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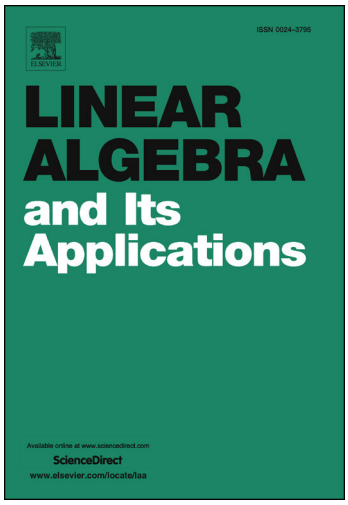

Modular representation theory of BIB designs

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MODULAR REPRESENTATION THEORY OF BIB DESIGNS

AKIHIDE HANAKI, YASUAKI MIYAZAKI, AND OSAMU SHIMABUKURO

Abstract. Our aim is to study the modular representation theory of coherent configurations. Let p be a prime. We consider structures of modular adjacency algebras of coherent configurations obtained from combinatorial designs. The structures of standard modules of modular adjacency algebras provide more information than p-ranks of incidence matrices of combinatorial designs.

1. Introduction

In this paper, we shall provide an interpretation of the p-ranks of the incidence matrices of symmetric balanced incomplete block (BIB) designs and quasi-symmetric Steiner BIB designs with modular representation theory of coherent configurations.

Some researchers have studied the p-ranks of incidence matrices of combinatorial designs [6, 10, 20]. The p-ranks of incidence matrices of combinatorial designs help us to classify combinatorial designs with the same parameters.

On the other hand, we can construct coherent configurations from some combinatorial designs. Each coherent configuration is accompanied by an algebra. It is called an adjacency algebra. Consequently, we can consider the structures of adjacency algebras of coherent configurations obtained from combinatorial designs. An adjacency algebra of a coherent configuration over a field of characteristic zero is always semisimple. This case was studied by Higman [14, 15] and some researchers studied [7, 8, 16, 21, 24]. The semisimplicity of adjacency algebras of coherent configurations over positive characteristic fields was studied [23]. An adjacency algebra of a coherent configuration over a field of positive characteristic is called a modular adjacency algebra. They are not always semisimple. They have not been sufficiently studied. The first author and Yoshikawa have considered the structures of

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Key words and phrases. coherent configuration; quasi-symmetric design; symmetric design ;strongly regular graph; modular adjacency algebra; modular standard module.

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