FPD-77

SINGLE-FLUX QUANTUM LOGIC CIRCUITS EXPLOITING COLLISION-BASED FUSION GATES

T. Asai, Y. Amemiya
(Hokkaido University)

We propose a single-flux-quantum (SFQ) logic system based on the reaction-diffusion-collision fusion computation.

The fusion computation is a way of digital processing that performs logic operation by applying analogy of nonlinear physical and chemical systems to the structure of the logic operation (see [1] for details). It is very powerful for implementing a given digital operation with a small number of logic gates.

A fusion computation system consists of regularly arrayed unit cells, where each cell has two input arms and two output arms and is connected to its neighboring cells with the arms. Each cell accepts two input signals A and B and produces two output signals AB’ and A’B. A fusion computation system, as a whole, can operate any combinational logic function.

We designed functional SFQ circuits that implemented the fusion computation. The unit cell was able to be made with ten Josephson junctions. Circuit simulation showed that SFQ fusion computation systems could operate at very high speed, about ten times faster than conventional CMOS logic systems.

Reference

[1] Yamada K., Motoike I.N., Asai T., and Amemiya Y., "Design methodologies for compact logic circuits based on collision-based computing," IEICE Electron. Express, vol. 3, no. 13, pp. 292-298, 2006.