Notes of Quantum Theory of Fields by S.Weinberg

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2.1 Symmetries

If the observations of possible experiments of a system do not change under a transformation, then the transformation is defined to be *symmetry transformation*. Saying in another way, observations under symmetry transformation can be seen as different observers look at the *same* system, and they must find the same probabilities

$$P(\mathcal{R} \to \mathcal{R}_n) = P(\mathcal{R}' \to \mathcal{R}'_n) \tag{2.1.1}$$

This is the only condition for a transformation to be a symmetry. Winger[1] has proved that for any transformation $\mathcal{R} \to \mathcal{R}'$ we may define an operator U on Hilbert space, and the operator is either unitary and linear *or* anti-unitary and anti-linear, such that if $\Psi \in \mathcal{R}$ then $U\Psi \in \mathcal{R}'$.

$$() = \tag{2.1.2}$$

References

[1] E.P. Wigner. *Gruppentheorie und ihre Anwendung auf die Quantenmechanik der Atomspektren*. Die Wissenschaft. F. Vieweg & sogn akt.-ges, 1944.