Research Result

Jieon Kim

A surface-link is a closed surface smoothly embedded in 4-space. One of fundamental problems in the study of surface-links is to find computable and effective invariants. The most common method of representing surface-link is a broken surface diagram, which is a projection image of it in 3-space with over/under sheet information at each double point curve. Recently established method of representing a surface-link is a marked graph diagram in the plane, which is a classical link diagram possibly with marked 4-valent vertices. Using marked graph representation of surface-links, we have the following results.

• **Generating sets of Yoshikawa moves for marked graph diagrams**
K. Yoshikawa introduced local moves on marked graph diagrams. A collection S of Yoshikawa moves is called a generating set of Yoshikawa moves if any Yoshikawa move is obtained by a finite sequence of the moves in the set S. We give some generating sets of Yoshikawa moves on marked graph diagrams representing surface-links and show independence of certain Yoshikawa moves from the other moves.

• **Ideal coset invariants for surface-links**
Using a state-model involving a given classical link invariant, S.Y. Lee introduced a polynomial [[D]] for a marked graph diagram D. We introduce an ideal coset invariant for surface-links, which is defined to be the coset of the polynomial [[D]] in a quotient ring of a certain polynomial ring modulo some ideal and represented by a normal form (a unique representative for the coset of [[D]]) that can be calculated from [[D]] with help of a Grbner basis package on computer.

• **Computations of quandle cocycle invariants of surface-links using marked graph diagrams**
Using the cohomology theory of quandles, quandle cocycle invariants of oriented surface-links are defined by J.S. Carter, D. Jelsovsky, S. Kamada, L. Langford and M. Saito via broken surface diagrams. J.S. Carter, S. Kamada, and M. Saito defined shadow quandle cocycle invariants of oriented surface-links, generalizations of quandle cocycle invariants. S. Kamada and K. Oshiro introduced the symmetric quandle cocycle invariant for unoriented surface-links via broken surface diagrams. We provide methods of computing them from a given marked graph diagram.

• **Alexander biquandles of oriented surface-links via marked graph diagrams**
T. Carrell defined the fundamental biquandle of oriented surface-links by a presentation obtained from its broken surface diagram, which is an invariant up to isomorphism of the fundamental biquandle. S. Ashihara gave a method of calculating the fundamental biquandles from marked graph diagrams. We deal with computable invariants obtained from the fundamental Alexander biquandles. By using these invariants, non-invertibility of orientable surface-links are discussed.