QUANTUM MAGNETIC TOP

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Abstract

The classical magnetic top is quantized by applying Schrödinger's method of quantization in non-Euclidean coordinate system. As different from a free top (for which one usually imposes the condition of single-valuedness of wave functions) in the case of a magnetic top this condition is not justified. Thanks to this fact a magnetic top could possess integer as well as half integer values of canonical angular momentum. This property makes a magnetic top a candidate for the classical model of spin.

1. INTRODUCTION

The need to study various tops in quantum mechanics used to come from different fields of physics.[1] The aim of the Kroning-Rabi work[2] on the symmetrical top in the undulatory mechanics was to explain rotational spectra of molecules. The explanation of nuclear spectra requires the study of tops too.[3] The discovery of spin and the search for the understanding of the physical nature of spin lead many authors to study quantum tops.[4–8] At the same time various arguments were raised against the theories of spin based on the quantum top.[9]

Recently, Barut et al. pointed out[10] that the classical model of spin has to explicitly take into account the linear relation between spin magnetic moment and spin angular momentum. According to Ali's classification,[11] this is one example of dequantization problem. The search for the solution of this problem lead Barut et al. to introduce the notion of magnetic top.[10]

By definition, a magnetic top is a spherically symmetric top which carries a magnetic moment $\vec{M}$ which is proportional to the kinetic angular momentum $\vec{\Sigma}$:

$$\vec{M} = \gamma\vec{\Sigma}. \tag{1.1}$$

In the case of a spherical top, $\vec{\Sigma}$ is proportional to $\vec{\omega}$,

$$\vec{\Sigma} = I\vec{\omega}. \tag{1.2}$$

As a consequence of this property, the potential of a magnetic top in a magnetic field $\vec{B}$ is velocity dependent. This requires to distinguish two quantities, kinetic angular

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