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A quasi-tree expansion of the Krushkal polynomial

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We introduce a generalization of the Krushkal polynomial to nonorientable surfaces, and prove that this polynomial has a natural quasi-tree expansion. This generalized Krushkal polynomial contains the Bollob\'as-Riordan polynomial of a (possibly nonorientable) ribbon graph as a specialization. The quasi-tree expansion proven here then extends the recent quasi-tree expansions of the Bollob\'as-Riordan polynomial deduced in the oriented case by A. Champanerkar et al. and in the more general unoriented case by E. Dewey and F. Vignes-Tourneret. The generalized Krushkal polynomial also contains the Las Vergnas polynomial of a cellulation of a surface as a specialization; we use this fact to deduce a quasi-tree expansion for the Las Vergnas polynomial.

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