GEOMETRICAL INTERPRETATION OF TIME-DEPENDENT SPIN PHASES

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ABSTRACT

The Pancharatnam and Aharonov-Anandan phases for spin in a rotating magnetic field are interpreted and represented geometrically using spherical triangle.

1. Introduction

Berry's article "Quantal phase factors accompanying adiabatic changes"[1] induced a renewal of interest in phases and phase differences in quantum mechanics.[2–5] As distinct from the standard quantum mechanics[6,7] which makes emphasis on the measurability of absolute squares of wave functions, in the works which follow Berry's paper the emphasis is on the measurability of phases (phase differences).[8,9]

A carefull analysis shows that the conditions of measurability of phases (phase differences) in Berry's and subsequent works are: 1) the existence of interference of two states φ_1 and φ_2 which belong to the same ray - $\varphi_2 = \varphi_1\, e^{i\beta}$; 2) the possibility to measure the intensity of their superposition $I = | \varphi_1 + \varphi_2 |^2 = 2 \mid \varphi_1 |^2 (1 + \cos\beta)$.

But, standard quantum mechanics is insisting on the following statement: *If, in a Hilbert space $\mathcal{H}$, $\mid \varphi\rangle$ represents a physical state of the system, all vectors of the form $e^{i\beta} \mid \varphi\rangle$, β real, represent the* **same** *physical state and are said to form a* **ray**. Also, standard quantum mechanics does not interpret intensity measurements in interference experiments as phase measurements. Instead, in standard quantum mechanics one usually argues that *relative phases* play an important role.[6]

Berry,[1] Kwiat and Chiao,[9] Jiao et al.[8] avoided to comment *explicitely* this departure from standard quantum mechanical thinking. Instead, different attributes were given to particular phases which were studied,[2] like: geometrical, adiabatic, topological, non-integrable, misterious etc. It seems to us that in this way has