A unified scheme of measurement and amplification processes

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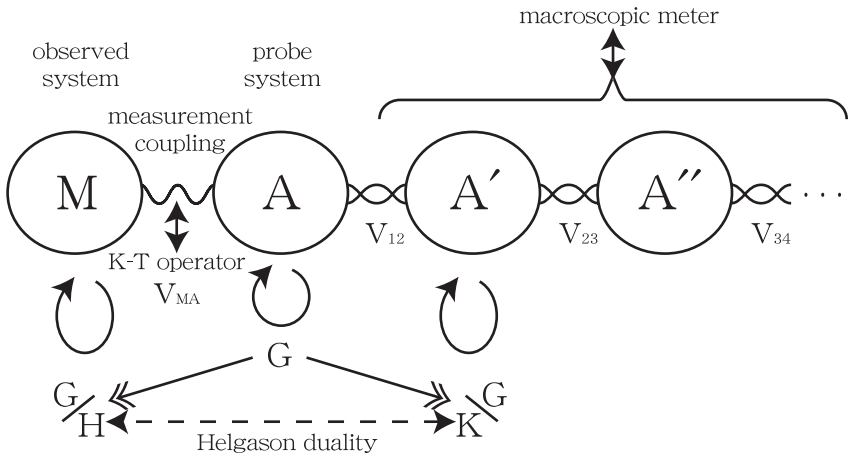
We present a unified scheme of quantum measurements containing the aspects of amplification processes, or *translation to macro-levels* on the basis of [1], a joint work with Prof. I. Ojima. This formulation is based on micro-macro duality [2] as a mathematical expression of the general idea of quantum-classical correspondence.

An essential difference between classical physics and quantum physics can be seen in their algebraic structures describing the physical systems. Quantum systems are generally described by non-commutative algebras (C*-algebras, von-Neumann algebras, and so on) consists of observables. The concept of amplification or translation to macro is nothing but how the information of (quantum) non-commutative observables is translated in the words of macroscopic worlds, which are described by (classical) commutative ones. This point of view is essential for understanding quantum measurements.

In mathematical words, the transformation from quantum internal degrees of freedom to classical ones is constructed by *Kac-Takesaki operator* or *multiplicative unitary*, which plays a fundamental roles in harmonic analysis, and the dual structure between q-numbers and c-numbers can be understood via the *Helgason duality* controlling the Radon transform (in somehow generalized meanings). A concrete observation for the case of Stern-Gerlach experiment can be seen in [1], and recently, we obtained more general formulation which is applicative to various situation.

In addition, this framework suggests us when ideal measurements (with no perturbation effects) go on; the so-called *adiabaticity conditions* can be said as sufficient for meaningful measurement results.

A synopsis for amplification processes:



References

[1] Harada, R. and Ojima, I., A unified scheme of measurement and amplification processes based on micro-macro duality – Stern-Gerlach experiment as a typical example, Open Systems and Information Dynamics, **16**, No.1, 55-74 (2009)

[2] Ojima, I., A unified scheme for generalized sectors based on selection criteria –Order parameters of symmetries and of thermality and physical meanings of adjunctions–, Open Systems and Information Dynamics, **10**, 235-279 (2003) ; Ojima, I., Micro-macro duality in quantum physics, pp.143–161 in Proc. Intern. Conf. on Stochastic Analysis, Classical and Quantum, World Scientific (2005) ; Ojima, I. and Takeori, M., How to observe quantum fields and recover them from observational data? – Takesaki duality as a Micro-Macro duality –, Open Systems and Information Dynamics, **14**, 307-318 (2007)