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On non-isotopic Seifert surfaces in the 4-ball

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Pete (in an informal seminar) and before him Livingston wondered, whether there exist non-isotopic oriented surfaces in the 3-sphere with boundary a fixed knot that remain non-isotopic when pushed into the 4-ball. It turns out that such examples exist, as recently observed by Hayden-Kim-Miller-Park-Sundberg, and, surprisingly, they can be distinguished by a classical invariant: the intersection form on the second homology of the double branched cover.

We report on work in progress with M. Akka, A. Miller, and A. Wieser, where we use an algebraic approach to finding pairs of such examples. A sample result is that, for all positive integers D with D=3 (mod 4) and (D+1)/4 not a prime nor the square of a prime, there exists a knot with determinant D that has genus one Seifert surfaces that remain non-isotopic when pushed into the 4-ball. The relevant algebra input is that the class group of Q(\sqrt(-D)) has non-trivial elements of order different than two. In fact, this class group corresponds to Gauss's group of equivalence classes of integral binary quadratic forms with discriminant -D, and our main result essentially characterizes (in terms of Gauss's group) when two such quadratic forms can arise as the intersection forms of the double branched cover of pushed-in Seifert surfaces of the same knot.

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