

# 圏論的量子力学 練習問題 1.4(b)

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$$\begin{array}{ccccc}
 (A \otimes C) \otimes B & \xleftarrow{\alpha_{A,C,B}^{-1}} & A \otimes (C \otimes B) \\
 \downarrow \sigma_{A,C} \otimes Id_B & & \uparrow Id_A \otimes \sigma_{B,C} \\
 (C \otimes A) \otimes B & \circlearrowleft \text{六角等式} & A \otimes (B \otimes C) \\
 \downarrow \alpha_{C,A,B} & & \uparrow \alpha_{A,B,C} \\
 C \otimes (A \otimes B) & \xleftarrow{\sigma_{A \otimes B, C}} & (A \otimes B) \otimes C \\
 \downarrow Id_C \otimes \sigma_{A,B} & \circlearrowleft \text{自然変換 } \sigma & \downarrow \sigma_{A,B} \otimes Id_C \\
 C \otimes (B \otimes A) & \xleftarrow{\sigma_{B \otimes A, C}} & (B \otimes A) \otimes C \\
 \downarrow \alpha_{C,B,A}^{-1} & & \downarrow \alpha_{B,A,C} \\
 (C \otimes B) \otimes A & \circlearrowleft \text{六角等式} & B \otimes (A \otimes C) \\
 \uparrow \sigma_{B,C} \otimes Id_A & & \downarrow Id_B \otimes \sigma_{A,C} \\
 (B \otimes C) \otimes A & \xleftarrow{\alpha_{B,C,A}^{-1}} & B \otimes (C \otimes A)
 \end{array}$$