Quantum Information and Computation, Vol. 8, No. 8&9 (2008) 0860–0860

BOOK REVIEW

on

Geometry of quantum states: an introduction to quantum entanglement

by Ingemar Bengtsson and Karol Zyczkowski

Cambridge University Press, 2006

Hardcover $100.00 (416 pages) ISBN: 0-52181-451-0

A long journey to a distant destination can be tedious but, keeping the anticipated pleasure of arrival in mind, we stoically make our way forward. On the other hand, there are travels for which the journey itself is more rewarding than the destination. The subtitle of this book, "An introduction to quantum entanglement", is in fact the subject of the last of fifteen chapters. While this is a worthwhile destination, it is the preceding fourteen chapters that make this book a delight to read and to savour.

In his recent book *The Mathematician's Brain* (Princeton University Press, 2007), David Ruelle writes: "··· some mathematicians (in particular beginners) like to write formulas rather than sentences because they think it is more 'rigorous'. But this practice rapidly produces and incomprehensible mess. Efficient transmission of mathematics to humans depends on lucky choices for what to express with formulas and what to express with words ···. Making these choices ··· is an art and some mathematicians are very much better at it than others" Bengtsson's and Zyczkowski's book is an artful presentation of the geometry that lies behind quantum theory. It begins with the notion of convexity, illustrated by way of colour theory. (Which, apparently, was Schroedinger's field of expertise before it became quantum mechanics). This beginning provides the background for the concepts of statistical distance efficiently treated in chapter two. The book then continues, through a digression on the geometry of spheres, complex projective spaces before taking a first run at the formalism of quantum theory in chapter 5. The following nine chapters extract and develop the intertwining themes of convexity and statistical distance in the quantum context, covering along the way density matrices, purification, majorisation, and quantum operations before landing at the penultimate chapter on monotone metrics and measures. Along the way the authors collect, and artfully explain, many important results scattered throughout the literature on mathematical physics. The careful explication of statistical distinguishability metrics (Fubini-Study and Bures) is the best I have read.

If you want a rapid introduction to quantum entanglement I suspect you should take a shorter journey than provided here, but your life will be the poorer for it. If however you are a mathematical traveller who delights in the unexpected experience, then I suggest you hang a gone fishin' notice on your office door and board the leisurely and stimulating ride conducted by Bengtsson and Zyczkowski.

Gerard J. Milburn (milburn@physics.uq.edu.au)
The University of Queensland, St Lucia 4072 Australia