

## On contracted codes: an extension of Pless' theorem on codes

Tsuyoshi ATSUMI

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**Abstract.** Using Higman's algebra homomorphism, we prove an extension of Pless' theorem on self-orthogonal symmetry codes. Let  $C$  be a self-orthogonal code over  $F$ , where  $F$  is one of  $\text{GF}(2)$ ,  $\text{GF}(3)$ ,  $\text{GF}(4)$ , or  $\text{GF}(p^a)$ . Let  $\tau$  be an automorphism of  $C$ . Then, under some additional conditions on  $\tau$ , the code can be mapped onto a code of a smaller length that is still self-orthogonal.

*Key words:* contracted code, dual code, group, algebra homomorphism.

### 1. Introduction

Pless [10] proved the following interesting result on self-orthogonal symmetry codes:

**Result 1** *Let  $C$  be a symmetry code over  $\text{GF}(3)$  and  $\tau$  an automorphism of  $C$ . Under some additional conditions on  $\tau$ , the code can be mapped onto a code of a smaller length which is still self-orthogonal.*

In this paper we shall extend Result 1 so that we can apply it to a wider class of orthogonal codes with automorphism groups. Our result will be given in Theorem 1 of Section 4.

Our proof of the main theorem in Section 5 is based on the fact that a contraction map given in [4] and [10] is nothing but Higman's algebra homomorphism (Section 2), which puts contraction of codes in a new perspective.

In Section 6 we study the contracted codes of the Golay code  $G_{24}$  and the extended binary quadratic residue code of length 48 as examples. Furthermore, we shall prove the useful lemma 5 which can be applied to decide the contracted code of a given code with a large automorphism group. (This lemma is interesting because it is related to Research Problem (16.4) of MacWilliams-Sloane's book [7].)

The method of attack is based on Higman's algebra homomorphism.