

# This Week's Citation Classic

**Domb C.** On the theory of cooperative phenomena in crystals. *Advan. Phys.* **9**:149-361, 1960. [King's College, University of London, London, England]

The article reviews theoretical developments relating to interacting systems on crystal lattices, focussing particular attention on discontinuous behaviour which arises from the interactions. An account is given of exact solutions. A critical assessment is undertaken of approximations used when exact methods are not available. [The *SCI*<sup>®</sup> indicates that this paper has been cited over 560 times since 1961.]

C. Domb  
Department of Physics  
King's College  
University of London  
London WC2R 2LS  
England

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"When I started research in the late-1940s at Cambridge on the statistical mechanics of interacting systems, the subject was distinctly unfashionable, and not more than a dozen people all over the world were actively engaged in research in this area. The remarkable exact solution by Onsager in 1944<sup>1</sup> of the two-dimensional Ising model showed that standard approximations which had been used previously were completely unreliable in relation to critical behaviour and phase transitions. The cluster integral theory of condensation provided an elegant formal structure, but detailed calculations proved prohibitively difficult. It was clear that some new approach was needed.

"My own contribution contained in my PhD thesis was to illustrate the advantages of lattice models, and to explore the development of perturbation series expansions for lattice models as a tool in the assessment of critical behaviour. In 1949, I moved to Oxford with an ICI fellowship and was fortunate in attracting a number of graduate students of ability (among them CM. Bell, R.B. Potts, and M.F. Sykes) who helped me to develop my ideas. A few years later, when I was appointed to the chair of theoretical physics at King's College, London, Sykes joined me, and I persuaded ME. Fisher (who was just completing his doctorate at King's) to interest himself in our

problems. During the next few years we were able to make substantial progress, and a coherent picture began to emerge. Other workers using different approaches were also gaining new in-sights; by 1960 the time seemed ripe for a review article which would coordinate all the information available.

"The review article which I then wrote runs to more than 200 pages and is really a book. I believe that one of the reasons why it is still quoted after more than 20 years is its definitive nature. It was not much concerned with ephemeral points under current discussion, but with established results likely to remain permanent, and it was written at a time when a sufficient number of such results became available which had not been collected together before.

"I remember feeling a definite sense of achievement when the article was completed. It was useful for my new graduate students who wished to learn about the field, and I think it was widely used for the same purpose elsewhere.

"But probably the main reason for its success as a standard reference was the great progress which occurred in the field of critical phenomena during the two succeeding decades. In the 1960s<sup>2</sup> a beautiful empirical pattern emerged, usually characterized by the terms *scaling* and *universality*; and in the 1970s<sup>3</sup> an explanation of this pattern was forthcoming in terms of the *renormalization group*. Many theoretical and experimental physicists of great ability were attracted to the field, and the literature burgeoned. My review was often cited as a starting point summarizing the early literature.

"For anyone interested in articles reviewing these subsequent developments, I would recommend the 1967 review article by Fisher<sup>4</sup> (which has itself become a *Citation Classic*), two reviews on the renormalization group,<sup>5,6</sup> and a series of review volumes<sup>7</sup> which I edited with the late M.S. Green. The latter provide clear evidence of the expansion of the field. Currently, I am editing further volumes in the series together with J.L. Lebowitz."

1. **Onsager L.** Crystal statistics. *Phys. Rev.* **65**:117-49, 1944.
2. **Griffiths R B.** Thermodynamic functions for fluids and magnets near the critical point. *Phys. Rev.* **158**:176-87, 1967.
3. **Wilson K G.** Renormalization group and critical phenomena. *Phys. Rev. B* **4**:3184-205, 1971.
4. **Fisher M E.** The theory of equilibrium critical phenomena. *Rep. Progr. Phys.* **30**:615-730, 1967. [Citation Classic. *Current Contents/Physical, Chemical & Earth Sciences* **20**(46): 18, 17 November 1980.]
5. **Wilson K G & Kogut J.** The renormalization group and the  $\epsilon$ -expansion. *Phys. Rep.* **12C**:75-200, 1974.
6. **Fisher M E.** The renormalization group in the theory of critical behaviour. *Rev. Mod. Phys.* **46**:597-616, 1974.
7. **Domb C & Green M S,** eds. *Phase transitions and critical phenomena*. London: Academic Press, 1972-1976. Vols. 1-6.