

$$\frac{1}{0} \begin{vmatrix} 0 \\ -1 \end{vmatrix} = \frac{a}{d} \begin{vmatrix} b \\ c \end{vmatrix} \frac{1}{0} \begin{vmatrix} 0 \\ -1 \end{vmatrix} \frac{a^*}{d} \begin{vmatrix} b \\ c \end{vmatrix} = \frac{a}{d} \begin{vmatrix} b \\ c \end{vmatrix} \frac{1}{0} \begin{vmatrix} 0 \\ -1 \end{vmatrix} \frac{\hat{a}}{\hat{b}} \begin{vmatrix} \hat{d} \\ \hat{c} \end{vmatrix} = \frac{a\hat{a} - b\hat{b}}{d\hat{a} - c\hat{b}} \begin{vmatrix} \hat{a}\hat{d} - \hat{b}\hat{c} \\ \hat{d}\hat{d} - \hat{c}\hat{c} \end{vmatrix}$$

$${}^w g = w \frac{a}{d} \begin{vmatrix} b \\ c \end{vmatrix} = \underbrace{a + wd}_{-1} \underbrace{b + wc}_{-1} = \underbrace{\hat{a}w + \hat{d}}_{-1} \underbrace{\hat{b}w + \hat{c}}_{-1}$$

$$\underbrace{a + wd}_{=1} \underbrace{\hat{a}w + \hat{d}}_{=0} - \underbrace{b + wc}_{=0} \underbrace{\hat{b}w + \hat{c}}_{=0} = \underbrace{a\hat{a} - b\hat{b}}_{=0} w + \underbrace{ad^* - bc^*}_{=0} + w \underbrace{d\hat{a} - c\hat{b}}_{=0} w + w \underbrace{dd^* - cc^*}_{=-1} = w - w = 0$$

$$\Rightarrow \underbrace{a + wd}_{-1} \underbrace{\hat{a}w + \hat{d}}_{-1} = \underbrace{b + wc}_{-1} \underbrace{\hat{b}w + \hat{c}}_{-1}$$

$$c - d {}^w g = \underbrace{\hat{b}w + \hat{c}}_{-1}$$

$$\underbrace{c - d {}^w g}_{=0} \underbrace{\hat{b}w + \hat{c}}_{-1} = c \underbrace{\hat{b}w + \hat{c}}_{-1} - d \underbrace{\hat{a}w + \hat{d}}_{-1} = \underbrace{c\hat{b} - d\hat{a}}_{=0} w + \underbrace{c\hat{c} - d\hat{d}}_{=1} = 1$$

$$\dot{w} \underbrace{{}^w g}_{-1} = \underbrace{a + wd}_{-1} \dot{w} \underbrace{\hat{b}w + \hat{c}}_{-1}$$

$$\underbrace{a + wd}_{-1} {}^w g = b + wc \Rightarrow \dot{w} c = \dot{w} d {}^w g + \underbrace{a + wd}_{-1} \dot{w} \underbrace{{}^w g}_{-1}$$

$$\Rightarrow \underbrace{a + wd}_{-1} \dot{w} \underbrace{{}^w g}_{-1} = \dot{w} \underbrace{c - d {}^w g}_{-1} = \dot{w} \underbrace{\hat{b}w + \hat{c}}_{-1}$$

$$x^u \underbrace{\hat{g}}_{-1}^\dagger = \underbrace{\hat{a} + d^* \hat{u}}_{-1} x \underbrace{\hat{b} + c}_{-1}$$