PROJECT SUMMARY:
QUANTUM TECHNIQUES FOR STOCHASTIC PHYSICS

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Feynman diagrams and related techniques from quantum physics can also be applied to collections of *classical* particles interacting in a random way. Though this fact has been known for some time, the PI has recently shown that something much bigger is at work here: we can take quantum theory, substitute probabilities for amplitudes throughout, and obtain techniques for studying 'stochastic physics': that is, classical systems with random interactions.

The main result of the proposed project will be a deeper understanding of stochastic systems, obtained using techniques from quantum field theory. Stochastic systems are widely studied in chemistry, where molecules are often approximately treated as classical but subject to random interactions. Some of these systems function as 'biological clocks' and 'switches' in living organisms. Chemists have proved powerful theorems about these systems, but quantum techniques will give significant improvements of their work. This is especially true when 'finite size effects' are important: in other words, when we cannot take the limit as the number of molecules involved goes to infinity, this being analogous to a 'classical limit'.

The **intellectual merit of the proposed activity** is that it will turn techniques from quantum physics toward a large new range of very practical applications. Tools such as creation and annihilation operators, coherent states and the like are often seen as limited to quantum physics. In fact they will be useful in stochastic physics as well, with potentially major benefits to chemistry and biology.

The **broader impacts resulting from the proposed activity** include starting a new dialogue between mathematical chemists and quantum field theorists. Experts in these subjects are largely unaware of the mathematical bridge linking their work. Inviting two top experts in mathematical chemistry to visit, and training two graduate students in both fields, will address this problem. The PI, well-known on the internet, will also widely publicize the results of this research and these visits.