6.5 a) $\vec{K} = (K_1, K_2, K_3)^T$, $K_i = -i\frac{1}{2}\sigma_i$, so,

$$B_1(\varphi_1) = \exp\{\tfrac{1}{2}\varphi_1\sigma_1\} = \sum_{k=0}^{\infty} \frac{1}{k!}\frac{1}{2^k}\varphi_1^k\sigma_1^k = \sum_{k=0}^{\infty}\left(\frac{1}{2^{2k}(2k)!}\varphi^{2k}\mathbb{1} + \frac{1}{2^{2k+1}(2k+1)!}\varphi^{2k+1}\sigma_1\right)$$

$$= \mathbb{1}\cosh\left(\frac{\varphi_1}{2}\right) + \sigma_1\sinh\left(\frac{\varphi_1}{2}\right) = \begin{pmatrix} \cosh(\varphi_1/2) & \sinh(\varphi_1/2) \\ \sinh(\varphi_1/2) & \cosh(\varphi_1/2) \end{pmatrix}$$

b) Using the above, we can get,

$$B_2(\varphi_2) = \mathbb{1}\cosh\left(\frac{\varphi_2}{2}\right) + \sigma_2\sinh\left(\frac{\varphi_2}{2}\right) = \begin{pmatrix} \cosh(\varphi_2/2) & -i\sinh(\varphi_2/2) \\ i\sinh(\varphi_2/2) & \cosh(\varphi_2/2) \end{pmatrix}$$

c) Again, we have that,

$$B_3(\varphi_3) = \mathbb{1}\cosh\left(\frac{\varphi_3}{2}\right) + \sigma_3\sinh\left(\frac{\varphi_3}{2}\right) = \begin{pmatrix} \cosh(\frac{\varphi_3}{2}) + \sinh(\frac{\varphi_3}{2}) & 0 \\ 0 & \cosh(\frac{\varphi_3}{2}) - \sinh(\frac{\varphi_3}{2}) \end{pmatrix}$$

$$= \begin{pmatrix} e^{\varphi_3/2} & 0 \\ 0 & e^{-\varphi_3/2} \end{pmatrix}$$