

$$z^w = \overbrace{z^{-1} - \dot{w}^*}^{-1}$$

$$\overbrace{z^w}^{-1} = z^{-1} - \dot{w}^*$$

$$\text{LHS} = \overbrace{1 - z\dot{w}^*}^{-1} z = \overbrace{z z^{-1} - \dot{w}^*}^{-1} z = \overbrace{z^{-1} - \dot{w}^*}^{-1} z^{-1} z = \text{RHS}$$