

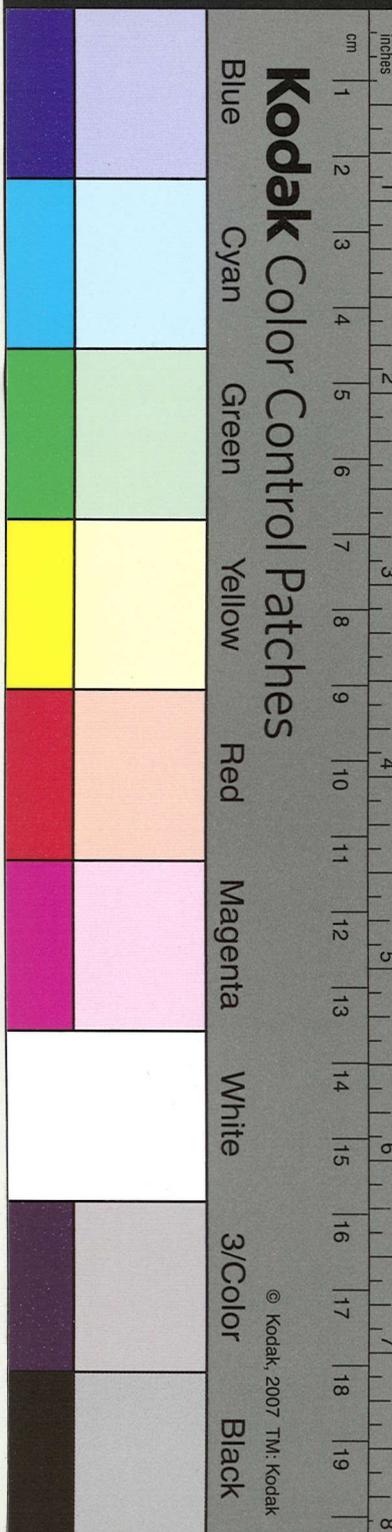
Irreversibility and Observation in Quantum Theory

(17)

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§1. Introduction

Since the advent of quantum mechanics and its statistical interpretation physicists have begun to hope that the age-old ~~problem~~ ~~cloud~~ which had been surrounding for many year the problem of thermodynamical irreversibility could finally be cleared. In fact, the theory of observation which ~~was developed~~ in quantum mechanics was developed by von Neumann¹⁾ to the extent ~~the extent~~ that could account for the thermodynamical irreversibility could be understood in terms of the uncontrollable disturbances acting on the system. ~~the~~ ~~reaction~~ Such disturbances are always accompanied by the reactions on the some other system S_2 near the thermodynamical system in question. These reactions in turn may serve the observer for giving information about ~~the~~ S_1 . In particular, ~~some~~ useful pieces of ~~some~~ some of such pieces may be interpreted as the results of measurements of physical quantities belonging to S_1 . According to the © 5, 1957, 10, 20, 000
von Neumann,



S_1 , as represented by a (2)

~~well-known definition of~~ ^{the} entropy of a quantum mechanical mixture by ~~von Neumann~~, ~~was~~ is defined in such a way that it increases, in general, whenever ~~there is~~ a disturbance ~~to~~ with the character of measuring process is acted on the mixture S_1 , but the observer does not know the result of the measurement. ~~This von~~

~~Many physicists including the~~

~~The above~~ This rough sketch of the reasoning by von Neumann would be sufficient to show that an entirely new way of approach to the problem of irreversibility was opened. Here the ~~main~~ process of observation which is peculiar to quantum mechanics plays an essential part, whereas customary interpretations of irreversibility concerned with a thermodynamical system could be applied to an isolated ~~the~~ system entirely free from external disturbances. (Indeed, ~~the latter~~ ^{customary interpretations} ~~are~~ ^{can be} much more easily accepted ~~simply~~ ^{could be} because the entropy has been regarded as

so that ~~the reasoning is~~ ^{the} essentially ~~the~~ ^{the} same reasoning the reasoning is essentially the same whether it started from classical or quantum mechanics.

