Preface to the second edition

The present edition is an expanded and revised version of the first edition. Several changes have been added. These changes are based on a set of lectures given at Osaka City University and the University of the Ryukyus, and on seminars in several universities. These lectures were addressed to graduate and undergraduate students with interests in Probability and Analysis.

In the 1970s Professor P. Malliavin has begun analytic studies of the Wiener space; he gave a probabilistic proof of the hypoellipticity result in PDE theory due to L. Hörmander. The method he used on the Wiener space is called stochastic calculus of variations, now called Malliavin calculus. The spirit of Malliavin's work was clarified by J.-M. Bismut, S. Watanabe, I. Shigekawa, D. Nualart, and others.

In the 1980s and 1990s, the movement of stochastic calculus of variations on the Wiener space has been extended to the Poisson space by J.-M. Bismut, J. Jacod, K. Bichteler–J. M. Gravereaux–J. Jacod, and others. Due to their development of the theory, problems concerning integro-differential operators in the potential theory have come to be resolved. The author has encountered with these techniques and the atmosphere in Strassburg, Clermont-Ferrand, La Rochelle, and Kyoto.

The main purpose of this monograph is to summarize and explain analytic and probabilistic problems concerning jump processes and jump-diffusion processes in perspective. Our approach to those problems relies largely on the recent developments in the stochastic analysis on the Poisson space and that of SDEs on it. Several perturbation methods on the Poisson space are proposed, each resulting in an integration-by-parts formula of its own type.

The analysis of jump processes has its proper value, since processes with discontinuous trajectories are as natural as processes with continuous trajectories. Professor K. Itô has been interested, and has had a sharp sense, in jump processes (especially in Lévy processes) from the period of his inquiry for the theory of stochastic integration. The theory of stochastic calculus of variations for jump processes is still developing. Its application will cover from economics to mathematical biology, although materials for the latter are not contained in this volume.

It has been three years since the first edition had appeared. There have been intense activities focused on stochastic calculus for jump and jump-diffusion processes. The present monograph is an expanded and revised version of the first edition. Changes to the present edition are twofold: on the one hand, there was the necessity to correct typos and small errors, and a necessity for a clearer treatment of many topics to improve the expressions or to give sharp estimates. On the other hand, I have included new material. In Chapter 3, I have added Section 3.6.5 which treats the analysis of the transition density. In particular, it includes recent development on the Hörmander-type hypoellipticity problem for integro-differential operators related to jump-diffusion processes. The notes at the end of the volume are also extended.

https://doi.org/10.1515/9783110675290-202

For the help during the preparation of the second edition, I am indebted to many professors and colleagues regarding the contents and motivation. Especially, I am indebted to Professors H. Kunita, M. Tsuchiya, E. Hausenblas, A. Kohatsu-Higa, A. Takeuchi, N. Privault, and R. Schilling.

A major part of this work was done at Ehime university (1999–) with the aid of Grant-in-Aid for General Scientific Research, Ministry of Education, Culture Sports, Science and Technology, Japan (No. 24540176). I take this opportunity to express my sincere gratitude to all those who are related.

The year 2015 is the centennial of the birth of late Professor K. Itô. The development of Itô's theory has been a good example of international cooperation among people in Japan, Europe, and the U.S. I hope, in this way, we would contribute to peace and development of the world in the future.

Matsuyama, October 2015 Yasushi Ishikawa