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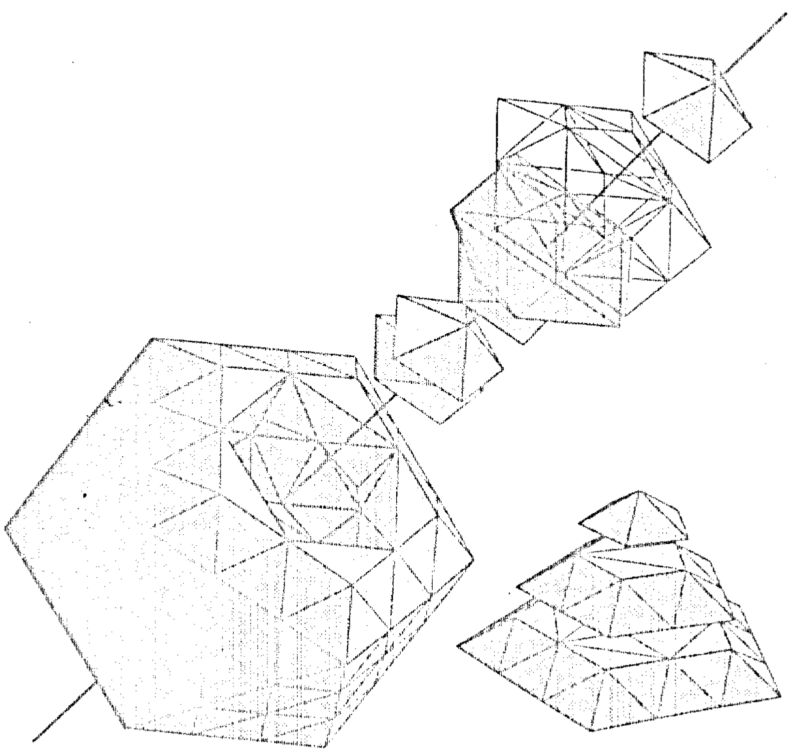

AN ORIGIN OF SYMMETRY BREAKING: IRREVERSIBLE THERMODYNAMICS FROM AN INTERNALIST PERSPECTIVE

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Symmetry and its preservation have long been taken as the fundamental ingredients of any dynamics (Wigner, 1964) . Identification of symmetry presumes the dichotomy of the operation of preserving a symmetry property and the state to which such operation applies. This formulation of dynamics leaves the state to which the operation of symmetry preservation applies as being a mere passive entity. Dynamics of the quantum mechanical state as embodied in Schroedinger's equation of motion is just a successful example of showing the separation between the symmetry preserving dynamic operator and the quantum state to be operated. However, the present scheme of depriving the quantum state of its dynamic activity raises a fundamental question on how could the initial quantum state to be acted on subsequently be prepared in the first place. This question in fact centers around the problem of measurement in quantum mechanics. Although it is possible to predetermine the value of a quantum mechanical observable if the initial quantum state happens to be available by whatever means, it is not the symmetry preserving quantum operator itself which could prepare and determine the initial quantum state.

Availability of state on a nonlocal scale which is prerequisite to dynamics of the quantum mechanical state is, however, a theoretical artifact at its best no matter how successful it has been in countless physical experiments. Initial preparation of the quantum state does assume an active operation on the part of the agency in charge, or experimenters. State dynamics of preserving a symmetry property could be permissible only in the limit case that the operation of preparing the initial state would not interfere with another operation of preserving the symmetry property latent in the once prepared state. This potential difficulty with any type of state dynamics preserving its symmetry property would become most keen when one comes to face with thermodynamics or irreversible thermodynamics in particular, since in the latter of which the idea of state variables has been questioned. For instance, whether the idea of entropy as a state variable could firmly be established even in irreversible thermodynamics still remains to be seen.

Irreversible thermodynamics unquestionably allows in itself a set of local observables such as local energy flows, but they cannot be equated with local state variables in their own right. For the insistence on local state variables and on the resulting state dynamics preserving a certain symmetry would have to claim to be prepared with the initial state without having any interference with the subsequent dynamic development. On the other hand, local observables assume measurement dynamics of their own identification because they are identifiable in the record, though not accompanied by state dynamics. The measured record of local observables cannot substitute for the state to be driven by state dynamics, because the record is already a consequence of dynamics that has made measurement possible. Irreversible thermodynamics lacking its local state variables still, however, rests itself upon the process of measurement proceeding internally (Matsuno, 1989).

Internal measurement of local observables is intrinsically irreversible and breaks temporal symmetry because it lacks the state to be driven by symmetry preserving state dynamics. This fact simply implies that there is no means to predetermine what will be measured beforehand and that there is an apparent asymmetry between the prior indefiniteness yet to be actualized and the posterior definiteness in the record. Temporal symmetry breaking latent in internal measurement will become more evident in relation to the manner of how conservation laws such as energy flow continuity could materialize. Although state dynamics asking a complete identification of its local state variables takes conservation laws to be no more than a form of truism because the identification cannot be separated from observing these laws, internal measurement comes to fulfill them only a posteriori. How conservation laws will be fulfilled remains indefinite for internal measurement yet to come. Internal measurement as a local process assume only the limited access to the complete situation on a global scale. Only the record can tell how these conservation laws have been fulfilled. This leads to the fact that even the first law of thermodynamics on energy conservation, let alone the second law, is irreversible in its operation within the scheme of internal measurement.

Internal measurement in irreversible thermodynamics can serve as a generator of breaking temporal symmetry because of its incompatibility with the state to be driven by symmetry preserving state dynamics.

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