Holomorphs, Yang-Baxter, and Braids: A Through-line [Abstract]

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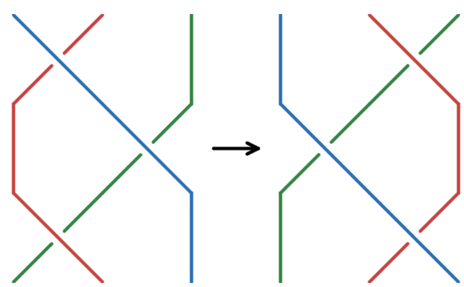
2026

Mathematical braids have wide-reaching applications from fluid dynamics to cryptography and are defined the same way as real-life braids found in hair and challah, just with infinitely thin strands. In particular, a braid is composed of several curves embedded into three dimensional space such that they do not intersect and have fixed points. These are often represented in two dimensions by projecting and then marking one strand going above another with the top strand being solid while the bottom is broken, as shown:



Braids are considered equivalent if one can be turned into the other by moving strands while leaving endpoints fixed and not letting strands intersect, so the two above braids are in fact equivalent. One of the main problems in braid theory is telling them apart, since braids that look different can in fact be equivalent through a series of strand movements. In general, telling braids apart is difficult, and so we use braid invariants to accomplish the task. These are certain values we assign braids that are the same for equivalent braids, so if two braids have a different value for an invariant, they must be different. The contribution of this project is to apply the connection between the holomorph of a group and the set-theoretic Yang-Baxter equation to produce new braid invariants. The concrete examples of this general approach that are investigated are the invariants arising from left- and right-regular subgroups of arbitrary groups and from any subgroups of abelian groups.