"This book dismantles the final, most daunting barriers to learning about moduli of higher dimensional varieties, from the point of view of the Minimal Model Program. The first chapter draws the reader in with a compelling history; a discussion of the main ideas; a visitor's trail through the subject, complete with guardrails around the most dangerous traps; and a rundown of the issues that one must overcome. The text that follows is the outcome of Kollár's monumental three-decades-long effort, with the final stones laid just in the last few years."

— Dan Abramovich, Brown University

"This is a fantastic book from János Kollár, one of the godfathers of the compact moduli theory of higher dimensional varieties. The book contains the definition of the moduli functor, the prerequisites required for the definition, and also the proof of the existence of the projective coarse moduli space. This is a stunning achievement, completing the story of 35 years of research. I expect this to become the main reference book, and also the principal place to learn about the theory for graduate students and others interested."

— Zsolt Patakfalvi, EPFL

"This excellent book provides a wealth of examples and technical details for those studying birational geometry and moduli spaces. It completely addresses several state-of-the-art topics in the field, including different stability notions, K-flatness, and subtleties in defining families of stable pairs over an arbitrary base. It will be an essential resource for both those first learning the subject and experts as it moves through history and examples before settling many of the (previously unknown) technicalities needed to define the correct moduli functor."

— Kristin DeVleming, University of Massachusetts Amherst



### CAMBRIDGE TRACTS IN MATHEMATICS

### General Editors

J. BERTOIN, B. BOLLOBÁS, W. FULTON, B. KRA, I. MOERDIJK, C. PRAEGER, P. SARNAK, B. SIMON, B. TOTARO

231 Families of Varieties of General Type

#### CAMBRIDGE TRACTS IN MATHEMATICS

#### GENERAL EDITORS

### J. BERTOIN, B. BOLLOBÁS, W. FULTON, B. KRA, I. MOERDIJK, C. PRAEGER, P. SARNAK, B. SIMON, B. TOTARO

A complete list of books in the series can be found at www.cambridge.org/mathematics. Recent titles include the following:

- 196. The Theory of Hardy's Z-Function. By A. Ivić
- 197. Induced Representations of Locally Compact Groups. By E. Kaniuth and K. F. Taylor
- 198. Topics in Critical Point Theory. By K. Perera and M. Schechter
- 199. Combinatorics of Minuscule Representations. By R. M. GREEN
- 200. Singularities of the Minimal Model Program. By J. Kollár
- 201. Coherence in Three-Dimensional Category Theory. By N. Gurski
- 202. Canonical Ramsey Theory on Polish Spaces. By V. Kanovei, M. Sabok, and J. Zapletal
- A Primer on the Dirichlet Space. By O. El-Fallah, K. Kellay, J. Mashreghi, and T. Ransford
- 204. Group Cohomology and Algebraic Cycles. By B. Totaro
- 205. Ridge Functions. By A. PINKUS
- 206. Probability on Real Lie Algebras. By U. Franz and N. Privault
- 207. Auxiliary Polynomials in Number Theory. By D. Masser
- 208. Representations of Elementary Abelian p-Groups and Vector Bundles. By D. J. Benson
- 209. Non-homogeneous Random Walks. By M. Menshikov, S. Popov, and A. Wade
- 210. Fourier Integrals in Classical Analysis (Second Edition). By C. D. Sogge
- 211. Eigenvalues, Multiplicities and Graphs, By C. R. Johnson and C. M. Salago
- 212. Applications of Diophantine Approximation to Integral Points and Transcendence. By P. Corvaja and U. Zannier
- 213. Variations on a Theme of Borel. By S. Weinberger
- 214. The Mathieu Groups. By A. A. Ivanov
- 215. Slenderness I: Foundations. By R. DIMITRIC
- 216. Justification Logic. By S. ARTEMOV and M. FITTING
- 217. Defocusing Nonlinear Schrödinger Equations. By B. Dodson
- 218. The Random Matrix Theory of the Classical Compact Groups. By E. S. Meckes
- 219. Operator Analysis. By J. AGLER, J. E. Mccarthy, and N. J. Young
- Lectures on Contact 3-Manifolds, Holomorphic Curves and Intersection Theory. By C. Wendl
- 221. Matrix Positivity. By C. R. Johnson, R. L. Smith, and M. J. Tsatsomeros
- 222. Assouad Dimension and Fractal Geometry. By J. M. Fraser
- 223. Coarse Geometry of Topological Groups. By C. ROSENDAL
- 224. Attractors of Hamiltonian Nonlinear Partial Differential Equations. By A. Komech and E. Kopylova
- 225. Noncommutative Function-Theoretic Operator Function and Applications. By J. A. Ball and V. Bolotnikov
- 226. The Mordell Conjecture. By A. Moriwaki, H. Ikoma, and S. Kawaguchi
- 227. Transcendence and Linear Relations of 1-Periods. By A. Huber and G. Wüstholz
- 228. Point-Counting and the Zilber-Pink Conjecture. By J. PILA
- 229. Large Deviations for Markov Chains. By A. D. DE ACOSTA
- 230. Fractional Sobolev Spaces and Inequalities. By D. E. Edmunds and W. D. Evans

# Families of Varieties of General Type

## JÁNOS KOLLÁR

Princeton University, New Jersey

with the collaboration of

KLAUS ALTMANN

Freie Universität Berlin

and

SÁNDOR J. KOVÁCS

University of Washington



# **CAMBRIDGE**UNIVERSITY PRESS

Shaftesbury Road, Cambridge CB2 8EA, United Kingdom One Liberty Plaza, 20th Floor, New York, NY 10006, USA 477 Williamstown Road, Port Melbourne, VIC 3207, Australia 314–321, 3rd Floor, Plot 3, Splendor Forum, Jasola District Centre,

New Delhi – 110025, India 103 Penang Road, #05–06/07, Visioncrest Commercial, Singapore 238467

Cambridge University Press is part of Cambridge University Press & Assessment, a department of the University of Cambridge.

We share the University's mission to contribute to society through the pursuit of education, learning and research at the highest international levels of excellence.

www.cambridge.org
Information on this title: www.cambridge.org/9781009346108
DOI: 10.1017/9781009346115

© János Kollár 2023

This publication is in copyright. Subject to statutory exception and to the provisions of relevant collective licensing agreements, no reproduction of any part may take place without the written permission of Cambridge University Press & Assessment.

First published 2023

A catalogue record for this publication is available from the British Library.

A Cataloging-in-Publication data record for this book is available from the Library of Congress.

ISBN 978-1-009-34610-8 Hardback

Cambridge University Press & Assessment has no responsibility for the persistence or accuracy of URLs for external or third-party internet websites referred to in this publication and does not guarantee that any content on such websites is, or will remain, accurate or appropriate.