HOW TO DISCOVER THAT THE REAL IS UNREAL

ABSTRACT. The measurement problem in quantum mechanics is presented in a completely non-technical way by means of the results of some very simple experiments. These experimental results themselves, rather than the formalism of quantum theory, are shown to be extremely hard to incorporate in a sensible state-space picture of the world. A novel twist is then added which makes the problem even harder than it appears to be in other presentations of the measurement problem.

HOW TO DISCOVER THAT THE REAL IS UNREAL*

Tamunuq is a world much like our world, except that there is no naturally available light, such as sunlight, starlight, or light that accompanies heat. Instead there are many naturally occurring boxes, of many sizes, each of which has a light bulb of a particular colour in it, a light switch and a peeking hole. One can place any Tamunuqi object in any such box, say a rabbit in a box with a red light, switch the light on, look through the peeking hole, and then one will either see a light red rabbit or a dark red rabbit. Indeed any object when viewed in a box with a red bulb will be seen either as light red or dark red. There seem to be exactly two shades of red and every object when viewed in a box with a red bulb switched on, will be seen as having one of these two shades of red. Similarly, if an object is placed in a box with a yellow light, then one sees either a light yellow object or a dark yellow object, when the light is switched on. The Tamunuqis also find that lightbulbs come only in three different colours: red, blue and yellow.

The Tamunuqis wanted to figure out what the possible colour properties of objects were, how they related to each other and how they developed. They therefore experimented with objects and boxes.

STAGE 1

They looked at many objects in a box with a red light, and classified them into light red objects and dark red objects, according to whether they saw them to be light red or dark red. They then looked at the same objects in a box with a yellow light, noted the results, and looked...
at the objects in blue light and noted the results. They classified each object that they had examined according to the results of the three consecutive observations, as being dark red and dark blue and dark yellow or as being dark red and dark blue and light yellow or as being dark red and light blue and dark yellow etc. Their first conjecture was that one has characterised the colour properties of an object completely by specifying a 'light' or a 'dark' for each of the three available colours. Since there are three colours that each can come in two shades, they conjectured that there are eight possible colour states for each object, one corresponding to each possible combination of shades of each of the three colours. To put it another way: they conjectured that there are three colour observables, each of which can have two values. They conjectured that objects could have any combination of these values and thus that there are 8 possible combinations of values of the three observables, each of which characterises a possible colour state of an object.

STAGE 2

The Tamunuqis now began to contemplate the statistics of the results, and noticed the following regularity. They found that there is a fixed percentage, say 80%, of objects which they recorded as dark blue when they looked at them in a box with a blue light, that were seen to be dark yellow when they next looked at them in a box with a yellow light. This percentage they found to be independent of the weight, shape, smell, and any other property of the objects that they could think of. No sub-selection of objects, on any property the Tamunuqis could think of, affected the fraction of initially dark blue objects that were seen to be dark yellow on the next measurement. The Tamunuqis found that this indeed held for any pair of shades of colours upon subsequent measurements (with differing fractions, which depend only on the shades of colours involved). The Tamunuqis now conjecture that there are statistical laws governing colour properties: 80% of dark blue objects are also dark yellow, 65% of light yellow objects are also dark blue etc. They conjectured that their Creator simply decided to paint dark yellow some random 80% of the objects he had already painted dark blue, and so on for other colour shades.