Entanglement versus untanglement: no-no go-go

We assume the method and apparatus of Meth8/VŁ4 with Tautology as the designated *proof* value, F as contradiction, N as truthity (non-contingency), and C as falsity (contingency). The 16-valued truth table is row-major and horizontal.

From: quantamagazine.org/entanglement-made-simple-20160428/ [Frank Wilczek], and see preposterousuniverse.com/wp-content/uploads/125c-2017-2.pdf .

LET: p, q, r, s: $\Phi_{\blacksquare}$, $\Phi_{\bullet}$, $\psi_{\blacksquare}$, $\psi_{\bullet}$(sub-systems); ~ Not; & And, ⊗; + Or, ⊕; - Not Or;
> Imply, greater than; < Not Imply, less than; = Equivalent; @ Not Equivalent;
% possibility, for one or some; # necessity, for all or every;
(p@p) ordinal 0, F; (%p>#p) ordinal 1; (%p<#p) ordinal 2; (p=p) ordinal 3, T;
(~(p<(p@p))&~(p>(%p>#p))) probability on interval]0,1[.

Remarks: Variables may also represent sub-systems, where an equation is entangled if it is *not* expressed as a tensor product. In other words, $(\Phi \oplus \psi)$ is entangled but $(\Phi \otimes \psi)$ untangled. Hence, (p+r) is entangled and (p&r) untangled, and (p+q) is entangled and (p&q) untangled.

Untangled: $(\Phi_{\blacksquare} + \Phi_{\bullet})(\psi_{\blacksquare} + \psi_{\bullet}) = (\Phi_{\blacksquare}\psi_{\blacksquare} + \Phi_{\blacksquare}\psi_{\bullet} + \Phi_{\bullet}\psi_{\blacksquare} + \Phi_{\bullet}\psi_{\bullet})$ (0.1.1)

(p+q)&(r+s) ; FFFF FTTT FTTT FTTT (0.1.2)

Entangled: $(\Phi_{\blacksquare}\psi_{\blacksquare} \qquad + \Phi_{\bullet}\psi_{\bullet})$ (0.2.1)

(p&r)+(q&s) ; FFFF FTFT FFTT FTTT (0.2.2)

From Eq. 1.1, the entangled state of $(\Phi_{\blacksquare}\psi_{\bullet} + \Phi_{\bullet}\psi_{\blacksquare})$ is not accounted for. (0.3.1)

(p&s)+(q&r) ; FFFF FFTT FTFT FTTT (0.3.2)

Consequently, we evaluate the combinations of pairs of variables as untangled and entangled units for completeness when applying their combined probability on the interval]0,1[.

Entangled form of (A and B):

p&q ; FTFT FTFT FTFT FTFT (1.2)
p&r ; FFFF FTFT FFFF FTFT (2.2)
p&s ; FFFF FFFF FTFT FTFT (3.2)
q&r ; FFFF FFTT FFFF FFTT (4.2)
q&s ; FFFF FFFF FFTT FFTT (5.2)
r&s ; FFFF FFFF FFFF TTTT (6.2)

Entangled form of (A and B) or (C and D):

(p&q)+(r&s) ; FFFT FFFT FFFT TTTT (7.2)
(p&r)+(q&s) ; FFFF FTFT FFTT FTTT (8.2)
(p&s)+(q&r) ; FFFF FFTT FTFT FTTT (9.2)

Entangled form of either (A and B) or (C and D) on interval]0,1[:

(p=((p&q)+(r&s)))>(~(p<(p@p))&~(p>(%p>#p))); FTFF FTFF FTFF TFTF (10.2)

(p=((p&r)+(q&s)))>(~(p<(p@p))&~(p>(%p>#p))); FTFT FFFF FTTF FFTF (11.2)

(p=((p&s)+(q&r)))>(~(p<(p@p))&~(p>(%p>#p))); FTFT FTTF FFFF FFTF (12.2)

Entangled form of (A and B) or (C and D), or (E and F) or (G and H), or (I and J) or (K and L) on interval]0,1[:

(p=(((p&q)+(r&s))+(((p&r)+(q&s))+((p&s)+(q&r)))))
>(~(p<(p@p))&~(p>(%p>#p))) ; FTFF FFTF FFTF TFTF (13.2)

Untangled form of (A or B):

p+q ; FTTT FTTT FTTT FTTT (21.2)

p+r ; FTFT TTTT FTFT TTTT (22.2)

p+s ; FTFT FTFT TTTT TTTT (23.2)

q+r ; FFTT TTTT FFTT TTTT (24.2)

q+s ; FFTT FFTT TTTT TTTT (25.2)

r+s ; FFFF TTTT TTTT TTTT (26.2)

Untangled form of (A or B) and (C or D):

(p+q)&(r+s) ; FFFF FTTT FTTT FTTT (27.2)

(p+r)&(q+s) ; FFFT FFTT FTFT TTTT (28.2)

(p+s)&(q+r) ; FFFT FTFT FFTT TTTT (29.2)

Untangled form of (A or B) and (C or D) on interval]0,1[:

(p=((p+q)&(r+s)))>(~(p<(p@p))&~(p>(%p>#p))) ; FTFT FFTF FFTF FFTF (30.2)

(p=((p+r)&(q+s)))>(~(p<(p@p))&~(p>(%p>#p))) ; FTFF FTTF FFFF TFTF (31.2)

(p=((p+s)&(q+r)))>(~(p<(p@p))&~(p>(%p>#p))) ; FTFF FFFF FTTF TFTF (32.2)

Because Eqs. 1.2 to 9.2 and 21.2 to 29.2 as rendered are *not* tautologous, the approach of entangled and untangled units is suspicious.

When we apply the combined probabilities to combinations in Eqs. 10.2-12.2 and 30.2-32.2 there are no tautologies, and grouping all combinations in Eq. 13.2 does no better.

We conclude that there is no tautological basis for sub-system states of entangled or untangled units in quantum theory.