

## Quadrangulations on the projective plane with $K_{3,4}$ -minors

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A quadrangulation on a closed surface  $F^2$  is a fixed embedding of a simple graph on  $F^2$  with each face is quadrilateral. In 2012, Maharry and Slilaty showed that the structures of graph with no  $K_{3,4}$ -minor were characterized by using patch graph as a special graph. In this talk, we shall characterize the concrete structure with  $K_{3,4}$ -minors for bipartite quadrangulations on the projective plane by two special operations consisting of minor operations. Moreover, we describe relationships between our result and patch graphs.

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