

2.7: On “alias” and “alibi”. The Object Group

It is fitting to conclude this review of algebraic preliminaries by formulating a rule that is to guide us in connecting the group theoretical concepts with physical principles. One of the concerns of physicists is to observe, identify and classify particles. Pursuing this objective we should be able to tell whether we observe the same object when encountered under different conditions in different states. Thus the identity of an object is implicitly given by the set of states in which we recognize it to be the same. It is plausible to consider the transformations which connect these states with each other, and to assume that they form a group. Accordingly, a precise way of identifying an object is to specify an associated object group.

The concept of object group is extremely general, as it should be, in view of the vast range of situations it is meant to cover. It is useful to consider specific situations in more detail.

First, the same object may be observed by different inertial observers whose findings are connected by the transformations of the inertial group, to be called also the passive kinematic group. Second, the space-time evolution of the object in a fixed frame of reference can be seen as generated by an active kinematic group. Finally, if the object is specified in phase space, we speak of the dynamic group.

The fact that linear transformations in a vector space can be given a passive and an active interpretation, is well known. In the mathematical literature these are sometimes designated by the colorful terms “alias” and “alibi,” respectively. The first means that the transformation of the basis leads to new “names” for the same geometrical, or physical objects. The second is a mapping by which the object is transformed to another “location” with respect to the same frame.

The important groups of invariance are to be classified as passive groups. Without in any way minimizing their importance, we shall give much attention also to the active groups. This will enable us to handle, within a unified group-theoretical framework, situations commonly described in terms of equations of motion, and also the so-called “preparations of systems” so important in quantum mechanics.

It is the systematic joint use of “alibi” and “alias” that characterizes the following argument.

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