

$$\dot{z} z \underline{E} = \widehat{\dot{z} z \underline{g}}^* \circ E z \underline{\hat{g}} + z \underline{\hat{g}}^* \circ E \widehat{\dot{z} z \underline{g}}$$

$$\begin{aligned} \dot{z} z \underline{E} &= \dot{z} \underline{\widehat{\dot{z} z \underline{g}}^{-1} \circ E z \underline{\hat{g}}} = -z \underline{\hat{g}}^{-1} \widehat{\dot{z} z \underline{g}} z \underline{\hat{g}}^{-1} \circ E z \underline{\hat{g}} + z \underline{\hat{g}}^{-1} \circ E \widehat{\dot{z} z \underline{g}} \\ &= -z \underline{\hat{g}}^{-1} \widehat{\dot{z} z \underline{g}} z \underline{E} + z \underline{\hat{g}}^{-1} \circ E \widehat{\dot{z} z \underline{g}} = z \underline{\hat{g}}^{-1} \circ E \widehat{\dot{z} z \underline{g}} - \widehat{\dot{z} z \underline{g}} z \underline{E} \end{aligned}$$

$$\int_{du} x \underline{\hat{g}}_u \widehat{\dot{z} z \underline{E}}_y = \int_{du} x \underline{E}_u \widehat{\dot{z} z \underline{g}}_y - \widehat{\dot{z} z \underline{g}}_u^x z \underline{E}_y$$

$$z \underline{\hat{g}} \widehat{\dot{z} z \underline{E}} = \circ E \widehat{\dot{z} z \underline{g}} - \widehat{\dot{z} z \underline{g}} z \underline{E} = \circ E \widehat{\dot{z} z \underline{g}} - \widehat{\dot{z} z \underline{g}} z \underline{\hat{g}}^{-1} \circ E z \underline{\hat{g}}$$

$$z \underline{\hat{g}}^* z \underline{\hat{g}} = \iota \Rightarrow 0 = \widehat{\dot{z} z \underline{g}}^* z \underline{\hat{g}} + z \underline{\hat{g}}^* \widehat{\dot{z} z \underline{g}} = \widehat{\dot{z} z \underline{g}}^* z \underline{\hat{g}} + z \underline{\hat{g}}^{-1} \widehat{\dot{z} z \underline{g}} \Rightarrow \widehat{\dot{z} z \underline{g}}^* = -z \underline{\hat{g}}^{-1} \widehat{\dot{z} z \underline{g}} z \underline{\hat{g}}^{-1}$$

$$\dot{z} z \underline{E} = -z \underline{\hat{g}}^{-1} \widehat{\dot{z} z \underline{g}} z \underline{E} + z \underline{\hat{g}}^{-1} \circ E \widehat{\dot{z} z \underline{g}} = \widehat{\dot{z} z \underline{g}}^* z \underline{\hat{g}} z \underline{E} + z \underline{\hat{g}}^{-1} \circ E \widehat{\dot{z} z \underline{g}} = \text{RHS}$$