References


Chitambar, E., Leung, D., Mančinska, L., Ozols, M., and Winter, A. 2014. Everything you always wanted to know about LOCC (but were afraid to ask). *Communications in Mathematical Physics*, 328(1), 303–326.


Dyson, F. 1962a. Statistical theory of the energy levels of complex systems. I. *Journal of Mathematical Physics*, 3(1), 140–156.

Dyson, F. 1962b. Statistical theory of the energy levels of complex systems. II. *Journal of Mathematical Physics*, 3(1), 157–165.

Dyson, F. 1962c. Statistical theory of the energy levels of complex systems. III. *Journal of Mathematical Physics*, 3(1), 166–175.


References


List of Symbols and Notations

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Σ, Γ, Λ</td>
<td>Typical names for alphabets (finite and nonempty sets whose elements are viewed as symbols).</td>
</tr>
<tr>
<td>( C^{\Sigma} )</td>
<td>The complex Euclidean space of functions from an alphabet ( \Sigma ) to the complex numbers. (Equivalently, the complex Euclidean space of vectors having entries indexed by ( \Sigma ).)</td>
</tr>
<tr>
<td>( W, \mathcal{X}, Y, Z )</td>
<td>Typical names for complex Euclidean spaces.</td>
</tr>
<tr>
<td>( \langle u, v \rangle )</td>
<td>The inner product between vectors ( u ) and ( v ).</td>
</tr>
<tr>
<td>( | u | )</td>
<td>The Euclidean norm of a vector ( u ).</td>
</tr>
<tr>
<td>( \mathcal{S}(\mathcal{X}) )</td>
<td>The unit sphere in a complex Euclidean space ( \mathcal{X} ).</td>
</tr>
<tr>
<td>( | u |_p )</td>
<td>The ( p )-norm of a vector ( u ).</td>
</tr>
<tr>
<td>( | u |_\infty )</td>
<td>The ( \infty )-norm of a vector ( u ).</td>
</tr>
<tr>
<td>( u \perp v, u \perp \mathcal{A} )</td>
<td>Indicates that a vector ( u ) is orthogonal to a vector ( v ), or to every element of a set of vectors ( \mathcal{A} ).</td>
</tr>
<tr>
<td>( e_a )</td>
<td>An element of the vector standard basis, corresponding to a symbol (or index) ( a ).</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>( \Sigma_1 \sqcup \cdots \sqcup \Sigma_n )</td>
<td>The disjoint union of alphabets ( \Sigma_1, \ldots, \Sigma_n ).</td>
</tr>
<tr>
<td>( \mathcal{X}_1 \oplus \cdots \oplus \mathcal{X}_n )</td>
<td>The direct sum of complex Euclidean spaces ( \mathcal{X}_1, \ldots, \mathcal{X}_n ).</td>
</tr>
<tr>
<td>( u_1 \oplus \cdots \oplus u_n )</td>
<td>The direct sum of vectors ( u_1, \ldots, u_n ).</td>
</tr>
<tr>
<td>( \mathcal{X}_1 \otimes \cdots \otimes \mathcal{X}_n )</td>
<td>The tensor product of complex Euclidean spaces ( \mathcal{X}_1, \ldots, \mathcal{X}_n ).</td>
</tr>
<tr>
<td>( u_1 \otimes \cdots \otimes u_n )</td>
<td>The tensor product of vectors ( u_1, \ldots, u_n ).</td>
</tr>
<tr>
<td>( \mathcal{X}^\otimes n )</td>
<td>The ( n )-fold tensor product of a complex Euclidean space ( \mathcal{X} ) with itself.</td>
</tr>
<tr>
<td>( u^\otimes n )</td>
<td>The ( n )-fold tensor product of a vector ( u ) with itself.</td>
</tr>
<tr>
<td>( \mathbb{R}^{\Sigma} )</td>
<td>The real Euclidean space of functions from an alphabet ( \Sigma ) to the real numbers. (Equivalently, the real Euclidean space of vectors having entries indexed by ( \Sigma ).)</td>
</tr>
<tr>
<td>( L(\mathcal{X}, \mathcal{Y}) )</td>
<td>Space of all linear operators mapping a complex Euclidean space ( \mathcal{X} ) to a complex Euclidean space ( \mathcal{Y} ).</td>
</tr>
<tr>
<td>( E_{a,b} )</td>
<td>An element of the operator standard basis, corresponding to symbols (or indices) ( a ) and ( b ).</td>
</tr>
<tr>
<td>( \overline{A}, \pi )</td>
<td>The entry-wise complex conjugate of an operator ( A ) or a vector ( u ).</td>
</tr>
<tr>
<td>( A^T, u^T )</td>
<td>The transpose of an operator ( A ) or a vector ( u ).</td>
</tr>
<tr>
<td>( A^<em>, u^</em> )</td>
<td>The adjoint of an operator ( A ) or a vector ( u ).</td>
</tr>
<tr>
<td>( \ker(A) )</td>
<td>The kernel of an operator ( A ).</td>
</tr>
<tr>
<td>( \operatorname{im}(A) )</td>
<td>The image of an operator ( A ).</td>
</tr>
<tr>
<td>( \operatorname{rank}(A) )</td>
<td>The rank of an operator ( A ).</td>
</tr>
<tr>
<td>Symbol</td>
<td>Description</td>
</tr>
<tr>
<td>-----------</td>
<td>-----------------------------------------------------------------------------</td>
</tr>
<tr>
<td>$A_1 \otimes \cdots \otimes A_n$</td>
<td>The tensor product of operators $A_1, \ldots, A_n$.</td>
</tr>
<tr>
<td>$A^\otimes n$</td>
<td>The $n$-fold tensor product of an operator $A$ with itself.</td>
</tr>
<tr>
<td>$L(\mathcal{X})$</td>
<td>Space of linear operators mapping a complex Euclidean space $\mathcal{X}$ to itself.</td>
</tr>
<tr>
<td>$\mathbf{1}$</td>
<td>The identity operator; denoted $\mathbf{1}_X$ when it acts on a complex Euclidean space $X$.</td>
</tr>
<tr>
<td>$X^{-1}$</td>
<td>The inverse of an invertible square operator $X \in L(\mathcal{X})$.</td>
</tr>
<tr>
<td>$\text{Tr}(X)$</td>
<td>The trace of a square operator $X \in L(\mathcal{X})$.</td>
</tr>
<tr>
<td>$(A, B)$</td>
<td>The inner product of operators $A$ and $B$.</td>
</tr>
<tr>
<td>$\text{Det}(X)$</td>
<td>The determinant of a square operator $X$.</td>
</tr>
<tr>
<td>$\text{Sym}(\Sigma)$</td>
<td>The set of permutations, or bijective functions, of the form $\pi : \Sigma \to \Sigma$.</td>
</tr>
<tr>
<td>$\text{sign}(\pi)$</td>
<td>The sign, or parity, of a permutation $\pi$.</td>
</tr>
<tr>
<td>$\text{spec}(X)$</td>
<td>The spectrum of a square operator $X$.</td>
</tr>
<tr>
<td>$[X, Y]$</td>
<td>The Lie bracket of square operators $X$ and $Y$.</td>
</tr>
<tr>
<td>$\text{comm}(A)$</td>
<td>The commutant of a set $A$ of square operators.</td>
</tr>
<tr>
<td>$\text{Herm}(\mathcal{X})$</td>
<td>The set of Hermitian operators acting on a complex Euclidean space $\mathcal{X}$.</td>
</tr>
<tr>
<td>$\text{Pos}(\mathcal{X})$</td>
<td>The set of positive semidefinite operators acting on a complex Euclidean space $\mathcal{X}$.</td>
</tr>
<tr>
<td>$\text{Pd}(\mathcal{X})$</td>
<td>The set of positive definite operators acting on a complex Euclidean space $\mathcal{X}$.</td>
</tr>
<tr>
<td>$\mathbf{1}_L(\mathcal{X})$</td>
<td>The identity map acting on $L(\mathcal{X})$.</td>
</tr>
<tr>
<td>$D(\mathcal{X})$</td>
<td>The set of density operators acting on a complex Euclidean space $\mathcal{X}$.</td>
</tr>
<tr>
<td>$\text{Proj}(\mathcal{X})$</td>
<td>The set of projection operators acting on a complex Euclidean space $\mathcal{X}$.</td>
</tr>
<tr>
<td>$\Pi_V$</td>
<td>The projection operator whose image is $V$.</td>
</tr>
<tr>
<td>$U(\mathcal{X}, \mathcal{Y})$</td>
<td>The set of isometries mapping a complex Euclidean space $\mathcal{X}$ to a complex Euclidean space $\mathcal{Y}$.</td>
</tr>
<tr>
<td>$U(\mathcal{X})$</td>
<td>The set of unitary operators acting on a complex Euclidean space $\mathcal{X}$.</td>
</tr>
<tr>
<td>$\text{Diag}(u)$</td>
<td>The diagonal square operator whose diagonal entries are described by the vector $u$.</td>
</tr>
<tr>
<td>$\lambda(H)$</td>
<td>The vector of eigenvalues of a Hermitian operator $H$.</td>
</tr>
<tr>
<td>$\lambda_k(H)$</td>
<td>The $k$-th largest eigenvalue of a Hermitian operator $H$.</td>
</tr>
<tr>
<td>$X \geq Y$ or $Y \leq X$</td>
<td>Indicates that $X - Y$ is positive semidefinite, for Hermitian operators $X$ and $Y$.</td>
</tr>
<tr>
<td>$X &gt; Y$ or $Y &lt; X$</td>
<td>Indicates that $X - Y$ is positive definite, for Hermitian operators $X$ and $Y$.</td>
</tr>
<tr>
<td>$T(\mathcal{X}, \mathcal{Y})$</td>
<td>The space of linear maps from $L(\mathcal{X})$ to $L(\mathcal{Y})$, for complex Euclidean spaces $\mathcal{X}$ and $\mathcal{Y}$.</td>
</tr>
<tr>
<td>$\Phi^*$</td>
<td>The adjoint of a map $\Phi \in T(\mathcal{X}, \mathcal{Y})$.</td>
</tr>
<tr>
<td>$\Phi_1 \otimes \cdots \otimes \Phi_n$</td>
<td>The tensor product of maps $\Phi_1, \ldots, \Phi_n$.</td>
</tr>
<tr>
<td>$\Phi^\otimes n$</td>
<td>The $n$-fold tensor product of a map $\Phi$ with itself.</td>
</tr>
<tr>
<td>$\mathbf{1}^n$</td>
<td>The $n$-fold tensor product of an operator $\mathbf{1}$ with itself.</td>
</tr>
<tr>
<td>Symbol</td>
<td>Description</td>
</tr>
<tr>
<td>--------</td>
<td>-------------</td>
</tr>
<tr>
<td>TrX</td>
<td>The partial trace over a complex Euclidean space X.</td>
</tr>
<tr>
<td>CP(X,Y)</td>
<td>The set of completely positive maps of the form Φ ∈ T(X,Y).</td>
</tr>
<tr>
<td>vec(A)</td>
<td>The vec mapping applied to an operator A.</td>
</tr>
<tr>
<td>√P</td>
<td>The square root of a positive semidefinite operator P.</td>
</tr>
<tr>
<td>s(A)</td>
<td>The vector of singular values of an operator A.</td>
</tr>
<tr>
<td>sk(A)</td>
<td>The k-th largest singular value of an operator A.</td>
</tr>
<tr>
<td>A⁺</td>
<td>The Moore–Penrose pseudo-inverse of an operator A.</td>
</tr>
<tr>
<td>∥A∥<em>p, ∥A∥</em>∞</td>
<td>The Schatten p-norm or ∞-norm of an operator A.</td>
</tr>
<tr>
<td>∥A∥_2</td>
<td>The Frobenius norm of an operator A. Equivalent to the Schatten ∞-norm of A.</td>
</tr>
<tr>
<td>∥A∥_1</td>
<td>The trace norm of an operator A. Equivalent to the Schatten 1-norm of A.</td>
</tr>
<tr>
<td>∇f(x)</td>
<td>The gradient vector of a function f : R^n → R at a vector x ∈ R^n.</td>
</tr>
<tr>
<td>(Df)(x)</td>
<td>The derivative of a (differentiable) function f : R^n → R at a vector x ∈ R^n.</td>
</tr>
<tr>
<td>B(χ)</td>
<td>The unit ball in a complex Euclidean space χ.</td>
</tr>
<tr>
<td>Borel(Δ)</td>
<td>The collection of all Borel subsets of a subset Δ of a real or complex vector space.</td>
</tr>
</tbody>
</table>

For example, the integral of a function f with respect to a Borel measure μ is denoted by $\int f(x) d\mu(x)$.
<table>
<thead>
<tr>
<th>Symbol</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>$F(P,Q)$</td>
<td>The fidelity between positive semidefinite operators $P$ and $Q$.</td>
</tr>
<tr>
<td>$B(P,Q</td>
<td>\mu)$</td>
</tr>
<tr>
<td>$B(\Phi,P)$</td>
<td>The mapping fidelity of a map $\Phi$ with respect to a positive semidefinite operator $P$.</td>
</tr>
<tr>
<td>$W$ or $W_{X}$</td>
<td>Typical name used to refer to the swap operator acting on a bipartite tensor product space $X \otimes X$.</td>
</tr>
<tr>
<td>$|\Phi|_1$</td>
<td>The induced trace norm of a map $\Phi$.</td>
</tr>
<tr>
<td>$\Phi_1$</td>
<td>The completely bounded trace norm of a map $\Phi$.</td>
</tr>
<tr>
<td>$N(X)$</td>
<td>The numerical range of a square operator $X$.</td>
</tr>
<tr>
<td>$F_{\text{max}}(\Psi_{0},\Psi_{1})$</td>
<td>The maximum output fidelity of positive maps $\Psi_{0}$ and $\Psi_{1}$.</td>
</tr>
<tr>
<td>$Z_{n}$</td>
<td>The ring of integers modulo $n$.</td>
</tr>
<tr>
<td>$W_{a,b}$</td>
<td>A discrete Weyl operator acting on $\mathbb{C}Z_{n}$, for $a,b \in Z_{n}$.</td>
</tr>
<tr>
<td>$\sigma_{x}$, $\sigma_{y}$, and $\sigma_{z}$</td>
<td>The Pauli operators.</td>
</tr>
<tr>
<td>$A \odot B$</td>
<td>The entry-wise product of operators $A$ and $B$.</td>
</tr>
<tr>
<td>$V_{\pi}$</td>
<td>Permutation operator corresponding to the permutation $\pi$.</td>
</tr>
<tr>
<td>$v \prec u$</td>
<td>Indicates that $u$ majorizes $v$, for real vectors $u$ and $v$.</td>
</tr>
<tr>
<td>Symbol</td>
<td>Description</td>
</tr>
<tr>
<td>--------</td>
<td>-------------</td>
</tr>
<tr>
<td>$T_{n,\varepsilon}(p)$</td>
<td>The set of $\varepsilon$-typical strings of length $n$ with respect to the probability vector $p$.</td>
</tr>
<tr>
<td>$\Pi_{n,\varepsilon}$</td>
<td>Projection operator corresponding to the $\varepsilon$-typical subspace of $\mathcal{X}^\otimes n$ with respect to a given state.</td>
</tr>
<tr>
<td>$I_{\text{acc}}(\eta)$</td>
<td>The accessible information of an ensemble $\eta$.</td>
</tr>
<tr>
<td>$\chi(\eta)$</td>
<td>The Holevo information of an ensemble $\eta$.</td>
</tr>
<tr>
<td>$\text{Sep}(\mathcal{X} : \mathcal{Y})$</td>
<td>The set of separable operators acting on the tensor product space $\mathcal{X} \otimes \mathcal{Y}$, respecting the bipartition between $\mathcal{X}$ and $\mathcal{Y}$.</td>
</tr>
<tr>
<td>$\text{SepD}(\mathcal{X} : \mathcal{Y})$</td>
<td>The set of separable density operators acting on the tensor product space $\mathcal{X} \otimes \mathcal{Y}$, respecting the bipartition between $\mathcal{X}$ and $\mathcal{Y}$.</td>
</tr>
<tr>
<td>$\text{Ent}_r(\mathcal{X} : \mathcal{Y})$</td>
<td>The set of operators acting on the tensor product space $\mathcal{X} \otimes \mathcal{Y}$ having entanglement rank bounded by $r$, with respect to the bipartition between $\mathcal{X}$ and $\mathcal{Y}$.</td>
</tr>
<tr>
<td>$\text{SepCP}(\mathcal{X}, \mathcal{Z} : \mathcal{Y}, W)$</td>
<td>The set of separable maps from $L(\mathcal{X} \otimes \mathcal{Y})$ to $L(\mathcal{Z} \otimes W)$, respecting the bipartition between $\mathcal{X}$ and $\mathcal{Y}$ and between $\mathcal{Z}$ and $W$.</td>
</tr>
<tr>
<td>$\text{SepC}(\mathcal{X}, \mathcal{Z} : \mathcal{Y}, W)$</td>
<td>The set of separable channels from $L(\mathcal{X} \otimes \mathcal{Y})$ to $L(\mathcal{Z} \otimes W)$, respecting the bipartition between $\mathcal{X}$ and $\mathcal{Y}$ and between $\mathcal{Z}$ and $W$.</td>
</tr>
<tr>
<td>$\text{LOCC}(\mathcal{X}, \mathcal{Z} : \mathcal{Y}, W)$</td>
<td>The set of LOCC channels from $L(\mathcal{X} \otimes \mathcal{Y})$ to $L(\mathcal{Z} \otimes W)$, respecting the bipartition between $\mathcal{X}$ and $\mathcal{Y}$ and between $\mathcal{Z}$ and $W$.</td>
</tr>
<tr>
<td>$E_d(\mathcal{X} : \mathcal{Y})$</td>
<td>The distillable entanglement of the state of a pair of registers $(\mathcal{X}, \mathcal{Y})$.</td>
</tr>
<tr>
<td>$E_c(\mathcal{X} : \mathcal{Y})$</td>
<td>The entanglement cost of the state of a pair of registers $(\mathcal{X}, \mathcal{Y})$.</td>
</tr>
<tr>
<td>$\text{PPT}(\mathcal{X} : \mathcal{Y})$</td>
<td>The set of PPT operators acting on $\mathcal{X} \otimes \mathcal{Y}$, respecting the bipartition between $\mathcal{X}$ and $\mathcal{Y}$.</td>
</tr>
<tr>
<td>$E_f(\mathcal{X} : \mathcal{Y})$</td>
<td>The entanglement of formation of the state of a pair of registers $(\mathcal{X}, \mathcal{Y})$.</td>
</tr>
<tr>
<td>$W_\pi$</td>
<td>A unitary operator acting on $\mathcal{X}^\otimes n$, for a complex Euclidean space $\mathcal{X}$, that permutes tensor factors according to the permutation $\pi$.</td>
</tr>
<tr>
<td>$\mathcal{X}^\otimes n$</td>
<td>The symmetric subspace of $\mathcal{X}^\otimes n$, for $\mathcal{X}$ a complex Euclidean space. Also denoted $\mathcal{X}_1 \otimes \cdots \otimes \mathcal{X}_n$ when $\mathcal{X}_1, \ldots, \mathcal{X}_n$ are identical copies of $\mathcal{X}$.</td>
</tr>
<tr>
<td>$\text{Bag}(n, \Sigma)$</td>
<td>The set of functions describing a bag of $n$ items, each labeled by an element of an alphabet $\Sigma$.</td>
</tr>
<tr>
<td>$\mathcal{N}$</td>
<td>The set of nonnegative integers ${0, 1, 2, \ldots}$.</td>
</tr>
<tr>
<td>$\Sigma_\phi^n$</td>
<td>The subset of $\Sigma^n$ consistent with a given function $\phi \in \text{Bag}(n, \Sigma)$.</td>
</tr>
<tr>
<td>$\mathcal{X}^\wedge n$</td>
<td>The anti-symmetric subspace of $\mathcal{X}^\otimes n$, for $\mathcal{X}$ a complex Euclidean space.</td>
</tr>
<tr>
<td>$L(\mathcal{X})^\otimes n$</td>
<td>The algebra of permutation-invariant operators acting on $\mathcal{X}^\otimes n$, for $\mathcal{X}$ a complex Euclidean space.</td>
</tr>
<tr>
<td>$\mu$</td>
<td>Symbol used to denote uniform spherical measure.</td>
</tr>
<tr>
<td>$\eta$</td>
<td>Symbol used to denote Haar measure.</td>
</tr>
<tr>
<td>Symbol</td>
<td>Description</td>
</tr>
<tr>
<td>--------</td>
<td>-------------</td>
</tr>
<tr>
<td>$H_{\text{min}}(\Phi)$</td>
<td>The minimum output entropy of a channel $\Phi$.</td>
</tr>
<tr>
<td>$C(\Phi)$</td>
<td>The classical capacity of a channel $\Phi$.</td>
</tr>
<tr>
<td>$C_E(\Phi)$</td>
<td>The entanglement-assisted classical capacity of a channel $\Phi$.</td>
</tr>
<tr>
<td>$\chi(\Phi)$</td>
<td>The Holevo capacity of a channel $\Phi$.</td>
</tr>
<tr>
<td>$\chi_E(\Phi)$</td>
<td>The entanglement-assisted Holevo capacity of a channel $\Phi$.</td>
</tr>
<tr>
<td>$I_C(\rho; \Phi)$</td>
<td>The coherent information of a state $\rho$ through a channel $\Phi$.</td>
</tr>
<tr>
<td>$I_C(\Phi)$</td>
<td>The maximum coherent information of a channel $\Phi$.</td>
</tr>
<tr>
<td>$K_{a_1 \cdots a_n, \varepsilon}(p)$</td>
<td>The set of $\varepsilon$-typical strings of length $n$, conditioned on a string $a_1 \cdots a_n$, with respect to the probability vector $p$.</td>
</tr>
<tr>
<td>$\Lambda_{a_1 \cdots a_n, \varepsilon}$</td>
<td>Projection onto the $\varepsilon$-typical subspace of $\mathcal{X}^\otimes n$, for $\mathcal{X}$ a complex Euclidean space, conditioned on a string $a_1 \cdots a_n$.</td>
</tr>
<tr>
<td>$S_{n, \varepsilon}(p)$</td>
<td>The set of $\varepsilon$-strongly typical strings of length $n$ with respect to the probability vector $p$.</td>
</tr>
<tr>
<td>$Q(\Phi)$</td>
<td>The quantum capacity of a channel $\Phi$.</td>
</tr>
<tr>
<td>$Q_{\text{EG}}(\Phi)$</td>
<td>The entanglement generation capacity of a channel $\Phi$.</td>
</tr>
<tr>
<td>$Q_{\text{E}}(\Phi)$</td>
<td>The entanglement-assisted quantum capacity of a channel $\Phi$.</td>
</tr>
<tr>
<td>$\Phi_0 \oplus \Phi_1$</td>
<td>The direct sum of maps $\Phi_0$ and $\Phi_1$.</td>
</tr>
</tbody>
</table>

Index

Abeyesinghe, A., 559
accessible information, 295–296
achievable rate, 466, 469, 513, 519
Adami, C., 558
Adami–Cerf lemma, 505–506
additivity conjecture, 539
adjoint, 10–11
affine subspace, 44
Aharonov, D., 199
Albert, G., 248
Alberti’s theorem, 147–151
Alberti, P., 198, 249
algebra of permutation-invariant operators, 400–401, 407–408
alphabet, 1
Ambainis, A., 309
Ando, T., 309
anti-degradable channel, 547
anti-symmetric subspace, 318, 398–400
Apostol, T., 57
Araki, H., 308
Arias, A., 248
Årjeson, W., 199
Ash, R., 308
associative algebra, 14
Aubrun, G., 463
Audenaert, K., 248, 308
auxiliary register, 164–166, 179–184
Axler, S., 57
bag, 393
Barnum, H., 198, 387, 558
Barrett, J., 389
Bartle, R., 57
Bekman, D., 123
Belavkin, V., 198
Bell basis, 366
Bell inequality, 374–376
Bell, J., 389
Ben-Aroya, A., 200
Bengtsson, I., 122
Bennett, C., 387–389, 463, 558, 559
Bernstein, E., 388
Beth, T., 248
Bhatia, R., 57
Bhattacharyya coefficient, 152
binary alphabet, 2
Birkhoff–von Neumann theorem, 234
Borel function, 38
Borel measure, 39
Borel set, 38
Brassard, G., 387–389
Bratteli, O., 248
Buscemi, F., 248
Carathéodory’s theorem, 44
Cauchy–Schwarz inequality, 4
Caves, C., 198, 462
Cerf, N., 558
chain rule for differentiation, 37
channel, 72–100
representations of, 77–82
channel approximation, 466
channel code, 478
channel discrimination, 164–166, 175–182
isometric channels, 179–182
channel fidelity, see mapping fidelity
Charnes, C., 248
$\chi$-distribution, 52
Childs, A., 199, 388
Chiribella, G., 123
Chittambar, E., 387
Choi operator, 78
Choi rank, 78
Choi representation, 78
Choi, M.-D., 122, 123
Christandl, M., 463
Chuang, I., 122
classical capacity, 465–468
classical channel, 94
classical communication, 94, 331–332, 466
classical register, 65, 95–96
quantum, 289
spectral norm, 24, 33
spectral radius, 16
spectral theorem, 24–26
Spekkens, R., 198
square operator, 14
standard basis
for operators, 9
for vectors, 5
standard Borel measure, 39
standard Gaussian measure, 50–53
standard normal random variable, 51
state, see quantum state; classical state;
probabilistic state
state discrimination, 124–139
by LOCC measurements, 337–339
by separable measurements, 335–337
convex sets of states, 130–132
ensembles of states, 132–139
pairs of states, 127–130
probabilistic states, 125–127
Stinespring representation, 79–80
unitary equivalence of, 85
Stinespring, W., 123
stochastic operator, 233
Streater, R., 247
strong subadditivity, see von Neumann
entropy, strong subadditivity
strongly typical string, 497–501
Størmer, E., 389
subalgebra, 16
super-activation, 538–539, 545–556
swap operator, 94, 317
symmetric subspace, 318, 391–397
Synak-Radtke, B., 388
Szarek, S., 463
Talagrand, M., 463
teleportation, 359–367
tensor product
of maps, 21–22
of operators, 13
do vectors, 6–7
Thirul, B., 388, 389
Thapliyal, A., 558
Thomas, J., 308
Timoney, R., 200
Toeplitz–Hausdorff theorem, 180–181
trace, 14–16
trace distance, 33
trace norm, 24, 33–34
trace-preserving map, 23, 87–89
transpose, 10–11, 93, 170
Tregub, S., 247
Tribus, M., 308
trivial register, 60, 75–76
Tsirelson’s bound, 383
Tsirelson’s theorem, 377–384
Tsirelson, B., 389
Tsukada, M., 309
twirling, see Werner twirling channel; isotropic
twirling channel
typical string, 286
joint distribution, 479–481
typical subspace, 291, 481
Uhlmann’s theorem, 151–152
Uhlmann, A., 198, 249, 309
Umegaki, H., 308
unextendable product set, 353–356
uniform spherical measure, 408–410, 414–415
union bound, 47
unit channel, 201–202, 426–429
unit map, 23, 87
unitary channel, 73, 91
unitary operator, 18
van de Graaf, J., 199
Vandenberghe, L., 57
Vazirani, U., 389
vec mapping, see operator-vector
 correspondence
Vedral, V., 387, 388
Verghese, G., 198
von Neumann entropy, 265–274, 281–282
concavity, 269–270
conditional, 267
continuity, 268
purification technique, 271
strong subadditivity, 281–282
subadditivity, 270
von Neumann, J., 122, 308, 462
Výššyi, M., 122, 199
Walgate, J., 388
Wallach, N., 462
Watrous, J., 123, 198–200, 463
weak law of large numbers, 50
Weil, A., 462
Werner state, 317–319, 417–420
Werner twirling channel, 418
Werner, E., 463
Werner, R., 123, 199, 248, 387, 389, 462
Werner–Holevo channels, 165–166
Westmoreland, M., 558
Weyl, H., 248
Weyl–Brauer operators, 378
Weyl–Brauer–Hausdorff–von Neumann operators, 378
Weyl–covariant channel, 212–219
Weyl–covariant map, 212–219
Wiener, S., 389, 462
Wilde, M., 122
Winter’s gentle measurement lemma, 142–143
Winter, A., 198, 387, 463, 558, 559
Wolf, M., 248, 559
Wolkowicz, H., 57
Wootters, W., 123, 198, 387–389, 462, 558
Woronowicz, S., 389