

# Graphs with nontrivial planar almost embeddings

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## Abstract

An *almost embedding* of a graph  $G$  is a drawing of  $G$  where only adjacent edges may cross. A drawing of a graph is *reduced* if it contains no empty bigon; equivalently, the number of crossings in the drawing cannot be decreased by homotopies of the edges that do not pass over the vertices. We characterize the class of graphs that have a reduced almost embedding on the sphere with at least one crossing. As an application we improve and generalize a recent result of Garaev about  $K_5$  minus an edge answering a question of A. Skopenkov and Karasev.

Joint work with J. Kynčl.