

Here are some things you can read--they are saved in two files, one with Chapter 2 from "Quantum Computing" and one with the rest of the articles:

1) \*Part of Chapter 2 from Quantum Computing by Michael Nielsen and Isaac Chuang\*  
on Entanglement and Density Matrices

(Notes (1) when they talk about measurements in the density matrix, they use a more general definition of measurements

than what one usually learns. You can just assume that one is measuring the value of a certain operator and if one measures that its value is  $a_n$ , then the wave-function collapses to just the part of it that has the value  $a_n$ . That is described by applying a projection operator  $M_n$  to the wave function.

For this type of measurement some of the formulae can be simplified because  $M_n$  equals its adjoint and  $M_n$  times its adjoint is the same as  $M_n$ . For example, the probability that the value of the operator is  $a_n$

is the expectation value of  $M_n$ . Note 2: The matrices  $X, Y, Z$  are the Pauli matrices.)

2) The paper by Einstein, Podolsky and Rosen about how entanglement contradicts intuitive ideas. It is really neat!

3) \*Paper by Wong et al.--just read section II\* which says how to calculate the entanglement Hamiltonian in relativistically

invariant theories (This is originally due to Bisognano and Wichmann).

4) How to recognize topological order using entanglement: a) In two-D phases.

There are two papers by \*Levin-and-Wen\* and Preskill-and-Kitaev. I think the one by Levin-and-Wen is better to read first (but they are both very neat).

b) In Symmetry Protected phases in 1D (see the beginning of Section III in the paper by Frank Pollmann, Erez Berg and me).

5) A review paper on the area law. The \*introduction\* and sections \*IV.F,H,I\* are the most conceptual sections.

6) The eigenstate thermalization hypothesis: papers by Srednicki and Rigol et al.

other references:

Chapters 11 and 12 of Nielsen and Chuang are about quantum information theory and quantum cryptography.

Quantum Measurement and Entanglement: Decoherence, einselection, and the quantum origins of the classical Wojciech H. Zurek, Rev. Mod. Phys. 75, 715 (2003), arXiv:quant-ph/0105127

Calculation of entanglement Hamiltonians for non-interacting Fermions:

Ingo Peschel, cond-mat/0212631, J. Phys. A, vol. 36, L205

Formula for entanglement entropy of conformal phases:

Geometric and renormalized entropy in conformal field theory

by C. Holzhey, F. Larsen, and F. Wilczek, Nuclear Physics B424 (1994) pg. 443

Calabrese and Cardy, Entanglement Entropy and conformal field theory,

Journal of Physics A Mathematical and General (This one uses conformal field theory, so it is more abstract)

Generalizations of  $c/6 \log L$  to higher dimensions:

Mutual Information and the F-theorem

<http://arxiv.org/pdf/1506.06195v1.pdf> by Casini, Huerta, Myers, and Yale.

Entanglement of Fermi liquids:

Violation of the Entropic Area Law for Fermions, by Wolf, Physical Review Letters, 96 010404 (2006)

Entanglement entropy of fermions in any dimension and the Widom conjecture,

Gioev and Klich, Physical Review Letters, 96, 100503 (2006) arxiv:quant-ph 0504151

You can use entanglement to predict the ordering behavior of a system. The higher dimensional analogue of the central charge (from the paper by Casini et al. helps to predict when gauge forces are confined: "Chiral Symmetry Breaking, Deconfinement and Entanglement Monotonicity" Tarun Grover, Phys. Rev. Lett. 112, 151601 (2014), <http://arxiv.org/abs/1211.1392>).

Entanglement and Anyons: "Entanglement Entropy as a Portal to the Physics of Quantum Spin Liquids", Tarun Grover, Yi Zhang, and Ashvin Vishwanath, New J. Phys. 15, 025002 (2013), arxiv:1302.0899 (see section II)