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A Chern-Simons approach to self-dual gravity in (2+1)-dimensions and quantisation of Poisson structure

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We present a Chern-Simons theory for the (2+1)-dimensional analog self-dual gravity theory that is based on the gauge group $SL(2,\mathbb{C})_{\mathbb{R}} \triangleright\!\!< \mathbb{R}^6$. This is formulated by mapping the $3d$ complex self-dual dynamical variable and connection to $6d$ real variables which combines into a $12d$ Cartan connection.

Quantization is given by the application of the combinatorial quantisation program of Chern-Simons theory. The Poisson structure for the moduli space of flat connections on $(SL(2,\mathbb{C})_{\mathbb{R}} \triangleright\!\!< \mathbb{R}^6)^{n+2g}$ which emerges in the combinatorial description of the phase space on $\mathbb{R} \times \Sigma_{g,n}$, where $\Sigma_{g,n}$ is a genus g surface with n punctures is given in terms of the classical r-matrix for the quantum double $D(SL(2,$
$CC)_{RR)}$ viewed as the double of a double $D(SU(2) \bowtie AN(2))$. This quantum double provides a feature for quantum symmetries of the quantum theory for the model.

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