SpringerBriefs in Mathematical Physics

Volume 13

SpringerBriefs are characterized in general by their size (50-125 pages) and fast production time (2-3 months compared to 6 months for a monograph).
Briefs are available in print but are intended as a primarily electronic publication to be included in Springer's e-book package.

Typical works might include:

An extended survey of a field
A link between new research papers published in journal articles
A presentation of core concepts that doctoral students must understand in order to make independent contributions
Lecture notes making a specialist topic accessible for non-specialist readers.

SpringerBriefs in Mathematical Physics showcase, in a compact format, topics of current relevance in the field of mathematical physics. Published titles will encompass all areas of theoretical and mathematical physics. This series is intended for mathematicians, physicists, and other scientists, as well as doctoral students in related areas.

More information about this series at http://www.springer.com/series/11953

J.-B. Bru · W. de Siqueira Pedra

Lieb-Robinson Bounds for Multi-Commutators and Applications to Response Theory

Springer

J.-B. Bru
Departamento de Matemáticas, Facultad de Ciencia y Tecnología
Universidad del País Vasco
Bilbao
Spain

and

IKERBASQUE, Basque Foundation for Science
Bilbao
Spain

and

BCAM—Basque Center for Applied Mathematics
Bilbao
Spain

W. de Siqueira Pedra
Department of Mathematical Physics, Institute of Physics
University of São Paulo
São Paulo
Brazil

ISSN 2197-1757 ISSN 2197-1765 (electronic)
SpringerBriefs in Mathematical Physics
ISBN 978-3-319-45783-3 ISBN 978-3-319-45784-0 (eBook)
DOI 10.1007/978-3-319-45784-0

Library of Congress Control Number: 2016950360

Mathematics Subject Classification (2010): 82C10, 82C20, 82C22, 47D06, 58D25, 82C70, 82C44, 34G10

Printed on acid-free paper

This Springer imprint is published by Springer Nature
The registered company is Springer International Publishing AG
The registered company address is: Gewerbestrasse 11, 6330 Cham, Switzerland

Contents

Abstract

We generalize to multi-commutators the usual Lieb–Robinson bounds for commutators. In the spirit of constructive QFT, this is done so as to allow the use of combinatorics of minimally connected graphs (tree expansions) in order to estimate time-dependent multi-commutators for interacting fermions. Lieb–Robinson bounds for multi-commutators are effective mathematical tools to handle analytic aspects of the dynamics of quantum particles with interactions which are non-vanishing in the whole space and possibly time-dependent. To illustrate this, we prove that the bounds for multi-commutators of order three yield existence of fundamental solutions for the corresponding non-autonomous initial value problems for observables of interacting fermions on lattices. We further show how bounds for multi-commutators of an order higher than two can be used to study linear and non-linear responses of interacting fermions to external perturbations. All results also apply to quantum spin systems, with obvious modifications. However, we only explain the fermionic case in detail, in view of applications to microscopic quantum theory of electrical conduction discussed here and because this case is technically more involved.