Referee A

I am pleased to send my impressions on the book proposal entitled "The Nuclear Cooper pair: Structure and Reactions", by G. Potel and R. Broglia. I would like to stress that, although my research topic is on nuclear structure and reactions, I am not an expert in many of the topics and formalisms covered by this book so my comments should be considered as coming from a somewhat outsider. For convenience, I follow the same items and questions you suggested:

Is there a need for a new book on nuclear structure/reactions, such as the one proposed, and why?
Many of the topics covered in this book are certainly not new, and have been covered by other books (see below). Yet, the approach followed by the authors is somewhat different as compared to these other books, since they try to frame and discuss the structure and dynamical (reactions) aspects within a common framework. In this regard, it is a novel and possibly useful approach for researchers on the field and, as such, this might justify this new book.

Is this area (i.e. its research and applications) growing, static or shrinking?
The topic of nuclear structure and reactions experienced an impulse since the late 1980s thanks to the development of accelerators capable of producing and accelerating radioactive beams. Since then, new facilities have been built around the work (GSI at Germany, RIKEN at Japan, GANIL at France...) and hence a large body new, interesting data are being produced and analyzed. The understanding of these data require and appropriate modeling of the underlying structure and reactions, as those presented in this book. In this respect, I would say it is a growing subject which will require more and more researchers, both in theory and experiments, in near future.

Who do you see as the target readership(s) in terms of subject areas and academic levels? Could this be used as a textbook for a taught course? If so, please suggest the relevant course names.
The topics covered by this monograph go certainly beyond the undergraduate level. Although the authors claim in the preface that this book would be useful also for fourth-year undergraduate student , the book employs in my opinion many advanced formalisms and concepts, such as the RPA ("Random Phase Approximation") , the PVC ("the Particle Vibration Coupling"), the DWBA ("Distorted Wave Born Approximation"), and others, which are rarely taught to undergraduate students.

As such, I would say that potential readers would range from PhD students to more senior researchers working in nuclear structure and reaction theory.

What are the main competing books on this topic, if any?
Many of the theories presented in this book were developed long ago, and are gathered in some other books, most notably in the books by the Nobel laureates A. Bohr and B. Mottelson ("Nuclear Structure", Vols. I and II, Benjamin, New York, 1969). Although this is still a basic reference, the present authors include new advances and applications of these theories, and present some of the most difficult concepts in a less arid and more friendly way.

There is also some overlap in the contents with the book "Nuclear Superflidity", by D. Brink and R. Broglia, also published by Cambridge University Press, but as stated by the authors in the preface of the present book, these two books are complementary to some extent.

Please comment on the Contents: is the structure logical, are there any topics missing or which could be removed? Do you have any suggestions for improvement?

Overall, the book has a sensible structure. In the first chapter, the authors try to give some broad overview of the elementary modes of excitation exhibited by nuclei, which are later on developed in more detail in subsequent sections. However, not being an expert on the subject, I had difficulties following some parts of the book. For example, the first chapter, which turns out to be quite long (~60 pages) uses already many concepts which are supposed to be explained in later chapters or which are not even explained in the book (appropriate references are given). Already in this first chapter, the reader is exposed with many figures containing NFT diagrams, but the rules to construct these diagrams are not explained until Sec. 2.7.

The choice for the placement of some chapters is also questionable. For example, Sec. 2.6 ("Coupling between intrinsic and relative motion") provides a derivation of a semiclassical coupled-channels method. This section is sandwiched between sections describing mostly structure properties so it looks a bit orphan here.

Some figures are probably overloaded and contain too much information for the average reader (Figs. 2.9.1 and 2.9.2 are extreme examples of this). I wonder whether, pedagogically, this is the optimal way of exposing these concepts.

Please comment on the writing samples: is the writing clear, accurate and suitable for its target audience?
Yes.

Is the proposed title appropriate? Do you have any suggestions for improvement?
Yes, although the book covers other topics, aside from "Cooper phenomena" in nuclei, I think this title reflects well what the reader will find the book and it is also an appealing name to catch potential readers.

If possible, please comment on the standing of the authors within the community.
R. Broglia is a senior researcher. He is a well-known and respected nuclear physicist. He has contributed substantially to the field, publishing many seminal scientific papers and has co-authored well-renowned textbooks.

G. Potel is a younger nuclear physicist. He has also gained a very good reputation in the field as a theoretician.

Would you recommend that Cambridge publishes this volume and why?
I would recommend publication of this book as it can be a good complement of two other books published by Cambridge University Press and co-authored by one of the present authors, namely, "Nuclear Superfluidity", by D. Brink and R. Broglia, and "Oscillations Finite Quantum Systems" by Bertsch and Broglia.

So, overall, I consider this could be an interesting book, clearly not for an introductory course on nuclear and reactions, but still useful for advanced practitioners and to be used in combination with some other books which complement many formal aspects touched in this book, but not explained in detail.

I hope these impressions are useful for your assessment on the publication of this book.

Referee B

Here is my review report; I thank you for waiting.

I have read through Chapters 1 and 2 provided to me. I understand that these first two chapters are probably an introductory part of the book. Chapter 1 is devoted to introducing some basic concepts of nuclear structure physics, with some emphasis on the authors' viewpoint; it appears to me that this chapter is a brief summary of the "companion volumes" (Preface), "Nuclear Superfluidity" and "Oscillations in Finite Quantum Systems". Chapter 2 is devoted to a brief introduction of a theoretical framework which are seemingly used throughout this book. The framework is the Nuclear Field Theory. In this framework the authors emphasize that the elementary modes of excitation are fundamental building blocks for understanding nuclear structure, and the Nuclear Field Theory (NFT) is a consistent theoretical framework that realizes this viewpoint. The NFT, which has been developed mainly in 1970's to describe nuclear structure by those including one of the present authors, is described to some significant detail in Chapter 2. What is interesting is that the authors present here a new application of the NFT to nuclear reactions, in particular, direct reactions such as one-nucleon and two-nucleon transfer reactions.

Speaking honestly, I found it difficult to evaluate the proposal on the basis of the information given to me. The reason is as follows.

1. It appears me that the main subjects of the book is theoretical methods and related concepts which can be utilized to probe nuclear pairing and nuclear Cooper pair in transfer reactions. This subject, however, is explained only very briefly in Chapters 1 and 2. The list of contents (p.9–13) suggests that this subject is described and discussed in great detail in remaining chapters (Chap. 3–7 and Appendices). The latter part appears to include some new ideas and concepts, e.g. 3.6.1 Cooper pair binding: a novel embodiment of Axel–Brink hypothesis, 3.7 & 3.B Nuclear van der Waals Cooper pair, 3.A Lindemann criterion. The detailed and overall discussion of the transfer reactions (Chap. 4, 5, 6 and 7) may be useful for current and near-future studies of exotic nuclei, which are developing worldwide in RI beam facilities. However, it is hard to deduce how these (seemingly) interesting issues are realized in the latter Chapters.

2. New developments of the NFT, i.e. application to nuclear direct reactions including one- and two-nucleon transfers, is certainly interesting. However, the explanation and discussion in Chapters 1 and 2 are insufficient. Since the latter chapters are not available, I tried to check their original papers, and I found similar contents in arXiv:1511.0387 (*Phys. Scr.* **91**, 063012 (2016)) and arXiv:1304.2569 (*Rep. Prog. Phys.* 2013). However, I found some difference, e.g. between the present manuscript and the above references (e.g. Fig.2.9.3 vs Fig.2 in arXiv:1511.0387). These are diagrams expressing the formalism of the NFT for reactions. A diagram is expected to correspond to an equation, term by term, but such correspondence is not explained, and differs in this book compared to the original papers. These cause difficulty of understanding.

Apart from the above difficulty, I realize some characteristic features of the proposed book:
3. The style of this book appears to be very different from the companion volumes "Nuclear Superfluidity" and "Oscillations in Finite Quantum Systems". The latter two are written in such a way that the readers obtain broad perspectives on the subjects without going into details. The proposed book, on the contrary, focus on the specific issues; the NFT theories and the reaction probes of the nuclear pairing. From the list of contents, I see that the total pages will be 540

pages, nearly 1.5 and 3 times longer than the companion volumes. I guess that detailed aspects of the transfer reactions, especially, two-neutron transfer reactions are presented in the latter chapters.

Let me answer the following questions.

Is there a need for a new book on nuclear structure theory, such as the one proposed, and why? Is this area (i.e. its research and applications) growing, static or shrinking?
Since late 1980's, the experimental facilities utilizing secondary beams of radioactive isotopes have opened new fields of the nuclear physics and have accelerated the study of neutron-rich or proton-rich unstable nuclei. Revolutionary changes are seen or expected in some of the basic concepts, and the nuclear pairing is one of such issues. The 3rd generation RI beam facilities are in operation (RIKEN), and under construction (FRIB), and the transfer reactions on unstable nuclei will be one of main topics in including the nuclear pairing. This book will be useful for researchers and graduate students who do such experiments and related theoretical studies.

Who do you see as the target readership(s) in terms of subject areas and academic levels? Could this be used as a textbook for a taught course? If so, please suggest the relevant course names.
The target level will be researchers and PhD students in the field. Because of the detailed and focused characteristics of the book, it may not be easy to be used for a taught course.

What are the main competing books on this topic, if any?
I do not see any competing books since this book is different from the standard textbooks on direct nuclear reactions such as "Direct Nuclear Reactions" (N.K. Glendenning) and from the books on the nuclear structure. This book focuses on specific issues and the authors' original viewpoints.

Please comment on the Contents: is the structure logical, are there any topics missing or which could be removed? Do you have any suggestions for improvement?
There are some repetitions and overlaps, e.g. Section 1.2 and 2.3, Section 1.7 and 2.2. Since the planned page size is quite big, it may be reasonable to remove overlaps. This might help the readers to read more easily.

Please comment on the writing samples: is the writing clear, accurate and suitable for its target audience?
I feel that the sentences have a flavor of the literature, rather than simple and straightforward scientific writing. Whether this style is favored may depend on the readers.

Is the proposed title appropriate? Do you have any suggestions for improvement?
I am not sure that the tile "Nuclear Cooper Pair: structure and reactions" fits well the contents. I suppose that the central subjects are the nucleon transfer reactions and the application of the NFT, and the two-nucleon transfer reaction as a probe to the nuclear pairing. I guess that a much big weight is put on "reactions" than on "structure". If I do not mind the catchiness of the title, a title like "Nuclear Cooper Pair: probing in transfer reactions" may match my feeling.

Would you recommend that Cambridge publishes this volume and why?
This book will be useful for expert usage since the details of two-nuclear transfer reactions and its background theory are presented in a single volume. It will be purchased by those, like me, who are interested in nuclear pairing and transfer reactions to probe it. However, it is not certain to me whether it appeals to a wide audience.

Referee C

With apologies for the delay, here is my assessment of the book.

I have read with interest the proposal by G. Potel and R. Broglia as the topic pairing correlations in atomic nuclei is very close to my own interests.

Is there a need for a new book on nuclear structure/reactions, such as the one proposed, and why?
Yes. The (modern) approach followed by authors is usually not covered in other texts and the emphasis is placed on the properties of exotic nuclei and the treatment of both structure and reactions.

Is this area (i.e. its research and applications) growing, static or shrinking?
Given the worldwide development of new rare isotope facilities, such FRIB and FAIR, I believe the field is growing. The fact that we are now able to study nuclei far from stability, nuclear structure makes a strong impact in other areas of physics, notably nuclear astrophysics.

Who do you see as the target readership(s) in terms of subject areas and academic levels? Could this be used as a textbook for a taught course? If so, please suggest the relevant course names.
I don't have lots of experience in teaching as I'm not a teaching professor. However, I've lectured in several Nuclear Physics Schools and I find the level of these two chapters quite high and I have reservations that this will be at the proposed 4th-year physics undergraduates/starting PhD students. In my view, this can only be used in a graduate (post-graduate) class.

What are the main competing books on this topic, if any?
There are books that address the topic of pairing, in particular Brink and Broglia "Nuclear Superfluidity" also published by Cambridge University Press and others in reactions like Thomson and Nunes "Nuclear Reactions for Astrophysics: Principles, Calculation and Applications of Low-Energy Reactions" also from Cambridge.

Please comment on the Contents: is the structure logical, are there any topics missing or which could be removed? Do you have any suggestions for improvement?
The proposed contents look good to me.

Please comment on the writing samples: is the writing clear, accurate and suitable for its target audience?
I liked the samples I read.

In addition to the comment about the level of the presentation, a concern is on some of the figures shown, which I find very difficult to follow. For example: Figs. 2.9.2 and 2.9.3. The authors should revise Fig. 1.1.3, which shows the 2s level pushed down and is incorrect. (Interesting enough, this mistake has been with us since the original figure in Bohr & Mottelson.)

Is the proposed title appropriate? Do you have any suggestions for improvement?
I like the title, it's a catchy one.

If possible, please comment on the standing of the authors within the community.
The standing of Prof. Broglia in the Nuclear Physics community is, without any doubt, outstanding. He is known for many seminal contributions to the field, in particular the topics of this book.

Dr. Pottel, a former PhD student and post-doc with Broglia, is now Staff Scientist at Livermore National Lab and is becoming one of the young leaders in the field of nuclear reactions with exotic nuclei.

Would you recommend that Cambridge publishes this volume and why?
Yes I strongly recommend publication. I believe this book will be welcomed in the nuclear structure community and I, personally, look forward to having my own copy.