CCSU
DEPARTMENT OF MATHEMATICAL SCIENCES
COLLOQUIUM
Friday, November 4

3:00 – 4:00 PM

Maria Sanford, Room 101

PREPARING 2-QUBIT GATES USING CONTROLLED NOT GATES

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Abstract: In this talk we will explain why and how a 2-qubit gate can be prepared using local gates and 3 controlled NOT gates. Using linear algebra notation, we will show that for every 4 by 4 unitary matrix U, there exist 2 by 2 unitary matrices $K_1, \dots, K_8$ such that

$$U = (K_1 \otimes K_2)cn_{01}(K_3 \otimes K_4)cn_{10}(K_5 \otimes K_6)cn_{01}(K_7 \otimes K_8),$$

where $cn_{01} = \begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & 0 & 0 & 1 \\ 0 & 0 & 1 & 0 \\ 0 & 1 & 0 & 0 \end{bmatrix}$ and $cn_{10} = \begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 0 & 1 \\ 0 & 0 & 1 & 0 \end{bmatrix}$.

Along the process of showing the reasons why this decomposition can be done, we solve interesting problems on their own as this one:

Problem 1: Assume that we know that there exist 8 numbers x,y,z,w and u,v,r,s such that
xu=0.6, xv=-0.24, xr=0.08, xs=-2.2, yu=2.1, yv=-0.84, yr=0.28, ys=-7.7,
zu=-0.9, zv=0.36, zr=-0.12, zs=3.3, wu=0.75, wv=-0.3, wr=0.1, ws=-2.75.
Find a solution of the system above.

In general, we will explain how to find the best solution of a system of the form:

xu=b_1, xv=b_2, xr=b_3, xs=b_4, yu=b_5, yv=b_6, yr=b_7, ys=b_8,
zu=b_9, zv=b_{10}, zr=b_{11}, zs=b_{12}, wu=b_{13}, wv=b_{14}, wr=b_{15}, ws=b_{16}

where $b_1, \dots, b_{16}$ are given.

We also provide some properties of the magic matrix $M = \begin{bmatrix} \frac{1}{\sqrt{2}} & 0 & 0 & \frac{i}{\sqrt{2}} \\ 0 & \frac{i}{\sqrt{2}} & \frac{1}{\sqrt{2}} & 0 \\ 0 & \frac{i}{\sqrt{2}} & -\frac{1}{\sqrt{2}} & 0 \\ \frac{1}{\sqrt{2}} & 0 & 0 & -\frac{i}{\sqrt{2}} \end{bmatrix}$

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For further information: gotchevi@ccsu.edu; 860-832-2839; https://web.ccsu.edu/colloquium/