$$\mathcal{D}_a \psi$$

$$\mathcal{L}\,(a{:}\psi)$$

$${}_{\hbar}\ulcorner_{\infty}^{\underline{\hbar}}\llcorner\,\mathbb{C}^{\mho} \times {}_{\underline{\hbar}}\ulcorner\overset{+}{\mathbb{C}} \ni (\mathbb{A}{:}\psi)$$

$$A \in {}^{\underline{\hbar}}\llcorner\overset{\mho}{\mathbb{C}} \text{ imag } {:}\psi \in {}_{\underline{\hbar}}\ulcorner\overset{+}{\mathbb{C}}$$

$$\mathcal{L}_{1:1/2}\left(A{:}\bar{A}{:}\psi{:}\bar{\psi}\right) = \mathcal{L}_1\left(A{:}\bar{A}\right) + \mathcal{L}^{1/2}\left(\psi{:}\bar{\psi} + eA\psi\right) = \mathcal{L}_1\left(A{:}\bar{A}\right) + \mathcal{L}_{1/2}\left(\psi{:}\bar{\psi}\right) - \frac{e}{2}\psi \bowtie \tilde{A}\,\psi \text{ int-act}$$

$$\mathcal{L}^{A}_{1/2}\left(\psi{:}\bar{\psi}\right) = \mathcal{L}^{1/2}\left(\psi{:}\bar{\psi} + eA\psi\right)$$

$$\mathcal{L}_{1:1/2}\,(\mathbb{A}{:}\psi) = \mathcal{L}_1\,(\mathbb{A}) + \mathcal{L}^{1/2}\,(\psi{:}\,(d + e\mathbb{A})\,\psi) = \frac{1}{2}\psi \bowtie \underbrace{\overbrace{i\nwarrow h - e\mathbb{A}}\,\psi - m\psi}$$

$$\int^{\hbar} \mathcal{L}_{1:1/2}\,(\mathbb{A}{:}\psi) = \int^{\hbar} \mathcal{L}_1\,(\mathbb{A}) + \int^{\hbar} \mathcal{L}_{1/2}\,(\psi) + \frac{e}{2}\int^{\hbar} \psi \blacktriangledown \mathbb{A} \ltimes \psi$$

$$\bigwedge_{\vartheta \in \mathbb{C}^{\mho}} \mathcal{L}_{1/2}\left(\psi{:}\underline{\psi}\right) = \mathcal{L}_{1/2}\left(\vartheta\psi{:}\psi\underline{\psi}\right) \text{ glob inv}$$

$$\hbar \xrightarrow{\alpha} \mathbb{C}^{\mho} = i\mathbb{R}$$

$$\tilde{\mathbb{A}} = \mathbb{A} - \frac{1}{e}d\alpha{:}\,\tilde{\psi} = e^{\alpha}\psi$$

$$\mathcal{L}^{\mathbb{A}}_{1/2}\,(\psi) = \tilde{\mathcal{L}}^{\mathbb{A}}_{1/2}\left(\tilde{\psi}\right)$$

$$\mathcal{L}_{1:1/2}\,(\mathbb{A}{:}\psi) = \mathcal{L}_{1:1/2}\left(\tilde{\mathbb{A}}{:}\tilde{\psi}\right) \text{ lic inv:MAN/2}$$

$${}_{\underset{\sim}{\mathbb{R}}^4}\ulcorner_{\infty}^{\mathbb{R}^4}\llcorner\,\mathbb{C}^{\mho} \times {}_{\mathbb{R}^4}\ulcorner\overset{+}{\mathbb{C}} \ni (\mathbb{A}{:}\psi)$$

$$A \in {}^{\mathbb{R}^4}\llcorner\overset{\mho}{\mathbb{C}} \ni {}_{\mu}A{:}\psi \in {}_{\mathbb{R}^4}\ulcorner\overset{+}{\mathbb{C}} \ni {}_{\mu}\psi$$

$$A = g^{\mu\nu}\ {}_{\mu}\psi\ {}_{\nu}A \text{ ext feld}$$

$$\mathcal{L}^{A}_{1/2}\left(\psi{:}\,{}_{\mu}\psi\right) = \mathcal{L}_{1/2}\left(\psi{:}\,{}_{\mu}\psi + e_{\mu}A\psi\right) = \frac{1}{2}\left(\varepsilon^{\mu} \bowtie \gamma_{\mu}\psi\right) g \bowtie \blacktriangledown \left(i\underline{\psi} + eA \ltimes \psi\right) - \frac{m}{2}\psi \bowtie \psi$$

$$= \frac{1}{2} \psi \barwedge i \left(g^{\mu\nu} \gamma_{\mu} \left({}_{\nu}\psi + e_{\nu} A \psi \right) - m\psi \right) = \mathcal{L}^{A}_{1/2} \left(\psi{:}_{\mu}\psi \right) - \frac{e}{2} \psi \barwedge i \, g^{\mu\nu} \ {}_{\mu}\gamma \ {}_{\nu} A \, \psi$$

$$\mathcal{L}_{1:1/2} \left(A{:}_{\mu} A{:}\psi{:}_{\mu}\psi \right) = \mathcal{L}_{1} \left(A{:}_{\mu} A \right) + \mathcal{L}_{1/2} \left(\psi{:}_{\mu}\psi + e_{\mu} A \psi \right)$$

$$\mathcal{L}^{\mathbb{A}}_{1/2} \left(\psi{:}_{\mu}\partial\psi \right) = \frac{1}{2} \psi \barwedge i \left(g^{\mu\nu}{}_{\mu}\gamma \left({}_{\nu}\partial\psi + e_{\nu}\mathbb{A}\psi \right) - m\psi \right)$$

$$\mathcal{L}_{1:1/2} \left(\mathbb{A}{:}\psi \right) = \mathcal{L}_{1} \left(\mathbb{A} \right) + \mathcal{L}_{1/2} \left(\psi \right) - e \, \overset{*}{\psi} \, \gamma^{\mu} \ {}_{\mu}\mathbb{A} \, \psi = -\frac{1}{4} \mathbb{F}_{\mu\nu} \, \mathbb{F}^{\mu\nu} + \overset{*}{\psi} \, \gamma^{\mu} \left({}_{\mu}\partial - e_{\mu}\mathbb{A} \right) \psi \text{ non-lin}$$

$$\gamma \left(da \right) \text{ curv}$$

$$\mathcal{D} \divideontimes \gamma \left(a \right)$$