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BOHMIAN PICTURE OF THE WAVE FUNCTION AND THE GAUGE INVARIANCE

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Abstract. The representation of the wave function Ψ in exponential form (in terms of the square root of the density ρ and the wave phase θ), as Bohm has proposed, after separating the real and imaginary parts gives set of two nonlinear equations, the continuity equation and an equation analogous in a wide meaning to the classical equation of motion. In particular, it is shown that despite its non-linearity the gauge invariance discovered by Weyl and Dirac for the original linear Schrödinger's equation is still observed.

1. Introduction

Already, it is almost ninety years as Erwin Schrödinger proposed the wave equation in [25, 26]. This equation is commonly considered as one of the most important achievements of the twentieth century science, contributing to an immense development in all physics and chemistry. While Schrödinger's equation (SE) is universally accepted at the scientific level, the philosophical issues raised by it are still debated. Robin Blume-Kohout and Wojciech H. Zurek write that quantum mechanics (QM) is famously difficult to reconcile with everyday classical experience [4], cf. also [9, 23, 32, 35] and [24].

Also in experimental physics the efforts are made to overcome the dichotomy between classical and quantum pictures. In classical Rutherford's model, an electron runs around a nucleus in a planetary orbit, while according to the QM, the electron is spread out within an orbital. David M. Villeneuve reported the experimental efforts toward creating a Rutherford atom. The highly excited states of the hydrogen atom (Rydberg's states) provide a range of quantum states whose energy spacing is almost uniform. When many of these states are superposed, the resulting electron