Solving Integer Factorization with Stochastic Magnetic Tunnel Junctions and a Quantum Adiabatic Algorithm

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Optimization problems are a class of computationally complex problems that conventional computers struggle to solve. This struggle stems from the fact that optimization problems search for the most efficient solution out of a multitude of possible answers. Quantum computing shows potential for solving these problems, but is currently limited by technological barriers including decoherence, the number of implementable many-body interactions, and a current requirement of cryogenic temperatures for operation.

In this work, we demonstrate the use of a probabilistic computer to solve integer factorization, which can be cast as an optimization problem [1]. We develop an algorithm initially from the field of adiabatic quantum computing, but instead connect bits electrically, which allow us to circumvent some of the above challenges quantum computing faces. We implement these bits as probabilistic bits, or p-bits, which are composed of stochastic magnetic tunnel junctions (s-MTJs) fluctuating in time between 0 and 1 at room temperature. We first describe the characterization of s-MTJs where we modify a typical magneto-resistive random-access memory (MRAM) stack structure. We then connect the s-MTJ with CMOS circuit components to create a p-bit where the probability for the output to be either 0 or 1 is controlled by the input. By connecting eight p-bits we then demonstrate integer factorization up to 945. These result show that probabilistic computing with p-bits can provide a classical analog to quantum computing and offer a scalable hardware for solving optimization problems.

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