III. PREPARATIONS AND MEASUREMENTS

A. The Game

In quantum physics, any situation is based on preparations and measurements. In such a game, the preparation of the system in a state $\hat{\rho}_m$ can be associated to a classical information that we call the *choice* 'm'. The measurement, corresponding to the POVM element $\hat{\Pi}_n$, gives another classical information which is simply the *result* 'n'. However, we can only make predictions about these choices 'm' and these results 'n'. We have then two approaches in quantum physics, that we will examine in details in the following. Each approach needs a quantum state and propositions, allowing predictions about the measurement results or retrodictions about the state preparations, as pictured on Fig. 1.

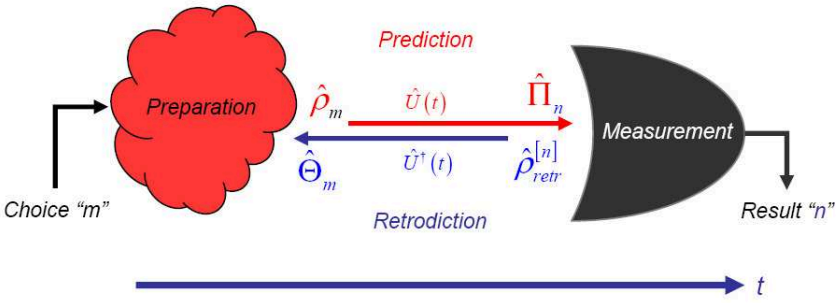

Figure 1: (color online) The game of preparations and measurements in quantum physics: *the prediction and the retrodiction need quantum states and propositions that we respectively note* $\left(\hat{\rho}_m, \hat{\Pi}_n\right)$ *and* $\left(\hat{\rho}_{\text{retr}}^{[n]}, \hat{\Theta}_m\right)$. *The time-evolution operator* $\hat{\mathcal{U}}(t)$ *allows us to propagate forward or backward in time these states between the preparation and the measurement, in order to make these predictions.*

B. Predictive approach

We usually prepare the system in a given quantum state based on a choice 'm', and we make propositions about the results of any subsequent measurement which will be performed on this system. The conditional probability of obtaining a certain result 'n', after that the