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POS-G70 – Implementation of skyrmion cellular automaton using Brownian motion

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The quantum dot cellular automaton (QCA) is a device that uses the interaction between confined electrons in aligned cells to transfer and process information. In QCA architecture, two antipodal arrangements of two electrons confined in square shaped cell are defined as digital "0"and "1". QCA requires no electrical current for its operation therefore, extremely low power computing can be realized.[1] However, the operation of QCA is limited at cryogenic temperature.[2,3] In this study, we demonstrated a device similar to QCA utilizing magnetic skyrmion instead of electron at room-temperature. Ta/CoFeB/Ta/MgO/SiO2 thin films were deposited on thermally oxidized silicon substrates at room-temperature through magnetron sputtering. Skyrmions observed in our films showed Brownian motion at room-temperature. This Brownian motion of skyrmions was utilized to transfer and process information. Square-shaped cells containing single skyrmion or pair of skyrmions were implemented by controlling the magnetic anisotropy of the continuous magnetic film.[4] At first, we fabricated neighbored two cells containing pair of skyrmions and found the correlation coefficient between the y-coordinate of the skyrmions near the gap was negative. The negative correlation coefficient indicates that the repulsive interaction between the skyrmions works across the two isolated regions. Next, we investigated interaction between single fixed skyrmions and pair of free skyrmions skyrmions confined in different cells. By changing distance between two cells, we clarified magnitude of repulsive interaction between skyrmions depended on distance. These results show that the Brownian motion of skyrmions has the potential to realize a novel computing architecture similar to QCA. Detailed experimental method and results will be discussed at the presentation.

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