driven by their imperfect parallels. This kind of research has precedence, for example in work of J. Rasmussen, who modelled his celebrated s-invariant [Ras05] on Ozsváth–Szabó's τ [OS03] and of Kotelskiy–Watson–Zibrowius, who used the symplectic description of bordered Heegaard Floer homology [HRW23, Zib20] as inspiration for their symplectic description of the Bar-Natan homology of 4-ended tangles [KWZ19]. The applications of this line of work are to problems in low-dimensional topology. I plan to continue research in this area by developing tools that reveal more clearly the structure of knots that can be described as the union of two 4-ended tangles, by applying these tools to an analysis of the equivariant concordance group of strongly-invertible knots, and by studying neighbouring theories such as odd Khovanov homology.

2. Past

2.1. **(1,1) L-space knots.** My first project in low-dimensional topology was on the knot Floer homology of $(1,1)$-knots [Mar20], a class for which the theory is combinatorial. This fact was noticed in [GMM05] and has made $(1,1)$-knots into an important sandbox for the development of more direct versions of knot Floer homology [CH23, Han23]. Foreshadowing some of this development, my thesis contains an alternate proof of the main theorem of [GLV18], which concerns a central question of understanding what simplicity means in Heegaard Floer theory. It is known that if Y is a rational homology 3-sphere, then its Heegaard Floer homology satisfies $\mathrm{rk}(\widehat{HF}(Y)) \geq |H_1(Y;\mathbb{Z})|$. An L-space is a rational homology sphere for which $\widehat{HF}$ has minimal rank. The now famous and still open L-space conjecture posits the geometric meaning of this minimality. In the service of constructing examples, [GLV18, Theorem 1.2] is a criterion that determines if a $(1,1)$-knot admits nontrivial Dehn surgery to an L-space. For a knot K, let (T^2,α,β) be a Heegaard diagram for K, i.e. a genus 1 surface with two (embedded) attaching circles. The GLV L-space criterion involves comparing orientations of segments of α and β that are separated by the intersection points $x \in \alpha\cap\beta$. The criterion is computable: I implemented it and found (within minutes) that approximately 24% of the diagrams with $|\alpha\cap\beta| < 100$ admit L-space surgeries. However, what I focused on is the observation that the GLV criterion is formally very similar to a characterization due to [HRW23]. There, the authors identified the bordered Heegaard Floer invariants for manifolds with torus boundary M with immersed curves $\widehat{HF}(M)$ in a Fukaya category of the punctured torus, $\mathscr{F}(T^2_*)$. In this context, the Heegaard Floer homology of a manifold obtained by Dehn surgery on a knot K is given as a count of intersection points between $\widehat{HF}(K^c)$ and the image of a line in the universal abelian cover of the punctured torus; it is easy to see geometrically which lines minimize this count. Moreover, in small examples, such as for torus knots, the data of the immersed curve invariant $\widehat{HF}(K^c) \subset T^2_*$ and of the auxiliary manifold (T^2, α, β) are alluringly similar. As a means to study this similarity, I reinterpreted and reproved the main theorem of [GLV18] using immersed curves, under a mild technical condition:

Theorem 1 ([Mar20]). *A GP $(1,1)$-knot K admits L-space surgeries if and only if $\widehat{HF}(K^c)$ is monotone. Moreover, this can be shown without the "staircase lemma" used in* [GLV18].

The impact of this was a more direct connection of the immersed curve technology to the topological input of a knot, in the $(1,1)$-case. Moreover, the thesis is of a high expository quality and I am told that some professors have recommended it to their students to get acquainted with knot Floer homology.



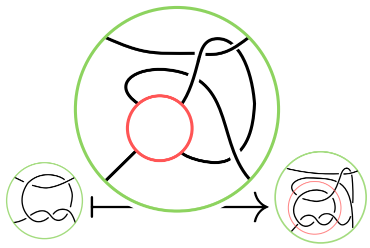
2.2. **New concordance from Khovanov.** Lewark–Zibrowius recently came up with a remarkable smooth concordance invariant of knots $\vartheta(K)$ [LZ24]. Its origin is the following linearity property of Rasmussen's s-invariant, a special case of which I also studied. Suppose P and T are 4-ended tangles, T is "cap-trivial", i.e., has trivial 0-closure, and the link obtained by gluing P to T as in the adjacent figure (with $n = 0$) is a knot. Note that the cap-trivial condition on 4-ended tangles is analogous to the condition that a knot be in S^3, rather than a more general 3-manifold; see also §4.2 below. Let $P_n(T)$ be the knot obtained by adding an integer number of full twists in the gluing, as indicated in the figure. Then the s-invariant of $P_n(T)$, as a function of n, is either affine or it is the restriction of a piecewise affine function $\mathbb{R} \to \mathbb{R}$ with a unique jump discontinuity.

One particular class of cap-trivial tangles is the knot doubles: given a knot K, its knot double is a tangle T_K obtained by taking the union of K with its Seifert longitude and cutting this link so as to obtain a 4-ended tangle. Remarkably, Lewark–Zibrowius found that, if T is a knot double T_K, then the jump-discontinuity described above depends only on the connectivity on P and is a concordance invariant of K, that they denote $\vartheta(K)$. In their study of ϑ, they formulate several questions and conjectures, one of which involves a class of knots that they term "ϑ-rational". By appealing to a generalization of the s-invariant to links, I established their conjecture:

Theorem 2 ([Mar25b]). *If a knot K is ϑ-rational, then $\vartheta(K) = 0$.*

Naturally, there is a relationship between ϑ and s. The above simplifies it:

Corollary 3. *Let K be a ϑ-rational knot and let P have winding number ± 2. Then $s(P_0(T_K)) = s(P_0(\asymp))$.*

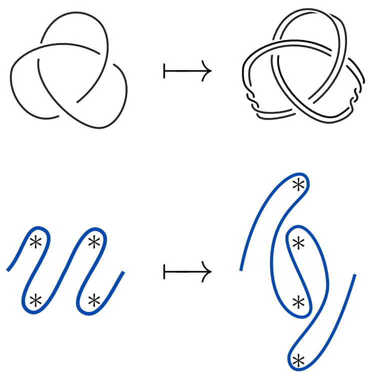


2.3. **A first bimodule.** My recent preprint [Mar25a] contains the first description of a complicated operator (or, equivalently, bimodule) $\mathscr{C}$ that acts on Bar-Natan's cobordism category [BN05]. It is the annular tangle depicted on the right and, as illustrated, it acts on 4-ended tangles, so it induces an operator on the Fukaya category $\mathcal{W}(S^2_{4,*})$ defined in [KWZ19]; its action on an example is depicted on the right of Fig. 1. Although Bar-Natan gave the initial structure that allows for the construction of such operators, it was only used twice before: first by Bar-Natan himself, to prove that his tangle theory has good gluing properties and second to show the important naturality result for the immersed curve invariant of 4-ended tangles [KWZ19]. This latter follows from the computation of the annular operator with a single crossing. My work is a first step in a bimodule theory that will be important for computations of Bar-Natan invariants, but it also opens up the possibility of a functorial symplectic model of bordered Khovanov invariants of tangles. First, in terms of computability, I proved that the operator on subcategory of $\mathcal{W}(S^2_{4,*})$ generated by Bar-Natan invariants of cap-trivial tangles factors through a much simpler subcategory. The result takes the following form:

Theorem 4 ([Mar25a])**.** *If T is cap-trivial, then $\mathscr{C}(\widetilde{BN}(T)) = \mathscr{C}\Big(\widetilde{BN}(T)\Big|_{D_\bullet=0}\Big)$.*

Together with geography results on the Bar-Natan invariants of cap-trivial tangles [Mar25a, Lemma 4.9], the above theorem computes the effect of the operator extremely rapidly. Indeed, I have found a complete description of the bimodule induced by the annular tangle pictured above, restricted to cap-trivial tangles. A snippet of this description:

Theorem 5 ([Mar25a])**.** *Given a cap-trivial tangle T, the unique non-compact component of the immersed curve $\mathscr{C}(\widetilde{BN}(T))$ is, up to mirroring and framing, one of $\widetilde{BN}($$)$ or $\widetilde{BN}($$)$.*



Second, in terms of the symplectic theory, the operator shows surprising complexity, compared to the behaviour of cabling in Heegaard Floer theory. To discuss the parallel, let me talk about the topological origin of the operator $\mathscr{C}$. Given a strongly invertible knot, which is a knot together with an involution h that reverses its orientation, its cables have uniquely induced strong inversions. For example, the pictured knots both have such a symmetry, given by skewering the knots through the y-axis on the page and rotating them by π. The quotient of the pair consisting of the knot complement and fixed-set of the symmetry, $(K^c, \mathrm{Fix}(h))$, by the symmetry yields a cap-trivial 4-ended tangle in a 3-ball. This is how the operator $\mathscr{C}$ is defined: it takes the tangle associated with a strong inversion into the tangle associated with the strong inversion on the $(2,1)$-cable. The analysis of this operator is motivated by bordered Floer theory. There, we can consider the operation that takes a knot complement K^c into the complement of its (p,q)-cable $K^c_{p,q}$, and it is natural to ask how the bordered invariant behaves under this operation. In the category $\mathscr{F}(T^2_*)$, the operators induced by cabling have a beautiful geometric interpretation as Lagrangian submanifolds of $T^2_* \times T^2_*$ with the usual product symplectic structure [HW23]. This description turns the computation of the bordered invariant $\widehat{HF}(K^c_{p,q})$ into a simple procedure amounting to a plane shear in the universal Abelian cover of T^2_*; it is illustrated in the figure on this page for $(p,q) = (2,1)$. That a Lagrangian interpretation should exist is predicted by symplectic topology [Aur10], but only for Heegaard Floer theory. One wonders naturally if there is a similar structure in Khovanov theory. Based on my work in the case of 2-cabling, the answer is "yes", although with surprising differences:

Theorem 6 ([Mar25a])**.** *The operator $\mathscr{C}\colon \mathcal{W}(S^2_{4,*}) \to \mathcal{W}(S^2_{4,*})$ is not induced from a Lagrangian correspondence that is the graph of a p-valued function for any p.*

3. Present

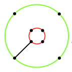
3.1. **Equivariant concordance.** I am now working on an application of the operator described in the previous section. I want to use it to study the equivariant concordance group $\widetilde{\mathcal{C}}$ of strongly invertible knots. Defined by Sakuma [Sak85], it is a variation of the classical concordance group that respects the strong inversion symmetry. The group $\widetilde{\mathcal{C}}$ has only recently been proved to be non-Abelian [DP22] and this has reinvigorated interest in it. The strategy is to study equivariant concordance classes of knots by passing to the immersed curve invariants of the associated 4-ended tangles, on which the group operation in $\widetilde{\mathcal{C}}$ induces a tensor product. After taking an appropriate quotient, this tensor product induces a group structure $\mathcal{BN}$ on the collection of immersed curve invariants, and in this algebraic group, sufficient structure of $\widetilde{\mathcal{C}}$ will be preserved to find interesting subgroups. This strategy is inspired by [DHST21], where an algebraic model $\mathcal{CFK}$ for the classical smooth concordance group $\mathcal{C}$ is defined and it is used to show that a certain subgroup of $\mathcal{C}$ contains an infinite rank summand. The existence of this algebraic model stems from work of the second author [Hom15], who used a single concordance invariant valued in $\{-1, 0, 1\}$ to define it as well as an order on it, which eventually was shown to separate the concordance classes of certain satellites in [DHST21]. In particular, this required the computation of satellites in Heegaard Floer theory. The main point is that there are tractable, algebraically defined groups that allow us to see the complexity of concordance groups.

Some pieces are already in place for this project. First, and of independent interest, it is possible to explicitly describe the group operation on $\mathcal{BN}$, by similar work to that of [Mar25a]. Second, I have candidate equivariant concordance invariants, coming from previous unpublished work [Mar23]. The proof of their invariance should go through by adapting Sakuma's original arguments. Third, a feature of the operator $\mathscr{C}$ is that it iterates easily, allowing for construction of immersed curve invariants in infinite families. Finally, the way in which the operator simplifies when restricting to cap-trivial tangles suggests the appropriate quotient required to obtain $\mathcal{BN}$, and it is similar to the construction of $\mathcal{CFK}$ [DHST21]. I conjecture that iteration of $\mathscr{C}$ on well-chosen strongly invertible knots will yield an infinite rank subgroup of $\widetilde{\mathcal{C}}$, in accordance with the predicted expanding nature of satellite operations [HPC21]. Finally, it is worth noting that the immersed curve perspective makes it possible to see the parallels between the two theories very clearly, sometimes short-circuiting heavy algebraic work. Indeed, as a corollary of their work, Hanselman–Watson gave an alternate and rapid proof that the smooth concordance group contains a $\mathbb{Z}^\infty$-summand [HW23].

4. Future

4.1. **Other cabling bimodules.** Providing a symplectic description for Khovanov homology in general is a problem that has attracted considerable attention. It is one way of probing the similarities between Khovanov and knot Floer homology, this latter being symplectic by construction. This problem has been resolved recently [Aga23, LS25], but in a way that is not obviously compatible with my work. One question then is to explain how exactly the symplectic structure that I describe is related, if at all, to Aganagic's construction. One can also try to develop the bimodule theory as far as possible: given that the objective is not just to find a symplectic description of Khovanov homology, but to actually use it, it is worthwhile to develop a theory with distinct strengths. A difficult project I plan to tackle next is:

Problem 1. *Describe the bimodules (and corresponding Lagrangians) on $\mathcal{W}(S^2_{4,*})$ induced by (4,4)-tangles.*

Annular tangles are complex in general, but there is an important inroad to Problem 1: the (4,4)-tangles induced by cabling strongly invertible knots. The associated annular (4,4)-tangle always has one straight-line strand, as , so the operator that it induces on Bar-Natan invariants lives in a simpler subcategory. Moreover, when we also restrict the tangle operator to act on invariants of cap-trivial tangles, the context in which these operators arise in the first place, the bimodule becomes tractable and computable through the development of existing tools. I thus propose Problem 2 as a serious stepping stone towards Problem 1.

Problem 2. *Given coprime integers (p, q), describe the bimodules induced by (p, q)-cabling on the subcategory of $\mathcal{W}(S^2_{4,*})$ that is generated by immersed curve invariants of cap-trivial tangles.*

To approach Problem 2, I will first develop an efficient parametrization of the annular tangles corresponding to (p, q)-cabling. It is not difficult to compute explicit examples of these tangles, such as the one pictured in Section 2.3; the main work will be to find ways to describe them as a family. The pattern for the case $q = 1$ is clear enough that the general situation looks promising. This, together with the methods in [HW23], suggests that the annular tangle induced by (p, q)-cabling is the result of a certain mapping class action related to a continued fraction decomposition of the rational number p/q.

Next, I will develop more sophisticated techniques than the ones in [Mar25a]. There, the computation was facilitated by the observation that Bar-Natan's planar algebra formalism reduces to the computation of a 3-crossing cube of resolutions. This certainly does not occur for (p, q) with $p \geq 3$. However, the method of computation that I used for the $(2, 1)$-cabling operator can be streamlined: it is possible to write down a bimodule associated to an annular $(4, 4)$ tangle by computing the image of the operator on a small number of basic tangles. This latter bimodule might not be exactly the one that the annular tangle induces, but there would be a spectral sequence that connects the two. I conjecture that that this spectral sequence collapses when restricting to cap-trivial tangle invariants; this is the case in [Mar25a]. I will approach this conjecture by a similar delicate analysis to the one for the $(2, 1)$-cable. Proving it will enable efficient computation of these induced cabling operators on Bar-Natan invariants of 4-ended tangles, solving Problem 2.

4.2. **A mapping cone formula in Khovanov homology.** The first project of my PhD is the description of a mapping cone formula in Khovanov theory, inspired by the mapping cone formula in Heegaard Floer theory [OS08, OS10, MO25]. The first instance[1] of this latter gives the (hat or plus) Heegaard Floer homology of integer surgery on a knot $K \subset Y$ as a mapping cone determined from the filtration on the knot Floer chain complex $CFK^\infty(K)$. Such a formula, and indeed, a theory akin to knot Floer homology, is missing in Khovanov theory, although a shadows of it showed up (e.g., in [Wat17, Lemma 13]). The idea is that, by the Montesinos trick, a 4-ended tangle T inside of a knot K corresponds to a knot J inside the 3-manifold $\Sigma(K)$, the double cover of S^3 branched

[1] The latter references construct MCFs for rational knot surgery, and for the "minus" and "∞" versions of surgeries on links.

over K. Moreover, Dehn surgery on J corresponds to rational tangle replacement of T. In short, $\Sigma(K_r(T)) = \Sigma(K)_r(J)$. This is particularly clear if K is an unknot, so that $\Sigma(K) = S^3$, and this corresponds precisely to the case mentioned above of cap-trivial tangles.

Problem 3. *Given a knot K, together with a decomposition of K into 4-ended tangles $K = T \cup T^c$, construct filtered bigraded objects $Kh^\circ(K,T)$, together with mapping cone formulas describing $Kh^\circ(K_r(T))$, where $\circ \in \{\widehat{\ }, +, -, \infty\}$ and $K_r(T)$ is the knot obtained by performing an r-framed rational tangle replacement on T.*

It is unclear in the above problem where the filtration should come from and what the object $Kh(K,T)$ should look like in general. Some simplifications make it tractable. First, we may suppose that K is the unknot U (the tangle T may nonetheless be complicated; e.g. the tangles in Fig. 1 could be subtangles of an unknot). The second simplification is to look for a formula for $Kh(U_n(T))$ first, and find the appropriate filtered structure second; this can be readily done using the bordered theory [KWZ19]. Finally, the case of Khovanov homology should be the easiest, as can be gleaned from [MO25], where the algebraic set-up for the "minus" theory is more involved than the one for "hat". Nonetheless, I have shown the following partial result:

Theorem 7 ([Mar23])**.** *Let T be a cap-trivial tangle. Then there is an integer $N \in \mathbb{Z}$ such that the Bar-Natan homology of $T(n)$ (with coefficients in the field $\Bbbk$) is quasi-isomorphic to a mapping cone:*

$$\widetilde{BN}(T(n);\Bbbk) \cong \begin{cases} \text{Cone}\left[\widetilde{BN}(T(N)) \to \Bbbk[H]\right] \oplus \widetilde{BN}^t(T_{2,(n-N)}) & \text{if } n > N \\ \text{Cone}\left[\Bbbk[H] \to \widetilde{BN}(T(N))\right] \oplus \widetilde{BN}^t(T_{2,(n-N)}) & \text{if } n < N, \end{cases}$$

where $\widetilde{BN}^t(T_{2,m})$ is a truncated Bar-Natan homology of the $(2,m)$ torus knot.

The insights gained in the previous work I describe are opening new avenues to further study Problem 3. Beyond the computational benefits of the mapping cone formula in Heegaard Floer theory, it was used to describe new knot invariants that helped to severely restrict the Dehn surgery coefficients of cosmetic surgeries [NW13, Han22]. The straightforward parallel of this work is to use a mapping cone formula in Khovanov theory to study the cosmetic crossing conjecture.

4.3. **The spectral sequence.** Finally, a central problem in the interplay between Khovanov and Heegaard Floer theory is to generalize a spectral sequence due to Ozsváth–Szabó [OS05]. Its second page is the reduced Khovanov homology of (the mirror of) a link L, namely $\widetilde{Kh}(mL;\mathbb{F}_2)$, and it converges to the Heegaard Floer homology group of the branched double-cover, $\widehat{HF}(\Sigma(K);\mathbb{F}_2)$. The Ozsváth–Szabó spectral sequence was the first in a family connecting Khovanov theory with symplectic or gauge-theoretic invariants. Another was constructed by Kronheimer–Mrowka and used to show that Khovanov homology detects the unknot [KM11]; these are important ways of deducing geometric applications from Khovanov homology.

By the Montesinos trick, for each Dehn surgery r on a strongly invertible knot (K,h), there is an Ozsváth–Szabó spectral sequence

$$\widetilde{Kh}(mT_h(r);\mathbb{F}_2) \rightrightarrows \widehat{HF}(S^3_r(K);\mathbb{F}_2),$$

where $T_h(r)$ is the r-framed rational closure of the associated tangle T_h. As a first step, the generalization should be as follows:

Problem 4. *Construct a spectral sequence relating the bordered Heegaard Floer homology of a strongly invertible knot complement and the bordered Khovanov homology of the quotient tangle.*

For example, this suggests that there should be a spectral sequence from the immersed curve invariants in Fig. 1 to the Heegaard Floer immersed curve invariants on page 4, at least over $\mathbb{F}_2$. This indicates that the spectral sequence will be quite interesting. The construction of bimodules supporting that I describe earlier in §4.1 produces a wealth of examples that help constrain Problem 4. Moreover, we can leverage some previous work: since $(1,1)$-knots have tunnel number 1, they are strongly invertible [BM88, §1.3]. Thus, they have an associated tangle, and we have a starting step for analyzing the above spectral sequences and producing partial answers to Problem 4.

Finally, in the study of Problem 3, I have been led to defining decorated cobordisms similar to the ones in [Put14], which were used to understand the theory known as odd Khovanov homology [ORS13]. This latter theory is quite promising: it is not equal to Khovanov homology, but agrees with it over the field $\mathbb{F}_2$, and it is conjectured to admit a spectral sequence akin to Ozsváth–Szabó's, with coefficients in $\mathbb{Z}$. Given the hopes associated with odd Khovanov homology and the importance of working with coefficients in $\mathbb{Z}$, I plan to investigate this theory as well. It may well be the correct theory with which to form a bridge between Khovanov theory and Heegaard Floer theory.

References

Aga23. Mina Aganagic. *Homological knot invariants from mirror symmetry*, pages 2108–2144. EMS Press, December 2023.

Aur10. Denis Auroux. Fukaya categories of symmetric products and bordered heegaard-floer homology. *Journal of Gökova Geometry Topology*, 4:1–54, 2010.

BM88. Steven A. Bleiler and Yoav Moriah. Heegaard splittings and branched coverings of B^3. *Mathematische Annalen*, 281(4):531–543, December 1988.

BN05. Dror Bar-Natan. Khovanov's homology for tangles and cobordisms. *Geometry & Topology*, 9(3):1443–1499, August 2005.

CH23. Wenzhao Chen and Jonathan Hanselman. Satellite knots and immersed Heegaard Floer homology. September 2023.

DHST21. Irving Dai, Jennifer Hom, Matthew Stoffregen, and Linh Truong. More concordance homomorphisms from knot Floer homology. *Geometry & Topology*, 25(1):275–338, March 2021.

DP22. Alessio Di Prisa. The equivariant concordance group is not abelian. *Bulletin of the London Mathematical Society*, 55(1):502–507, October 2022.

GLV18. Joshua Evan Greene, Sam Lewallen, and Faramarz Vafaee. (1,1) L-space knots. *Compositio Mathematica*, 154(5):918–933, March 2018.

GMM05. Hiroshi Goda, Hiroshi Matsuda, and Takayuki Morifuji. Knot Floer Homology of $(1,1)$-Knots. *Geometriae Dedicata*, 112(1):197–214, April 2005.

Han22. Jonathan Hanselman. Heegaard Floer homology and cosmetic surgeries in S^3. *Journal of the European Mathematical Society*, 25(5):1627–1670, March 2022.

Han23. Jonathan Hanselman. Knot Floer homology as immersed curves. May 2023.

Hom15. Jennifer Hom. An infinite-rank summand of topologically slice knots. *Geometry & Topology*, 19(2):1063–1110, April 2015.

HPC21. Matthew Hedden and Juanita Pinzón-Caicedo. Satellites of infinite rank in the smooth concordance group. *Inventiones Mathematicae*, 225(1):131–157, January 2021.

HRW23. Jonathan Hanselman, Jacob Rasmussen, and Liam Watson. Bordered Floer homology for manifolds with torus boundary via immersed curves. *Journal of the American Mathematical Society*, August 2023.

HW23. Jonathan Hanselman and Liam Watson. Cabling in terms of immersed curves. *Geometry & Topology*, 27(3):925–952, June 2023.

Kho00. Mikhail Khovanov. A categorification of the Jones polynomial. *Duke Mathematical Journal*, 101(3), February 2000.

KM11. P. B. Kronheimer and T. S. Mrowka. Khovanov homology is an unknot-detector. *Publications mathématiques de l'IHÉS*, 113(1):97–208, feb 2011.

KWZ19. Artem Kotelskiy, Liam Watson, and Claudius Zibrowius. Immersed curves in Khovanov homology. October 2019.

LOT18. Robert Lipshitz, Peter Steven Ozsváth, and Dylan P. Thurston. *Bordered Heegaard Floer homology.* Number volume 254, number 1216 in Memoirs of the American Mathematical Society. American Mathematical Society, Providence, RI, 2018. Enthält bibliographische Angaben und Index.

LS25. Elise LePage and Vivek Shende. Aganagic's invariant is Khovanov homology. May 2025.

LZ24. Lukas Lewark and Claudius Zibrowius. Rasmussen invariants of Whitehead doubles and other satellites. *Journal für die reine und angewandte Mathematik (Crelles Journal)*, September 2024.

Mar20. Mihai **Marian**. Thinking of (1,1) knots using elastic bands on peg-boards and combed glazing on the mille-feuille. Master's thesis, University of British Columbia, 2020.

Mar23. Mihai **Marian** . Progress on the construction of a relative Bar-Natan invariant. Unpublished thesis proposal, May 2023.

Mar25a. Mihai **Marian**. 2-cabling and tangle operators in Khovanov theory. August 2025.

Mar25b. Mihai **Marian**. A remark on the Lewark–Zibrowius invariant. *Pacific Journal of Mathematics*, 339(1):191–200, September 2025.

MO25. Ciprian Manolescu and Peter Ozsváth. Heegaard Floer homology and integer surgeries on links. *Geometry & Topology*, 29(6):2783–3062, September 2025.

NW13. Yi Ni and Zhongtao Wu. Cosmetic surgeries on knots in s^3. *Journal für die reine und angewandte Mathematik (Crelles Journal)*, 2015(706):1–17, August 2013.

ORS13. Peter S. Ozsváth, Jacob Rasmussen, and Zoltán Szabó. Odd Khovanov homology. *Algebraic & Geometric Topology*, 13(3):1465–1488, April 2013.

OS03. Peter Ozsváth and Zoltán Szabó. Knot Floer homology and the four-ball genus. *Geometry & Topology*, 7(2):615–639, October 2003.

OS04a. Peter Ozsváth and Zoltán Szabó. Holomorphic disks and knot invariants. *Advances in Mathematics*, 186(1):58–116, aug 2004.

OS04b. Peter Ozsváth and Zoltán Szabó. Holomorphic disks and topological invariants for closed three-manifolds. *Annals of Mathematics*, 159(3):1027–1158, may 2004.

OS05. Peter Ozsváth and Zoltán Szabó. On the Heegaard Floer homology of branched double-covers. *Advances in Mathematics*, 194(1):1–33, jun 2005.

OS08. Peter Ozsváth and Zoltán Szabó. Knot Floer homology and integer surgeries. *Algebraic & Geometric Topology*, 8(1):101–153, feb 2008.

OS10. Peter Ozsváth and Zoltán Szabó. Knot Floer homology and rational surgeries. *Algebraic & Geometric Topology*, 11(1):1–68, January 2010.

Put14. Krzysztof K. Putyra. A 2-category of chronological cobordisms and odd Khovanov homology. *Banach Center Publications*, 103:291–355, 2014.

Ras03. Jacob Andrew Rasmussen. *Floer homology and knot complements.* PhD thesis, Harvard University, 2003. Thesis (Ph.D.)–Harvard University.

Ras05. Jacob A. Rasmussen. Knot polynomials and knot homologies. In *Geometry and topology of manifolds*, volume 47 of *Fields Inst. Commun.*, pages 261–280. Amer. Math. Soc., Providence, RI, 2005.

Sak85. Makoto Sakuma. On strongly invertible knots. *Algebraic and topological theories*, pages 176–196, 1985.

Wat17. Liam Watson. Khovanov homology and the symmetry group of a knot. *Advances in Mathematics*, 313:915–946, June 2017.

Zib20. Claudius Zibrowius. Peculiar modules for 4-ended tangles. *Journal of Topology*, 13(1):77–158, March 2020.