This is a review text file submitted electronically to MR.

Reviewer: Znojil, Miloslav

Reviewer number:

Address:
NPI ASCR, 250 68 Rez,
Czech Republic
znojil@ujf.cas.cz

Author: Moiseyev, Nimrod

Short title: Non-Hermitian quantum mechanics.

MR Number: 2768169

Primary classification: 81Q12

Secondary classification(s): 81U20 81V55 81U10 92D25

Review text:

The title of the book "Non-Hermitian Quantum Mechanics" (NHQM) is like the new dress for an old lady. Under this name the book under review truly does identify and fill the lasting gap in the market. Still, by the personal opinion of the reviewer (which need not necessarily be shared by the author - and probably even is not), the book does not certainly describe any new Quantum Theory. It rather summarizes some of the most recent and advanced applications of the standard formalism, with the title making the subject just looking more attractive. A more conservative author would call this text "Contemporary theory of resonances" or something like that.

I am not saying that the latter title would sound better or that it would attract a broader audience but certainly, the word "resonance" could have then been omitted from the titles of chapters (out of the total of ten, it occurs in four). Plus: the word "resonance" would more precisely target the potential readers with predominant interest in atomic, molecular, chemical (and, perhaps, also nuclear and condensed matter and optical) physics.

This being said, this book really is top class. Being written by an extremely experienced active scientist it summarizes, first of all, the results of his own research performed during the last thirty or so years. The reading of this text should be recommended warmly. The message should be praised for being timely and well organized.

The text is well written and compact. Its main strength is not in the listing of references. Just a short list of the most relevant ones is added, to each chapter, as a "further reading", rather exceptionally not (co-)authored by N.M. Moreover, the text is self-characterized as a "textbook" and this name fits well (note just that almost one quarter of pages is devoted to exercises and their

solutions).

Perhaps, as "the first book ever written that presents NHQM" (cited from the first line of preface and/or from the author's homepage) the text should have been less centered around applications in quantum chemistry and around the subset of these applications which are better known as the "complex scaling method". On the other hand, such an author's decision and strategy protects this review from getting separated from the reality of physics of the surrounding-us world. The author never breaks this contact and, in analogy with classical drama, his book keeps the unity of place and action and preserves the integrity of the style without ceasing to be useful.

According to the present reviewer's taste (and in my full personal admiration towards the author's achievements!), a sprinkle of a more abstract framing of the material would still help. In places, it could even simplify and shorten the explanations (typically, in chapter 6, where the introduction of the elementary notion of biorthogonal systems is too much practice-motivated and, hence, rather clumsy and too long). The abstract mathematical details of "NHQM theory" also come rather late – too late, perhaps (mainly in chapter 7).

In consequence, the less informed readers (or naive undergraduates, at which the book is also aimed) might feel quite puzzled by many physics-explaining commentaries about NHQM, appearing in the first and/or last chapter but lacking any sufficiently explicit or mathematical specification of what the notion really means. For example: Is it really so that (according to chapter 10) "QM branches into two formalisms"? And: should we believe that (according to chapter 1) "there is no (known) transformation which enables one to map results which were obtained using one formalism to the other one"?

At the same time, having passed through the bulk text, it is a pleasure of reader to get rewarded, in by far the longest chapter 8, by the author's particularly personal account of the extension of the formalism to the scattering regime (here, also the list of "further reading" gets particularly long and multifaceted), with several extremely interesting applications – let me mention just the so called high-order harmonic generation and above-threshold ionization of atoms in laser fields for illustration.

If we omit comments on the rather off-stream and comparatively incomplete account of the well known Feshbach's projection-operator method in chapter 10 (which would deserve to be longer) and if we politely pretend that we did not notice the absence of any global summary (a "missing chapter 11"?) we will definitely feel pleased also by the effectively last chapter 9. This chapter might be perceived as a certain climax of the story, by having dealt with one of the true highlights of the formalism, viz., with the concept and properties of the so

called "exceptional points".

By its origin, the term "exceptional point" (EP) belongs to the theory of analytic functions. In the context of mathematical physics its introduction should be attributed to T. Kato who recognized its role in Rayleigh-Schrödinger perturbation theory. Unfortunately (i.e., to my small personal disappointment), the title of chapter 9 does not carry any immediate reference to EPs. Still, the contents reflect several truly newest, EP-related developments in the NHQM field.

In PS let me add that (1) in the list of references appended to chapter 9, the papers by N.M. just take the exceptionally small share of cca 25 percent; apparently, more people are currently entering the N.M.'s traditional NHQM field at present; (2) in November 2010, Dieter Heiss organized, in Stellenbosch, the first special international meeting devoted strictly to the physics of exceptional points (during which, incidentally, I personally met the author); the details may still be googled out (or clicked: http://www.nithep.ac.za/2g6.htm); (3) the NHQM subject appeared (newly and, presumably, under the influence of the N.M.'s years-long publication output) in the MR Mathematics Subject Classification scheme, released in the year 2010, as the separate item Nr. 81Q12.