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Homology representations of compactified configurations on graphs applied to $\mathcal{M}_{2,n}$.

The homology of a compactified configuration space of a graph is equipped with commuting actions of a symmetric group and the outer automorphism group of a free group. We construct an efficient free resolution for these homology representations. Using the Peter-Weyl Theorem for symmetric groups, we consider irreducible representations individually, vastly simplifying the calculation of these homology representations from the free resolution.

As our main application, we obtain computer calculations of the top weight rational cohomology of the moduli spaces $\mathcal{M}_{2,n}$, equivalently the rational homology of the tropical moduli spaces $\Delta_{2,n}$, as a representation of S_n acting by permuting point labels for all $n \leq 10$. We further give new multiplicity calculations for specific irreducible representations of S_n appearing in cohomology for $n \leq 17$. Our approach produces information about these homology groups in a range well beyond what was feasible with previous techniques. (Received September 21, 2021)