1. TENSOR RENORMALIZATION GROUP . . . .

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Real space renormalization group methods, such as grouping several neighbouring spins to form a "block spin," or "decimating" all but one representative spin, form a class of methods which implement renormalization group (RG) ideas in a simple way. In practice, however, these have not proven to be very efficient methods of obtaining accurate values for critical exponents. A new method, called the tensor renormalization group [1], builds upon new ideas from quantum information to design a more efficent method of finding critical exponents. Ref. [2] applies these ideas to the 2-dimensional square Ising model and finds significant improvement compared to Migdal-Kadanoff blocking methods; this and a few of its references might be a good place to start reading.
The successful essay will

- Very briefly review real space renormalization group methods, such as "blocking" or "decimation" (see e.g. [3,4]).
- Very briefly review the main idea of tensor network states (see e.g. [5]) which motivate the tensor RG.
- Discuss in some detail how tensor RG works in some specific case.

Relevant Courses

Essential: Statistical Field Theory

References

[1] M. Levin and C.P. Nave, Phys. Rev. Lett. **99**, 120601 (2007).
[2] Y. Meurice, Phys. Rev. B, **87**, 064422 (2013).
[3] J.J. Binney, N.J. Dowrick, A.J. Fisher, and M.E.J. Newman, *The Theory of Critical Phenomena* (Oxford University Press, 1992).
[4] M. Kardar, *Statistical Physics of Fields* (Cambridge University Press, 2007).
[5] J.I. Cirac and F. Verstraete, J. Phys. A **42**, 504004 (2009) [arXiv:0910.1130].