Further Classes of Binary, Ternary and Quaternary Error-Correcting Codes for Quantum Computers using the GO-UP and the CSS Construction from Subfield of Subcodes of Some AG Codes and Their Parameters

Heeralal Janwa[1], Fernando Pinèro[2], Eddie Arrieta[*3],
1 University of Puerto Rico Rio Piedras, 2 University of Puerto Rico Ponce, 3 Inter American University, Bayamon

To overcome decades of obstacles and constraints implied by the no-cloning theorem, Calderbank and Shor constructed codes to control errors in quantum computers. Their construction uses a pair of binary or quaternary error-control codes for classical channels. Classic codes such as Reed-Muller codes provide such pairs. However, their performance is not as good as other Algebraic Error Correcting Codes. In this article, we use codes from algebraic curves over high degree extensions of $\mathbb{F}_2$ to construct the required self–orthogonal binary code or quaternary code pairs. We also present further results on the parameters of the resulting subfield codes over $\mathbb{F}_2$ or $\mathbb{F}_4$ from Hermitian curves, Norm–Trace curves, quasi–Hermitian curves, Castle curves, and others. We use the CSS and the GO-UP construction to derive our results. Several of these results are novel and provide a pathway to make progress towards making quantum computers feasible and practical during the next decade.

Keywords: Quantum error-correcting codes, CSS pair, AG codes, Hermitian, Quasi-Hermitian, Giuletti–Korchmaros, Suzuki, Castle curves, GO-UP Construction.