

$$\begin{aligned}
\overset{*}{C}C &= \overline{I - z\overset{*}{z}} \\
\zeta_z &= \overline{I - z\overset{*}{z}} \underbrace{\zeta - z\bar{\zeta}} \\
\gamma_z^{-1}\zeta &= C \underbrace{\zeta - z\bar{\zeta}} = C \overbrace{\overset{*}{C}C}^{-1/2} \overbrace{\overset{*}{C}C}^{1/2} \underbrace{\zeta - z\bar{\zeta}} = C \overbrace{\overset{*}{C}C}^{-1/2} \overbrace{I - z\overset{*}{z}}^{-1/2} \underbrace{\zeta - z\bar{\zeta}} = C \overbrace{\overset{*}{C}C}^{-1/2} \zeta_z
\end{aligned}$$

$$\underbrace{\gamma_z^{-1}\zeta} | \underbrace{\gamma_z^{-1}\omega} = \zeta_z | \omega_z$$

$$\overbrace{C \overset{*}{C} C}^{-1/2} \text{ unitary}$$

$$\begin{aligned}
\zeta_w &= u^{-1/2} \overline{\underbrace{w + e\zeta}_+ + \underbrace{w - e\bar{\zeta}}_-} \\
&\frac{1 - u^{1/2} \overbrace{\dot{w} + \overset{*}{w}}^{-1} u^{1/2}}{\dot{u}^{1/2} \overbrace{\dot{w} + \overset{*}{w}}^{-1} u^{1/2}} \left| \frac{u^{1/2} \overbrace{\dot{w} + \overset{*}{w}}^{-1} \dot{u}^{1/2}}{1 - \dot{u}^{1/2} \overbrace{\dot{w} + \overset{*}{w}}^{-1} \dot{u}^{1/2}} \right. \\
&\left[\overset{*}{\omega} u^{-1/2} \quad \overset{+}{\zeta} \dot{u}^{-1/2} \right] \frac{1 - u^{1/2} \overbrace{\dot{w} + \overset{*}{w}}^{-1} u^{1/2}}{\dot{u}^{1/2} \overbrace{\dot{w} + \overset{*}{w}}^{-1} u^{1/2}} \left| \frac{u^{1/2} \overbrace{\dot{w} + \overset{*}{w}}^{-1} \dot{u}^{1/2}}{1 - \dot{u}^{1/2} \overbrace{\dot{w} + \overset{*}{w}}^{-1} \dot{u}^{1/2}} \right. \left[\begin{matrix} u^{-1/2} \bar{\alpha} \\ \dot{u}^{-1/2} \zeta_z \end{matrix} \right] \\
&= \left[\overset{*}{\omega} u^{-1/2} \quad \overset{+}{\zeta} \dot{u}^{-1/2} \right] \left[\begin{matrix} \left(1 - u^{1/2} \overbrace{\dot{w} + \overset{*}{w}}^{-1} u^{1/2} \right) u^{-1/2} \bar{\alpha} + u^{1/2} \overbrace{\dot{w} + \overset{*}{w}}^{-1} \dot{u}^{1/2} \dot{u}^{-1/2} \zeta_z \\ \dot{u}^{1/2} \overbrace{\dot{w} + \overset{*}{w}}^{-1} u^{1/2} u^{-1/2} \bar{\alpha} + \left(1 - \dot{u}^{1/2} \overbrace{\dot{w} + \overset{*}{w}}^{-1} \dot{u}^{1/2} \right) \dot{u}^{-1/2} \zeta_z \end{matrix} \right] \\
&= \left[\overset{*}{\omega} u^{-1/2} \quad \overset{+}{\zeta} \dot{u}^{-1/2} \right] \left[\begin{matrix} \left(u^{-1/2} - u^{1/2} \overbrace{\dot{w} + \overset{*}{w}}^{-1} \right) \bar{\alpha} + u^{1/2} \overbrace{\dot{w} + \overset{*}{w}}^{-1} \zeta_z \\ \dot{u}^{1/2} \overbrace{\dot{w} + \overset{*}{w}}^{-1} \bar{\alpha} + \left(\dot{u}^{-1/2} - \dot{u}^{1/2} \overbrace{\dot{w} + \overset{*}{w}}^{-1} \right) \zeta_z \end{matrix} \right] \\
&= \overset{*}{\omega} u^{-1/2} \left(u^{-1/2} - u^{1/2} \overbrace{\dot{w} + \overset{*}{w}}^{-1} \right) \bar{\alpha} + \overset{*}{\omega} u^{-1/2} u^{1/2} \overbrace{\dot{w} + \overset{*}{w}}^{-1} \zeta_z + \zeta 8 \\
&\quad + \dot{u}^{-1/2} \dot{u}^{1/2} \overbrace{\dot{w} + \overset{*}{w}}^{-1} \bar{\alpha} + \overset{+}{\zeta} \dot{u}^{-1/2} \left(\dot{u}^{-1/2} - \dot{u}^{1/2} \overbrace{\dot{w} + \overset{*}{w}}^{-1} \right) \zeta_z
\end{aligned}$$

$$= \omega^* \underbrace{u^{-1} - \overbrace{w + w}^{-1}} \bar{\alpha} + \omega^* \overbrace{w + w}^{-1} \zeta_z + \zeta^+ \overbrace{w + w}^{-1} \bar{\alpha} + \zeta^+ \underbrace{u^{-1} - \overbrace{w + w}^{-1}} \zeta_z$$