Quantum Field Theory
Notation & Abbreviations

Tim Evans
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Abbreviations

Abbrv.	Full Name
c.c.	coupling constant, such as λ in $\lambda\phi^4$ interaction term.
c.c.	$(\ldots)^*$, complex conjugate, indicated by a star superscript.
c.c.r.	canonical commutation relations.
c. number	an object which commutes with all operators. Generally not an operator, just some (complex) number or a collection of complex numbers such as a vector or matrix (e.g. Pauli matrices when working with fermions).
EFS	Exercise For Students. Students should fill in the missing algebra themselves.
ETCR	Equal Time Commutation Relations.
e.o.m.	equation of motion
h.c.	$(\ldots)^\dagger$, Hermitian conjugate, indicated by a dagger superscript.
H.Pic	Heisenberg picture [Tong §2.6, p.35].
I.Pic	Interaction picture [Tong §3.1, p.50].
KG	Klein-Gordon equation
L.inv	Lorentz invariant.
pde	partial differential equation.
QM	Quantum Mechanics.
QFT	Quantum Field Theory.
SYTh	Scalar Yukawa Theory (see PS5) [Tong (3.7), p.49].
S.Pic	Schrödinger picture [Tong §2.6, p.35].
UV	Ultra-violet, here means the high energy and momentum region

Notation

Notation	Description
$\hbar = 1$	$\hbar$ is set to be one (natural units) unless otherwise specified.
$c = 1$	c is set to be one (natural units) unless otherwise specified.
$\boldsymbol{x}$	A Euclidean vector in typed notes
$\underset{\sim}{x}$	A Euclidean vector when hand written
$g^{\mu\nu}$	The metric here is diagonal with $g^{00} = +1$ and $g^{ii} = -1$ for $i = 1, 2, 3$.
$x \equiv x^\mu$	A four-vector so $x \equiv x^\mu = (t, \boldsymbol{x}) = (t, \underset{\sim}{x})$. Index may be dropped if clear from context.
$\boldsymbol{k}.\boldsymbol{x} \equiv \underset{\sim}{k}.\underset{\sim}{x}$	Scalar (dot) product for ordinary (Euclidean) vectors $= \boldsymbol{k} \cdot \boldsymbol{x} = k_i x_i \equiv \sum_i k_i x_i$
$k.x$	Four-vector scalar product $= k_\mu x^\mu = k_0 x_0 - \boldsymbol{k} \cdot \boldsymbol{x}$. Note that this implies a metric with diagonal entries $(+1, -1, -1, -1)$ which is the definition used in most QFT work including the notes of Tong (see [Tong (1.8), p.8]).
$đ^D k$	$= (2\pi)^{-D} d^D k$ (a slash through the d symbol)
$\eth^D(p-q)$	$= (2\pi)^D \delta^D(p-q)$ (a slash through the δ symbol)
$(\ldots)^\dagger$	Hermitian conjugation, a dagger superscript (not the plus sign used in Wick's theorem).
$\vert\,\psi\rangle_{\mathrm{H}}$	$= \vert\,\psi, t=0\rangle_{\mathrm{S}}$ Heisenberg picture state
$\vert\,\psi, t\rangle_{\mathrm{S}}$	$= \exp\{-iH_{\mathrm{S}}t\}\vert\,\psi, t=0\rangle_{\mathrm{S}}$ Schrödinger picture state
$\vert\,\psi, t\rangle = \vert\,\psi, t\rangle_{\mathrm{I}}$	$= \exp\{iH_{0\mathrm{S}}t\}\vert\,\psi, t\rangle_{\mathrm{S}}$ Interaction picture state
$\vert\,\boldsymbol{p}\rangle \equiv \vert\,\underset{\sim}{p}\rangle$	$= \hat{a}^\dagger_{\boldsymbol{p}}\vert\,0\rangle$, a one-particle free state defined with standard normalisation
$\vert\,p\rangle = \sqrt{2\omega_{\boldsymbol{p}}}\vert\,\boldsymbol{p}\rangle$	a one-particle free state defined with relativistic normalisation
$\mathcal{O}_{\mathrm{H}}(t)$	Heisenberg picture operator
$\mathcal{O}_{\mathrm{S}}$	$= \mathcal{O}(t=0)$ Schrödinger picture operator
$\mathcal{O}_{\mathrm{I}}(t)$	$= \exp\{iH_{\mathrm{S}}t\}\mathcal{O}(t=0)\exp\{-iH_{\mathrm{S}}t\}$ Interaction picture operator
H_0, H_{int}	Free and interacting parts of Hamiltonian $H = H_0 + H_{\mathrm{int}}$
ϕ^+, ϕ^-	An arbitrary split of fields used in Wick's theorem. $\phi = \phi^+ + \phi^-$.
N(fields)	General normal ordering operator with $\hat{\phi}^+$ ($\hat{\phi}^-$) operators moved to the right (left) but ordering within the set of $\{\hat{\phi}^+\}$ operators is maintained, and similarly the order within $\{\hat{\phi}^-\}$ operators is unchanged.
: fields :	Standard symbol for normal ordering operator but in this course is used only for the standard definition where annihilation (creation) operators are moved to the right (left)
T(fields)	Time ordering operator
$\overbrace{AB}$	Contraction of two operators $= \Delta = \mathrm{T}(AB) - \mathrm{N}(AB)$ [Tong (3.41), p.57]
$\vert 0\rangle$	The vacuum state. In the interaction picture this is the free vacuum (no interactions).
$\vert\Omega\rangle$	In the interaction picture this is the vacuum in the fully interacting case.