I. LIST OF SYMBOLS

\(a, b, \ldots\) spatial indices for tensor fields on the 3-manifold \(M\)
\(\alpha, \beta, \ldots\) space-time indices in the classical theory
\(\alpha, \beta, \ldots\) labels for graphs on \(M\) in quantum theory
\(A^i_a\) a connection 1-form on \(M\)
\(A(e)\) holonomy along an edge \(e\) defined by a connection \(A\)
\(\tilde{A}\) space of smooth connections on \(M\) for a given gauge group \(G\)
\(\hat{A}\) a generalized connection
\(\hat{A}(e)\) holonomy along an edge \(e\) defined by a generalized connection \(\tilde{A}\)
\(\tilde{A}(e)\) —corresponding quantum operator
\(\hat{A}\) quantum configuration space (of generalized connections)
\(A_S\) area of a 2-surface (without boundary) \(S\)
\(\tilde{A}_a\) —corresponding quantum operator
\(A_a\) Maxwell vector potential
\(\tilde{A}(e)\) —corresponding holonomy along an edge \(e\)
\(B^a\) Maxwell magnetic (vector density) field
\(C\) the set of complex numbers
\(C_{\text{Diff}}(\vec{N})\) diffeomorphism constraint smeared with \(N^a\)
\(\tilde{C}_{\text{Diff}}(\vec{N})\) —corresponding quantum operator
\(\tilde{C}(N)\) scalar constraint smeared with \(N\)
\(\hat{C}(N)\) —corresponding quantum operator
\(C_{G}(\Lambda)\) Gauss constraint smeared with \(\Lambda^i\)
\(\hat{C}_{G}(\Lambda)\) —corresponding quantum operator
\(C^{(\alpha)}\) a differentiability class
\(\text{Cyl}\) algebra of cylindrical functions on \(\mathcal{A}\)
\(\text{Cyl}_\alpha\) algebra of the cylindrical functions defined by a graph \(\alpha\)
\(\text{Cyl}^*\) space of linear functionals on \(\text{Cyl}\)
\(\text{Cyl}_{\text{diff}}^*\) the image of \(\text{Cyl}\) under the diffeomorphism averaging map
\(\text{Diff}\) group of certain diffeomorphisms of \(M\) (defined in Section ??)
\(e\) a closed-piecewise analytic edge (defined in section ??)
\(E^a_{ij}\) triads with density weight one, defining the Riemannian geometry on \(M\)
\(e_{jk}^i\) structure constants of \(\text{su}(2)\) (of a general \(\mathfrak{g}\) in section ??)
\(\eta_{ij}\) the Killing form on \(\text{su}(2)\) (on a general \(\mathfrak{g}\) in section ??)
\(\eta_{abc}\) metric independent, totally skew pseudo tensor density of weight 1 on \(M\)
\(\eta_{abc}\) metric independent, totally skew pseudo tensor density of weight -1 on \(M\)
\(\eta_{\text{diff}}\) diffeomorphism averaging map (defined in section ??)
\(F^i_{ab}\) curvature of \(A^i_a\)
\(G\) a compact Lie group
\(\mathfrak{g}\) —its Lie algebra
\(G\) Newton’s constant
\(\gamma\) Barbero-Immirzi parameter
\( \mathcal{H} \)  kinematical Hilbert space of quantum geometry
\( \mathcal{H}_\alpha \)  subspace of \( \mathcal{H} \) defined by cylindrical functions compatible with graph \( \alpha \)
\( \mathcal{H}'_\alpha \)  subspace of \( \mathcal{H}_\alpha \) used in the spin-network decomposition of \( \mathcal{H} \)
\( i, j, \ldots \)  4-dimensional internal indices in section ??
\( I, J, \ldots \)  labels (e.g. for edges, punctures, etc) in sections ??-??
\( \mathcal{I}_E \)  map from the space of connections on a graph with \( n \) edges into \( G^n \)
\( \mathcal{I}_V \)  map from the space of gauge transformations on a graph with \( m \) vertices into \( G^m \)
\( j_{i(e,v)} \)  operator on \( \text{Cyl}_\alpha \) associated to an edge \( e \) and a vertex \( v \) of \( \alpha \)
\( k \)  \( 8\pi \) times Newton’s constant
\( \kappa \)  surface gravity of isolated horizons
\( \kappa(S,e) \)  a constant \( (0, \pm -1) \) assigned to a surface \( S \) an edge \( e \) intersecting it
\( \ell_{\text{Pl}} \)  Planck length
\( L^2 \)  space of square integrable functions
\( M \)  3-dimensional (‘spatial’) manifold (generally assumed to be compact)
\( \mathcal{M} \)  4-dimensional space-time manifold
\( \mathbb{N} \)  the set of natural numbers
\( P^i_a \)  momentum canonically conjugate to \( A^i_v \)
\( P(S,f) \)  flux across a two surface \( S \) of \( P^i_a \) smeared with a test field \( f^i \)
\( \hat{P}(S,f) \)  quantum operator corresponding to \( P(S,f) \)
\( \mathbb{P}^a \)  Momentum conjugate to the Maxwell connection \( A^i_v \)
\( \mathbb{P}(g) \)  Maxwell momentum smeared against a test field \( g^a \)
\( \hat{\mathbb{P}}(g) \)  — correspondig definite quantum operator
\( q_{ab} \)  positive definite metric on \( M \)
\( q_{e,v} \)  the quantum operator representing determinant of \( q_{ab}(v) \), restricted to \( \text{Cyl}_\alpha \)
\( \mathbb{R} \)  the set of real numbers
\( S \)  A closed-piecewise analytic sub-manifold of \( M \) (defined in section ??)
\( \Sigma_{ab}^i \)  Hodge-dual of the gravitational momentum \( P^a_i \)  \( (\Sigma_{ab}^i = \eta_{abo}\eta^{ij}E_j^i) \)
\( \text{Tr} \)  trace
\( V_\mathcal{R} \)  the volume of a region \( \mathcal{R} \) defined by \( q_{ab} \)
\( \hat{V}_\mathcal{R} \)  — correspondig quantum volume