

LETTERS TO THE EDITORS

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Readers comments on "Quantum mechanics: new experiments, new applications, new formulations" by M B Menskiĭ

From the Editors. Today in the world literature, as at certain times in the past, are issues actively debated related to the interpretation and, more generally, to the foundations of quantum theory. At the same time these issues do not receive adequate treatment in the Russian-language physical publications. For this reason, *Usp. Fiz. Nauk* recently published a review by M B Menskiĭ entitled "Quantum mechanics: new experiments, new applications, new formulations of old problems" (*Usp. Fiz. Nauk* **170** (6) 631 (2000) [*Phys. Usp.* **43** 585 (2000)]). The editorial preface to this paper invited the readers to make their contributions to the discussion of the foundations of quantum theory. Some letters have been received and are presented below. Wishing to ensure free expression, we did not subject these letters to peer review, and take no responsibility for their content. We believe that such an approach is more or less justified by the current situation.

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Does the phenomenon of 'reduction of the wave function' exist in measurements in quantum mechanics?

A I Lipkin

This letter is in response to review [1]. My purpose is to point out a fundamentally different theory not mentioned in Ref. [1]. This theory rejects the phenomenon of 'reduction (collapse) of the wave function' (introduced by John von Neumann and Paul Dirac in the 1930s), and the closely related 'quantum theory of measurement', the unconditional existence of which is taken in Ref. [1] for the basis, as unjustified and not validated experimentally. I am referring first of all to the well-known works of D N Klyshko [2, 3]. The same view is shared by the author of this letter [4, 5]. This view was presented in our large joint paper entitled "On the 'collapse of the wave function', 'quantum theory of measurements', and the 'incomprehensibility' of quantum mechanics" [6], where we propose a clear-cut formulation of nonrelativistic quantum mechanics, free from the concept of 'reduction (collapse) of the wave function'. This letter is based on the ideas of Ref. [6] (see Sections 3.1, 3.3, 4) [1].

A I Lipkin Moscow Physico-Technical Institute,
141700 Dolgoprudnyĭ, Moscow Region, Russian Federation
Tel. (7-095) 408 46 81. E-mail lipkin@beep.ru
http://science.rsuh.ru/Arkady/engle/PofSengl.htm

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1. Analysis of the main points

The fundamental, seminal and axiomatic concept for the theory going back to von Neumann and adopted by M B Menskiĭ is the postulate of the 'reduction of the wave function' associated with measurement in quantum mechanics.

One of the most common illustrations of the 'reduction of wave function' is the following. Assume that we are measuring some variable — for example, the position of particle in the plane of the screen (photographic plate), and this variable corresponds to an operator B. The reading of the instrument is b_1. According to most textbooks and the vast majority of theoretical physicists, this implies that:

Statement 1: this measurement is the phenomenon that is to be described by quantum theory;

Statement 2: it is proclaimed that in the language of quantum theory this phenomenon is described as the instantaneous reduction of the wave function (WF) of the system from $\Psi = \sum_k c_k |b_k\rangle$ (in the general form in Dirac's notation) to $|b_1\rangle$ with the probability $|c_1|^2$ (according to Born's rules). This jump is known as the 'reduction' or 'collapse' of the WF;

Statement 3: it is proclaimed that this transition is not described by the Schrödinger equation — that is, it is 'illegal' as far as the equations of standard quantum mechanics are concerned.

The incompleteness of contemporary quantum mechanics, which follows from this last statement (based on the preceding two), and the resulting need for an extension of its foundations, are what has been understood since the times of von Neumann as the '**problem**' of 'reduction (collapse) of the wave function'.

[1] The main ideas of this comment to Ref. [1] were discussed with the late D N Klyshko directly after the presentation by M B Menskiĭ of his theory at V L Ginzburg's "All-Moscow seminar on theoretical physics" (23 February 2000).