Research - J. Dimock

My research has been various areas of mathematical physics, especially in statistical mechanics and quantum field theory. Here are the main areas of interest:

1. **conformal field theory/ string theory**

   Conformal field theory is massless quantum field theory on a Riemann surface. This has many special features not found in general field theories. It has applications to the study of critical phenomena for two dimensional statistical mechanical systems. But the main interest is as a framework for string theory - a model for elementary particle physics which gives structure on a very small scale - about 10^{-33} cm . (Contrast the more well-established quantum field theory which models physics on a scale down to about 10^{-16} cm)

   selected papers:

   (a) Locality in free string field theory, Journal of Mathematical Physics 41 (2000), 40-61.
   (b) Locality in free string field theory-II, Annales Henri Poincaré, 3 (2002), 613-634.
   (c) Markov quantum fields on a manifold, Reviews in Mathematical Physics 16 (2004) 243-255.
   (d) Transition amplitudes and sewing properties for bosons on the Riemann sphere, Journal of Mathematical Physics 48 (2007), 052308 -(1-31).

2. **renormalization group**

   Many problems in statistical mechanics and quantum field theory can be formulated as the evaluation of integrals of certain densities over infinite dimensional spaces. The renormalization group (which is not a group) is a technique for breaking this up into a series of finite dimensional integrals and tracking the corresponding flow on densities. This has been useful for studying critical phenomena in statistical mechanics. It has also been a powerful tool in the construction of quantum field theory models.

selected papers:

(a) (with D. Brydges, T. Hurd) The short distance behavior of ϕ_3^4, Comm. Math. Phys. 172 (1995), 143-186.

(b) (with D. Brydges, T. Hurd), A non-Gaussian fixed point for ϕ^4 in 4-ϵ dimensions, Communications in Mathematical Physics 198 (1998), 111-156.

(c) Bosonization of massive fermions, Communications in Mathematical Physics 198 (1998), 247-281.

(d) (with T. Hurd), Sine-Gordon revisited, Annales Henri Poincaré, 1 (2000), 491-541.

3. **quantum field theory on manifolds**

The general problem is to construct and study quantum field theories on a manifold with a Lorentzian metric, usually with a linear field equation. This is a nice testing ground for combining the somewhat antagonistic features of quantum field theory and general relativity. It has potential applications to black hole physics and cosmology.

selected papers:

(a) Algebras of local observables on a manifold, Communications in Mathematical Physics 77 (1980), 219-228.

(b) Dirac quantum fields on a manifold, Transactions of the American Mathematical Society 269 (1982), 133-147.

(c) Scattering for the wave equation on the Schwarzchild metric, General Relativity and Gravitation 17 (1985), 353-369.

(d) (with B. Kay) Scattering for massive scalar fields on Coulomb potentials and Schwarzchild metrics, Classical and Quantum Gravity 3 (1986), 71-80.

(e) Quantized electromagnetic field on a manifold, Reviews in Mathematical Physics 4 (1992) 223-233.