

國立中央大學數學系

線上專題演講

主 講 人：Dr. Tanmay Singal (Institute of Physics, Nicolaus Copernicus University)

演講題目：Approximate 3-designs and partial decomposition of the Clifford group representations using transvections

演講時間：2022年01月06日(星期四) 3:30 p.m. ~ 5:00 p.m.

線上演講連結：

- (1) <https://meet.google.com/ayr-hvnu-qyx>
- (2) 開啟 google meet 並輸入下列代碼：ayr-hvnu-qyx
- (3) 也可至中央大學鴻經館 M107 一起聽線上演講

Abstract：

We study a scheme to implement an asymptotic unitary 3-design. The scheme implements a random Pauli once followed by the implementation of a random transvection Clifford by using state twirling. Thus the scheme is implemented in the form of a quantum channel. We show that when this scheme is implemented k times, then, in the $k \rightarrow \infty$ limit, the overall scheme implements a unitary 3-design. This is proved by studying the eigendecomposition of the scheme: the $+1$ eigenspace of the scheme coincides with that of an exact unitary 3-design, and the remaining eigenvalues are bounded by a constant. Using this we prove that the scheme has to be implemented approximately $O(m + \log 1/\epsilon)$ times to obtain an ϵ -approximate unitary 3-design, where m is the number of qubits, and ϵ is the diamond-norm distance of the exact unitary 3-design. Also, the scheme implements an asymptotic unitary 2-design with the following convergence rate: it has to be sampled $O(\log 1/\epsilon)$ times to be an ϵ -approximate unitary 2-design. Since transvection Cliffords are a conjugacy class of the Clifford group, the eigenspaces of the scheme's quantum channel coincide with the irreducible invariant subspaces of the adjoint representation of the Clifford group. Some of the subrepresentations we obtain are the same as were obtained in J. Math. Phys. 59, 072201 (2018), whereas the remaining are new invariant subspaces. Thus we obtain a partial decomposition of the adjoint representation for 3 copies for the Clifford group. Thus, aside from providing a scheme for the implementation of unitary 3-design, this work is of interest for studying representation theory of the Clifford group, and the potential applications of this topic. The paper ends with open questions regarding the scheme and representation theory of the Clifford group.

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