$U(\sigma p)U^{-1}\,U\psi = E\,U\psi$

$\begin{pmatrix} 1 & \\ & -1 \end{pmatrix} U\psi_\pm = \pm U\psi_\pm$

$H = (\sigma p)$

$(\sigma p)\psi = E\psi$

$\sigma p = p(\sigma_x \sin\theta\cos\varphi + \sigma_y \sin\theta\sin\varphi + \sigma_z\cos\theta)$

$= p\begin{pmatrix} \cos\theta & e^{-i\varphi}\sin\theta \\ e^{i\varphi}\sin\theta & -\cos\theta \end{pmatrix}$ $\begin{pmatrix} 1 & 0 \\ 0 & -1 \end{pmatrix}$

$\begin{pmatrix} \cos\theta & e^{-i\varphi}\sin\theta \\ e^{i\varphi}\sin\theta & -\cos\theta \end{pmatrix}\begin{pmatrix} a_{11} & a_{12} \\ a_{21} & a_{22} \end{pmatrix} = \begin{pmatrix} a_{11} & a_{12} \\ a_{21} & a_{22} \end{pmatrix}$

$= \begin{pmatrix} a_{11} & -a_{12} \\ a_{21} & -a_{22} \end{pmatrix}$

$\cos\theta = 2\cos^2\frac{\theta}{2} - 1$

$= \begin{pmatrix} e^{-\frac{i\varphi}{2}}\cos\frac{\theta}{2} & +e^{-\frac{i\varphi}{2}}\sin\frac{\theta}{2} \\ e^{\frac{i\varphi}{2}}\sin\frac{\theta}{2} & e^{\frac{i\varphi}{2}}\cos\frac{\theta}{2} \end{pmatrix}$

$\sqrt{\frac{(1+\cos\theta)}{2}} = \cos\frac{\theta}{2}$

$\left(\cos^2\frac{\theta}{2} - \sin^2\frac{\theta}{2}\right)e^{-\frac{i\varphi}{2}}\cos\frac{\theta}{2} + 2e^{-\frac{i\varphi}{2}}\sin^2\frac{\theta}{2}\cos\frac{\theta}{2}$

$= e^{-\frac{i\varphi}{2}}\cos\frac{\theta}{2} = a_{11}$

$2e^{\frac{i\varphi}{2}}\sin\frac{\theta}{2}\cos^2\frac{\theta}{2} - \left(\cos^2\frac{\theta}{2} - \sin^2\frac{\theta}{2}\right)e^{\frac{i\varphi}{2}}\sin\frac{\theta}{2}$

$= e^{\frac{i\varphi}{2}}\sin\frac{\theta}{2} = a_{21}$

$\left(\cos^2\frac{\theta}{2} - \sin^2\frac{\theta}{2}\right)e^{-\frac{i\varphi}{2}}\sin\frac{\theta}{2} + 2e^{-\frac{i\varphi}{2}}\sin^2\frac{\theta}{2}\cos\frac{\theta}{2}$

$= e^{-\frac{i\varphi}{2}}\sin\frac{\theta}{2}$

$2e^{\frac{i\varphi}{2}}\sin\frac{\theta}{2}\cos\frac{\theta}{2}\sin\frac{\theta}{2} - e^{\frac{i\varphi}{2}}\left(\cos^2\frac{\theta}{2} - \sin^2\frac{\theta}{2}\right)\cos\frac{\theta}{2}$

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$$\left.\begin{aligned} J_1 &= L_1 + \frac{x_1}{x+x_3} S \\ J_2 &= L_2 + \frac{x_2}{x+x_3} S \\ J_3 &= L_3 + S \end{aligned}\right\} \quad S = \frac{1}{2}\left(\sigma_2 - \frac{1}{2}\right)$$

$$L_1 = x_2 p_3 - x_3 p_2$$

$$L_2 = x_3 p_1 - x_1 p_3$$

$$L_3 = x_1 p_2 - x_2 p_1$$

$$x_2\left(-i\hbar\frac{\partial}{\partial x_3} + \qquad\right) - x_3\left(-i\hbar\frac{\partial}{\partial x_2} + \qquad\right)$$

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