

# PGL<sub>2</sub> Webs on the Torus, the Punctured Torus, and the T-Shirt

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## Abstract

The Kauffman bracket skein algebra (KBSA) of a 3-manifold  $M$  — defined as the free algebra generated by unoriented framed links in  $M$  modulo the Kauffman relations — is generally an object of interest in the study of quantum topology. One particular modification to this construction is to consider instead the free algebra generated by trivalent graphs embedded in  $M$  modulo a different set of relations. This algebra is called the graph skein algebra of  $M$ . In this paper we describe bases for the graph skein algebras of the torus, the punctured torus, and the tee-shirt. Additionally, we fully describe multiplication in the graph skein algebra of the torus, and show that the algebras of the punctured torus and tee-shirt embed into their respective KBSAs. This is not the case for the graph skein algebra of the torus, and is the first known example for which this holds.