Preface

The tread of this book is formed by two fundamental principles of Harmonic Analysis: the Plancherel Formula and the Poisson Summation Formula. We first prove both for locally compact abelian groups. For non-abelian groups we discuss the Plancherel Theorem in the general situation for Type I groups. The generalization of the Poisson Summation Formula to non-abelian groups is the Selberg Trace Formula, which we prove for arbitrary groups admitting uniform lattices. As examples for the application of the Trace Formula we treat the Heisenberg group and the group $\mathrm{SL}_2(\mathbb{R})$. In the former case the trace formula yields a decomposition of the L^2-space of the Heisenberg group modulo a lattice. In the case $\mathrm{SL}_2(\mathbb{R})$, the trace formula is used to derive results like the Weil asymptotic law for hyperbolic surfaces and to provide the analytic continuation of the Selberg zeta function. We finally include a chapter on the applications of abstract Harmonic Analysis on the theory of wavelets.

The present book is a text book for a graduate course on abstract harmonic analysis and its applications. The book can be used as a follow up of the *First Course in Harmonic Analysis*, [9], or independently, if the students have required a modest knowledge of Fourier Analysis already. In this book, among other things, proofs are given of Pontryagin Duality and the Plancherel Theorem for LCA-groups, which were mentioned but not proved in [9]. Using Pontryagin duality, we also obtain various structure theorems for locally compact abelian groups.

Knowledge of set theoretic topology, Lebesgue integration, and functional analysis on an introductory level will be required in the body of the book. For the convenience of the reader we have included all necessary ingredients from these areas in the appendices.

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