

Abstract

This thesis studies snarks from the perspective of their coverability with four perfect matchings using the *method of tetrahedral flows*. We strengthen the previous results on the NP-completeness of deciding whether a cubic graph can be covered with four perfect matchings. The construction also creates a new infinite class of non-coverable graphs, each based on an arbitrary non-3-edge-colourable cubic graph. We present another infinite class of non-coverable graphs that arises from *5-product*, which is a method for combining two snarks, each containing a 5-cycle, in a Petersen-like manner. The extensive study of *5-product* leads to the introduction of a new concept of *adverse quintuples*, which is crucial for understanding this operation. The method of *5-product* allows us to build large infinite families of non-coverable snarks. In particular, by using *5-product* on already known non-coverable snarks with low circular flow number $\Phi_c < 5$, we present a new rich infinite class of non-coverable nontrivial snarks with low circular flow number $\Phi_c < 5$. Previously, only one family of non-coverable snarks with $\Phi_c < 5$ has been known.