

Khovanov homology and uniqueness of surfaces in the 4-ball

Isaac Sundberg

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DMV-Jahrestagung

16 September 2022

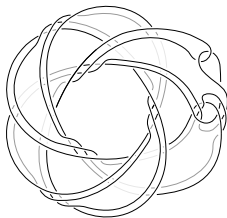


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- 1 Khovanov homology of surfaces
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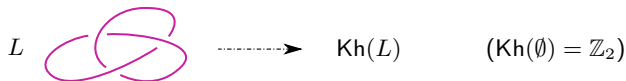
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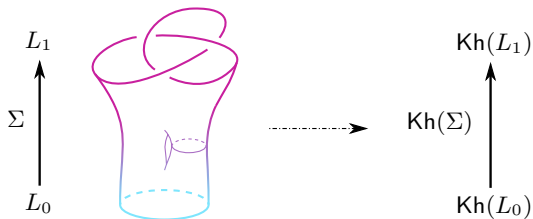
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$$\begin{array}{ccc} L_1 & & \text{Kh}(L_1) \\ \uparrow \Sigma & & \uparrow \\ L_0 & \text{---} & \text{Kh}(\Sigma) \\ & & \uparrow \\ & & \text{Kh}(L_0) \end{array}$$


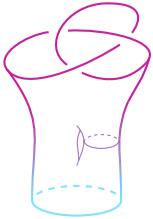
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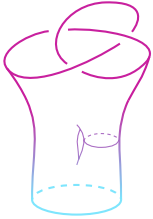

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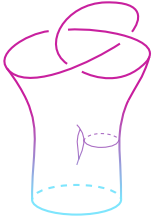

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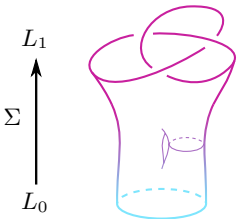

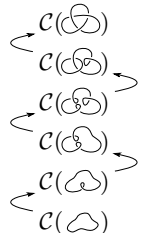
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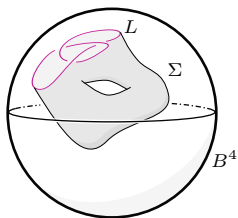
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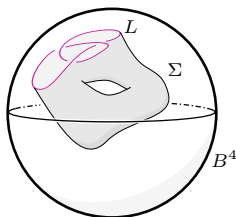
Theorem (MWW19)

Invariance of $\text{Kh}(\Sigma)$ holds for link cobordisms in $S^3 \times [0, 1]$.

Surfaces in the 4-ball

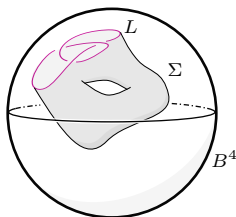


Surfaces in the 4-ball



For smooth, properly embedded surfaces $\Sigma \subset B^4$ bounding a link $L \subset S^3$, we study the link cobordism $L \rightarrow \emptyset$ (can also study the mirror $\emptyset \rightarrow L$).

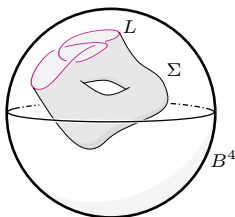
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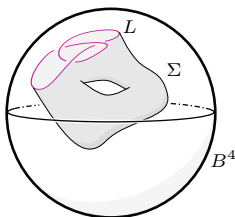


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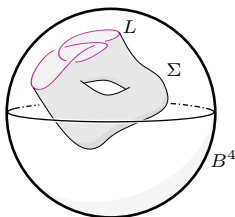


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- Seifert surfaces, $\Sigma \hookrightarrow S^3$

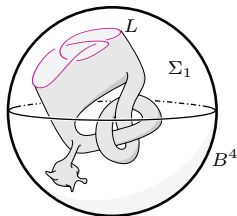
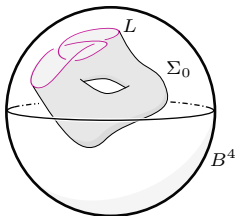
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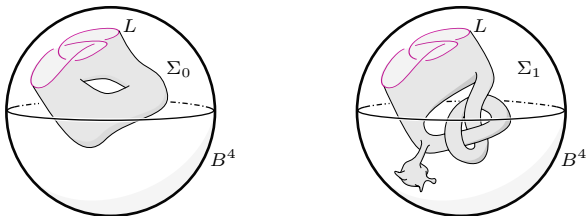
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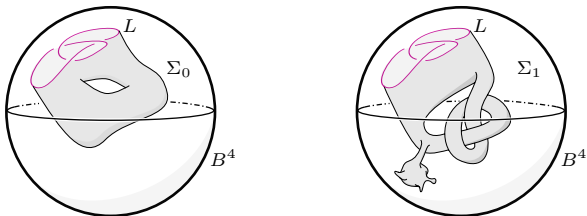
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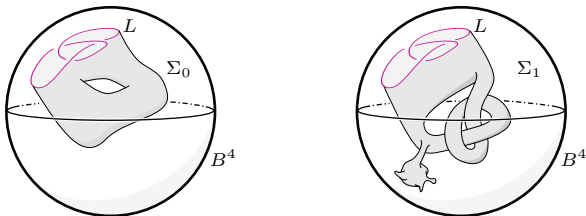


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Strategy: find $\varphi \in \text{Kh}(L)$ such that $\text{Kh}(\Sigma_0)(\varphi) \neq \text{Kh}(\Sigma_1)(\varphi)$

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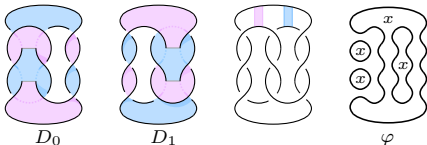
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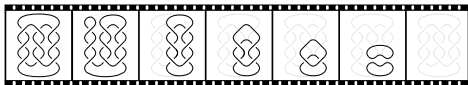
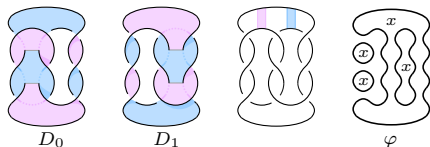
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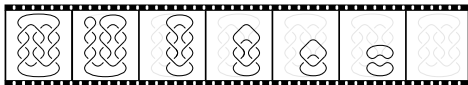
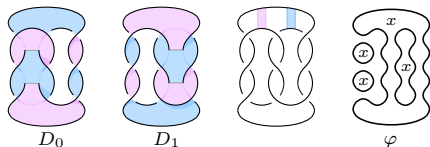
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$$\text{Kh}(D_1)(\varphi) : \text{Diagram 1} \rightarrow \text{Diagram 2} \rightarrow \text{Diagram 3} \rightarrow \text{Diagram 4} \rightarrow \text{Diagram 5} \rightarrow \text{Diagram 6} \rightarrow 1$$

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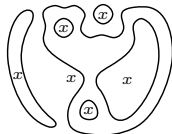
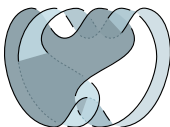
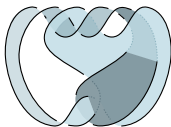
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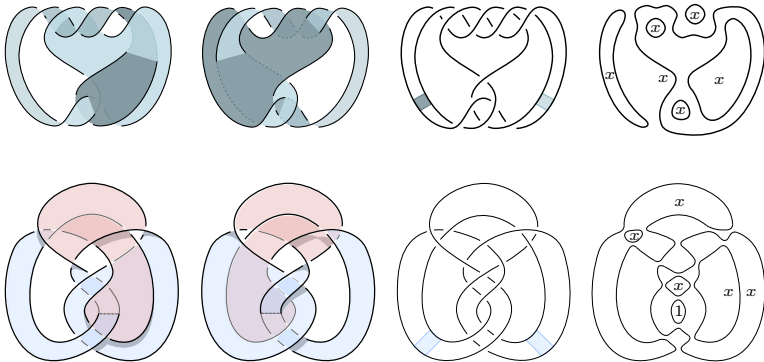
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- recent work extends to nonorientable surfaces [LS21]

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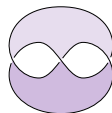
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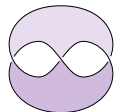
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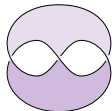
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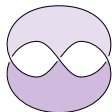
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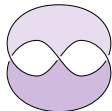
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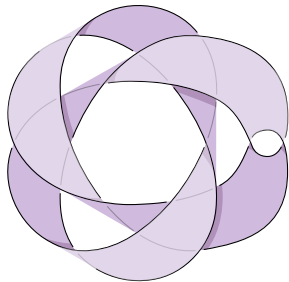
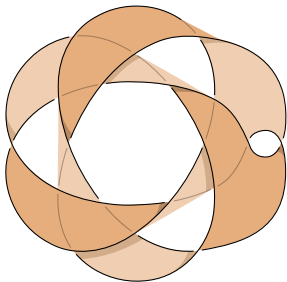
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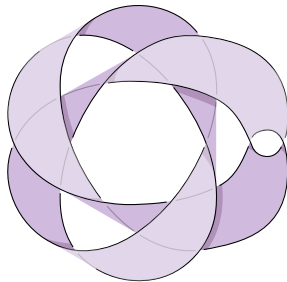
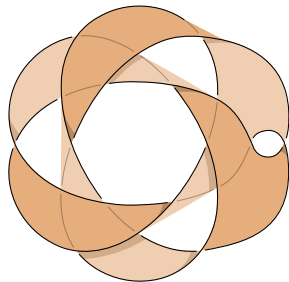
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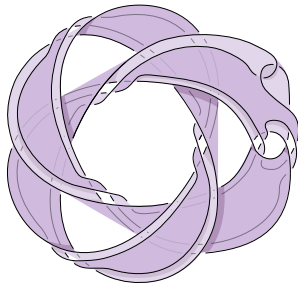
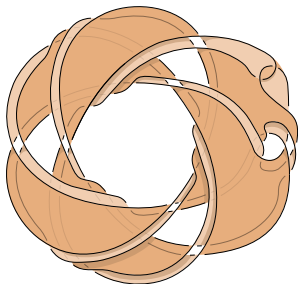


By Whitehead doubling, we produce exotic examples (see [CP20]).

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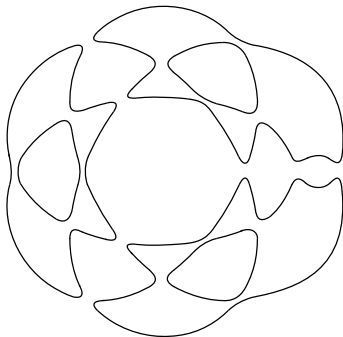


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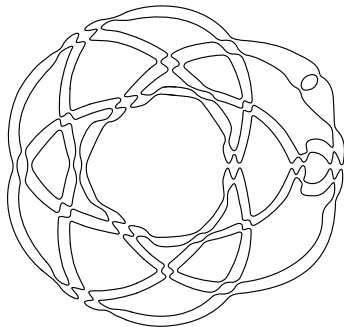


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Proposition (Hayden-Miller-Kim-Park-S. 22)

If J is a nontrivial, strongly quasipositive knot, then $\text{Wh}(J)$ bounds at least two exotic, pushed-in Seifert surfaces in B^4 .

Non-isotopic Seifert surfaces in B^4

Theorem (Hayden-Miller-Kim-Park-S. 22)

There are knots bounding pairs of non-isotopic Seifert surfaces, which remain non-isotopic when pushed into B^4 .

Proposition

If S is a strongly quasipositive Seifert surface for a knot J , then $\text{Wh}(S)$ induces a nontrivial map from $\text{Kh}(\text{Wh}(J))$ to \mathbb{Z}_2 .

Proposition (Hayden-Miller-Kim-Park-S. 22)

If J is a nontrivial, strongly quasipositive knot, then $\text{Wh}(J)$ bounds at least two exotic, pushed-in Seifert surfaces in B^4 .



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- study similar calculations with generalized Khovanov homologies:
 - reduced/odd Khovanov homology
 - deformed Khovanov homology (e.g., Lee and Bar-Natan)
 - Khovanov-Rozansky homology
 - annular Khovanov homology

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- study the induced maps from concordances (link cobordisms $\Sigma \cong S^1 \times [0, 1]$)

Thank You!

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