Simulating quantum computation on a macroscopic device

Diederik Aerts[*], Marek Czachor[*,†], Jeroen Dehaene[‡], Bart De Moor[‡]
Ellie D'Hondt[*] and Bart D'Hooghe[*]

We study the specific role played by superposition and entangled states in a quantum computation, by elaborating an entangled spin model developed within the hidden measurement approach of quantum mechanics [1, 2, 3]. For the individual qubits we use a sphere model representation, which is a generalization of the Bloch sphere representation, such that also the collapse and noncollapse measurements are represented [4]. Using the Schmidt diagonal form [5], we show that an arbitrary tensor product state representing two entangled qubits can be described in a complete way by a specific internal constraint between the ray or density states of the two qubits, which describes the behavior of the state of one of the spins if measurements are executed on the other spin. Since any n-qubit unitary operation can be decomposed in two-qubit gates and unary operations [6], 'understanding' two qubit entanglement contributes to understanding the role of n-qubit entanglement in quantum computation. We illustrate our approach on Deutsch's quantum algorithm for two qubits which determines in a single run whether a two-valued function on a domain containing two points is balanced or constant [7]. One of the advantages of the two qubit case besides its relative simplicity is that it allows for a nice geometrical representation of entanglement [8], resulting in a more intuitive grasp of what's going on in a two-qubit quantum computation.

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[*] Leo Apostel Centre, Brussels Free University, Krijgskundestraat 33, 1160 Brussels, Belgium; e-mail: diraerts@vub.ac.be, eldhondt@vub.ac.be, bdhooghe@vub.ac.be

[†] Katedra Fizyki Teoretycznej i Metod Matematycznych, Politechnika Gdańska, 80-952 Gdańsk, Poland; e-mail: mczachor@pg.gda.pl

[‡] SISTA, Department of Electrical Engineering (ESAT), Faculty of Engineering, Catholic University of Leuven, 3000 Leuven, Belgium; e-mail: Jeroen.Dehaene@esat.kuleuven.ac.be, bart.demoor@esat.kuleuven.ac.be