$$ {}^{u}\widetilde{\gamma} = {}^{u}\gamma - {}^{u}\gamma\, {}^{u}B_{u} $$

$$ {}^{u}\widetilde{\gamma} \in T_{u}\left(S_{\ell}^{\mathbb{C}}\right) = i\, X_{u}^{1} \times Z_{u}^{1/2} \Longrightarrow {}^{u}\widetilde{\gamma}\, {}^{u}B_{u} = 0 $$

$$ {}^{u}g_{t} - {}^{u}\widetilde{g}_{t} = \underbrace{{}^{u}g_{t} - {}^{u}\widetilde{g}_{t}}\, {}^{{}^{u}\widetilde{g}_{t}}B_{{}^{u}\widetilde{g}_{t}} $$

$$ \Longrightarrow {}^{u}\gamma - {}^{u}\widetilde{\gamma} = \underbrace{{}^{u}\gamma - {}^{u}\widetilde{\gamma}}\, {}^{u}B_{u} + \underbrace{u - u}_{=0}\, \partial_{t}^{0}\, {}^{{}^{u}\widetilde{g}_{t}}B_{{}^{u}\widetilde{g}_{t}} = \underbrace{{}^{u}\gamma - {}^{u}\widetilde{\gamma}}\, {}^{u}B_{u} = {}^{u}\gamma\, {}^{u}B_{u} $$

$$ {}^{z}\gamma_{w} = w - z\overset{*}{w}z $$

$$ {}^{u}\widetilde{\gamma}_{w} = w_{1} + w_{1/2} - w_{1}^{*} = 2u\overset{*}{u}w - w_{1} - w_{1}^{*} = 2u\overset{*}{u}w - Q_{u}^{2}w - Q_{u}w $$

$$ \text{LHS} = w - u\overset{*}{w}u - {}^{u}B_{u}w = w_{1} + w_{1/2} + w_{0} - w_{1}^{*} - w_{0} = \text{RHS} $$

$$ \lambda_{w} = \overset{*}{u}\,\overbrace{w_{1} + 2w_{1/2}} - \overset{*}{\overbrace{w_{1} + 2w_{1/2}}}\, u \in \mathfrak{k} $$

$$ u\,\lambda_{w} = {}^{u}\widetilde{\gamma}_{w} $$

$$ \text{LHS} = u\overset{*}{u}\,\overbrace{w_{1} + 2w_{1/2}} - u\,\overset{*}{\overbrace{w_{1} + 2w_{1/2}}}\, u = w_{1} + w_{1/2} - w_{1}^{*} = \text{RHS} $$

$$ Q_{u}\left(v\overset{*}{w}u\right) = 2u\overset{*}{u}\,\underbrace{w\overset{*}{v}u} - w\overset{*}{v}u $$

$$ \text{LHS} = u\,\underset{*}{\underbrace{v\overset{*}{w}u}}\,u \underset{\text{JP 14}}{=} \underbrace{w\overset{*}{v}u}\,\overset{*}{u}u + u\overset{*}{u}\,\underbrace{w\overset{*}{v}u} - w\overset{*}{v}\,\underbrace{u\overset{*}{u}u} = \text{RHS} $$

$$-v\,{}^{u}\underset{-}{\widetilde{\gamma}}_{w} = 4\,\overbrace{u\overset{*}{u}\underbrace{w\overset{*}{v}u} - w\overset{*}{v}u} + 2v\,\overset{*}{w}\,u - 2v\,\overset{*}{u}\,w_{\;1/2}$$

$$\text{LHS} \;= 2v\,\overbrace{Q_{u}w}^{*}\,u + 2\,Q_{u}\left(v\overset{*}{w}u\right) + 2v\,\overset{*}{w}\,u - 2v\,\overset{*}{u}\,w - 2u\,\overset{*}{v}\,w$$

$$= 2v\,\overset{*}{w}{}_{1}^{*}u + 2\,\overbrace{2u\overset{*}{u}\underbrace{w\overset{*}{v}u} - w\overset{*}{v}u} + 2v\,\overset{*}{w}\,u - 2v\,\overset{*}{u}\,w - 2u\,\overset{*}{v}\,w$$

$$= 2v\,\overset{*}{u}\,w_{1} + 4u\,\overset{*}{u}\,\underbrace{w\overset{*}{v}u} - 2w\,\overset{*}{v}\,u + 2v\,\overset{*}{w}\,u - 2v\,\overset{*}{u}\,w - 2u\,\overset{*}{v}\,w = \;\text{RHS}$$

$$v\,\lambda_{w} - v\,{}^{u}\underset{-}{\widetilde{\gamma}}_{w} = 4\,\overbrace{u\overset{*}{u}\underbrace{w\overset{*}{v}u} - w\overset{*}{v}u} + v\,\overset{*}{w}_{1}\,u + v\,\overset{*}{u}\,w_{1}$$

$$\text{LHS} \;= 4\,\overbrace{u\overset{*}{u}\underbrace{w\overset{*}{v}u} - w\overset{*}{v}u} + 2v\,\overset{*}{w}\,u - 2v\,\overset{*}{u}\,w_{\;1/2} + v\,\overset{*}{u}\,\overbrace{w_{1} + 2w_{\;1/2}} - v\,\overbrace{w_{1} + 2w_{\;1/2}}^{*}\,u$$

$$= 4\,\overbrace{u\overset{*}{u}\underbrace{w\overset{*}{v}u} - w\overset{*}{v}u} + 2v\,\overset{*}{w}_{1}\,u + v\,\overset{*}{u}\,w_{1} - v\,\overset{*}{w}_{1}\,u = \;\text{RHS}$$

$$x\,\lambda_{w} - x\,{}^{u}\underset{-}{\widetilde{\gamma}}_{w} = 2\,w_{\;1/2}\,\overset{*}{u}\,x + x\,\overset{*}{w}_{1}\,u + x\,\overset{*}{u}\,w_{1}$$

$$y\,\lambda_{w} - y\,{}^{u}\underset{-}{\widetilde{\gamma}}_{w} = -2\,w_{0}\,\overset{*}{y}\,u + y\,\overset{*}{w}_{1}\,u + y\,\overset{*}{u}\,w_{1}$$

$$u\,\overset{*}{u}\,\underbrace{w\overset{*}{x}u} - w\,\overset{*}{x}\,u = u\,\overset{*}{u}\,\underbrace{w_{1}\overset{*}{x}u} - w_{1}\,\overset{*}{x}\,u + u\,\overset{*}{u}\,\underbrace{w_{\;1/2}\overset{*}{x}u} - w_{\;1/2}\,\overset{*}{x}\,u = -\frac{1}{2}\,w_{\;1/2}\,\overset{*}{x}\,u = \frac{1}{2}\,w_{\;1/2}\,\overset{*}{u}\,x$$

$$u\,\overset{*}{u}\,\underbrace{w\overset{*}{y}u} - w\,\overset{*}{y}\,u = u\,\overset{*}{u}\,\underbrace{w_{1}\overset{*}{y}u} - w_{1}\,\overset{*}{y}\,u + u\,\overset{*}{u}\,\underbrace{w_{\;1/2}\overset{*}{y}u} - w_{\;1/2}\,\overset{*}{y}\,u + u\,\overset{*}{u}\,\underbrace{w_{0}\overset{*}{y}u} - w_{0}\,\overset{*}{y}\,u = -\frac{1}{2}\,w_{0}\,\overset{*}{y}\,u$$