

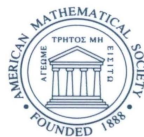
# CONTEMPORARY MATHEMATICS

181

## The Čech Centennial

A Conference on Homotopy Theory  
June 22–26, 1993  
Northeastern University

Mila Cenk  
Haynes Miller  
Editors



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*(Continued in the back of this publication)*

# CONTEMPORARY MATHEMATICS

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181

## The Čech Centennial

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**American Mathematical Society**  
Providence, Rhode Island

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The Čech Centennial Homotopy Theory Conference was organized to commemorate the one-hundredth anniversary of the birth of Eduard Čech. The conference was held at Northeastern University in Boston between June 22–26, 1993.

1991 *Mathematics Subject Classification*. Primary 55–06.

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### Library of Congress Cataloging-in-Publication Data

Conference on Homotopy Theory (1993 : Northeastern University, Boston, Mass.)

The Čech centennial : a Conference on Homotopy Theory, June 22–26, 1993, Northeastern University / Mila Cenk, Haynes Miller, editors.

p. cm. — (Contemporary mathematics, ISSN 0271-4132; v. 181)

ISBN 0-8218-0296-8 (acid free)

1. Homotopy theory—Congresses. I. Cenk, Mila, 1934–. II. Miller, Haynes R., 1948–.

III. Title. IV. Series: Contemporary mathematics (American Mathematical Society); v. 181.

QA612.7.C647 1993

514'.24-dc20

94-43164

CIP

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## Eduard Čech

June 29, 1893–March 15, 1960



*Photo courtesy of the Czech Academy of Sciences*



## Preface

The Čech Centennial Homotopy Theory Conference was organized to commemorate the one-hundredth anniversary of the birth of Eduard Čech. The conference was held at Northeastern University in Boston between June 22–26, 1993. The organizers were Mila Cenkľ, Mike Hopkins, Sol Jekel and Haynes Miller.

The main topics of the conference were the most recent results in the stable and unstable homotopy theory. The conference was attended by over one hundred mathematicians from around the world. In addition to the eleven plenary lectures there were thirty-three papers presented in two parallel sections.

This volume contains papers which were either presented or solicited at the conference. All papers were refereed, and we are glad to have this opportunity to thank the many referees who helped select and improve these papers.

We owe many thanks to Ms. Donna Marlowe and to all other staff members of the Department of Mathematics at Northeastern for making the conference and local arrangements a memorable success.

We acknowledge, with thanks, the generous support from Northeastern University, MIT, National Science Foundation, and the American Czech-and-Slovak Education Fund.

Finally we are grateful to Ms. Donna Harmon from the office of the American Mathematical Society for her fine secretarial support in assembling the volume.

Mila Cenkľ  
Haynes Miller

## Eduard Čech

It was in the spring of 1952 when, as a high school student, I first had the opportunity to meet Eduard Čech in person. He gave the opening address to the participants of the first Czechoslovak Mathematical Olympiad, a competition Čech himself had established the previous year. At that time I had already been influenced by his approach to mathematics for several years, as many of the textbooks in use were written either directly by him or in collaboration with his colleagues.

Eduard Čech was a professor of mathematics at Charles University in Prague and also a member of the Czechoslovak Academy of Sciences. He was not only one of the greatest Czech mathematicians, whose research in topology and differential geometry had a lasting impact on the directions in those fields, but he was also a very influential teacher and mentor.

Eduard Čech was born on June 29, 1893 in Stračov in northeastern Bohemia, about 100 miles from Prague. He studied at Charles University and received his doctoral degree there in 1920. At that time his interest was mainly in the study of local invariants of submanifolds of a projective space. This work and his collaboration with Q. Fubini culminated in two books on projective differential geometry. In the late twenties, his broad interests in mathematics were already focused on problems in topology.

What struck me most profoundly about Čech when I was an undergraduate at Charles University was his approach to mathematics, mathematical thinking and his unique way of reading a book in mathematics. For example, after he read a theorem he would proceed to prove the statement himself before looking up the proof in the text.

Mathematics with all of its aspects was Čech's life. He had a remarkable capacity to focus on a chosen task. He had a great intuition, but was never satisfied with any result without an exact proof. He was a perfectionist. In 1926 he published a book on projective differential geometry (in Czech), where he attempted to present a rigorous treatment of differential geometry several years before the appropriate tools were invented.

Apart from his strict approach to mathematics, Čech would occasionally recount stories from his many experiences. Once he mentioned a book of Lefschetz he had read before his trip to Princeton for a year-long stay at the Institute in

1935. He said that after reading the book he wrote to Lefschetz that the book was great, that all the theorems were correct but that none of the proofs were quite right. He also sent his proofs to Lefschetz. Years later, in 1968, when I had the opportunity to ask Lefschetz about this, he recalled the incident, saying that, “Oh yes, I remember that. Čech was quite an extraordinary young man.”

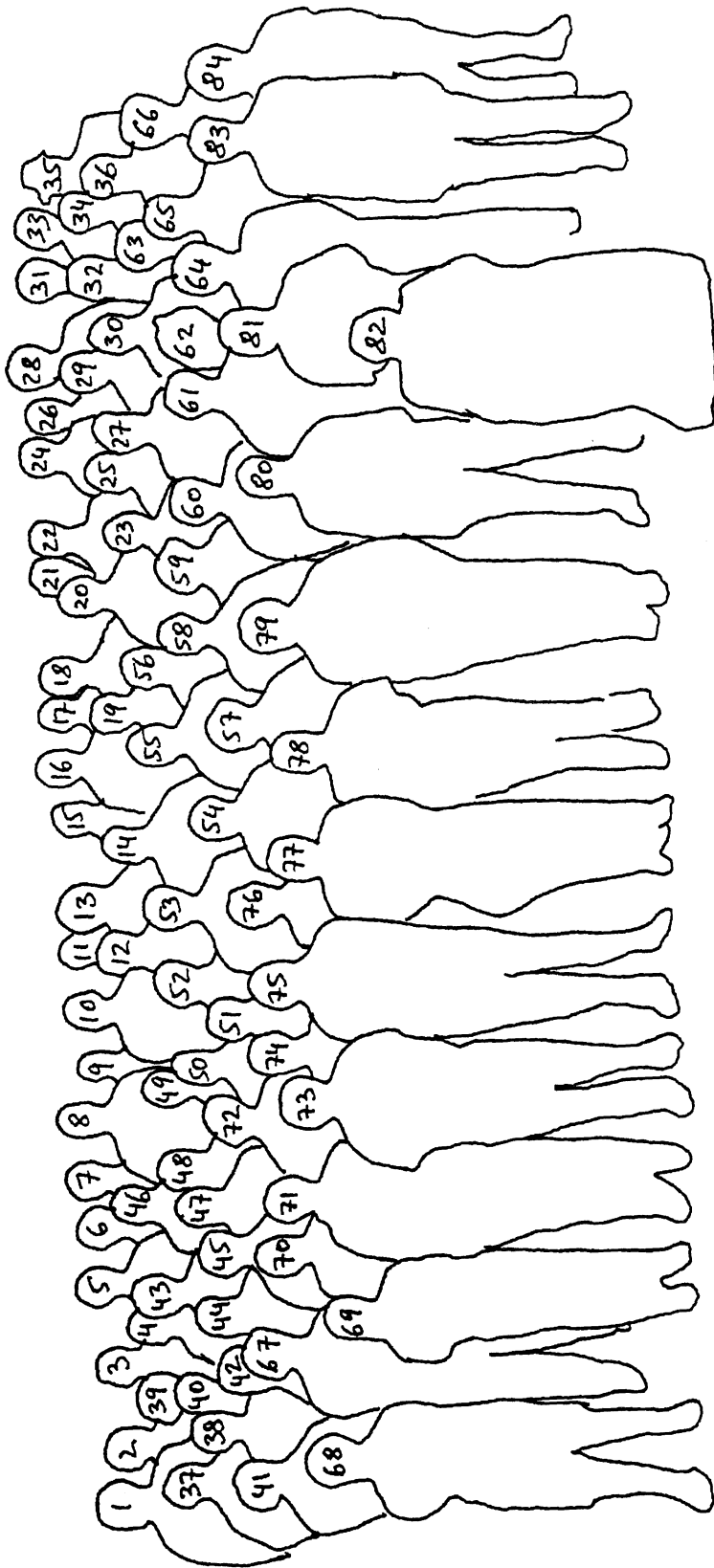
Čech’s paper which most closely reflects the main topic of the Čech Centennial Homotopy Conference is the brief communication on higher homotopy groups presented at the International Congress of Mathematicians held in Zürich in 1932. In that paper Čech defined the higher homotopy groups. Commenting on Čech’s definition, P. S. Alexandrov wrote in 1961: “This definition did not meet with the attention it merited; in fact, the commutativity of these groups for dimensions greater than one was criticized. We must express our admiration at the intuition and talent of Professor Čech, who defined the homotopy groups years before W. Hurewicz.”

Čech published 30 papers in topology between 1930 and 1938. All those papers were reprinted in the 1968 text, *Topological Papers of Eduard Čech*, by Academic Publishing House of the Czechoslovak Academy of Sciences. The papers containing some of Čech’s major contributions to topology are: *On bicomplex spaces*, Ann. of Math. **38** (1937), 823–844; *Sur la théorie de la dimension*, C.R. Acad. Sci. Paris **193** (1931), 976–977; *Sur la dimension des espaces parfaitement normaux*, Bull. Internat. Acad. Tchèque Sci. **33** (1932), 38–55; *Contribution to dimension theory* (in Czech), Časopis Pěst. Mat. Fys. **62** (1933), 277–291; *Théorie générale de l’homologie dans un espace quelconque*, Fund. Math. **19** (1932), 149–183; *Les groupes de Betti d’un complexe infini*, Fund. Math. **25** (1935), 33–44; *Multiplication on a complex*, Ann. of Math. **37** (1936), 681–697; *Höherdimensionale Homotopiegruppen*, Verh. des int. Kongr. Zürich **2** (1932), 203. An extended biography and a bibliography of Čech’s work can be found in the book *The Mathematical Legacy of Eduard Čech*, published by Academia, Praha, 1993.

Starting in 1939 all the universities in Bohemia and Moravia were closed for the duration of the German occupation. After the war, in 1945, Čech returned to problems in differential geometry. He played a major role in the reconstruction of mathematical life in Czechoslovakia. He was instrumental in founding the Mathematical Institute of the Czechoslovak Academy of Sciences in 1950 and the Mathematical Institute at Charles University in 1956. Čech remained very active in all aspects of mathematics in Czechoslovakia until his death on March 15, 1960.

Mila Cenkľ





## List of Participants

The numbers in the parantheses refer to the group picture

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A. Bajer	P. Hirschhorn (12)	J. Neisendorfer (73)
M. Bendersky (67)	M. Hopkins	A. Nofech (37)
T. Bisson (39)	M. Hovey (38)	J. Palmieri (25)
D. Blanc (9)	T. Hunter (42)	C. Peterson (69)
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E. Brown (75)	R. Jardine (21)	D. Robenson
R. Bruner (49)	J. Jones (76)	H. Sadofsky (11)
J. Bureš (77)	S. Jekel	J. Shank (29)
E. Campbell (20)	R. Kane (28)	P. Shick (61)
C. Casacuberta (55)	M. Kapranov	D. Shimamoto (40)
B. Cenkli (79)	K. Kelly (46)	B. Shipley
D. Christeasen (36)	S. Kochman (35)	E. Siegel
F. Cohen (3)	I. Kriz (1)	P. Silberbush (74)
O. Cornea (50)	P. Landweber (71)	J. Silverman (47)
D. Davis	L. Langsetmo (44)	W. Singer (66)
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E. Farjoun (41)	H. Marcum (5)	A. Suci
V. Franjou (7)	D. Massey	R. Thomson (15)
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B. Gray	K. Monks (84)	C. Y. Yu (60)

## Titles of Talks<sup>1</sup>

- \* **F. Cohen**                    *Combinatorial Group Theory in Homotopy.*
- \* **S. Stolz**                    *Manifolds of Positive Scalar Curvature.*
- J. Palmieri**                *Nilpotence and Periodicity over Steenrod Algebra.*
- K. Monks**                 *Polynomial Modules over the Steenrod Algebra  
and Conjugation in the Milnor Basis.*
- J. Silverman**            *On the Action of Steenrod Squares on  
Polynomial Algebras.*
- J. Møller**                *Centers of  $p$ -compact Groups.*
- V. Gorbunov**            *On Spectra  $(CP \wedge MSp)_{-\infty}$  and  $(P \wedge MSp)_{-\infty}$ .*
- R. Levi**                 *On Homotopy Uniqueness of Certain Loop Spaces.*
- \* **I. Kriz**                 *Algebraic Constructions of Spectra.*
- \* **C. Wilkerson**         *Centers and Semisimplicity for  $p$ -compact Groups.*
- \* **J. Bureš**                *Life and Work of Eduard Čech.*
- \* **M. Kapranov**         *Koszul Duality for Operads.*
- \* **R. Bott**                *Ruminations on Knots.*
- A. Elmendorf**         *A Conceptual Approach to Rings and Module  
Spectra.*
- P. Schick**              *A Corrected Version of the Telescope  
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- B. Mao**                 *BP Analogue of Lin's Theorem.*
- A. Nofech**             *Localization of Inverse Limits.*
- D. Blanc**              *Recognition Principles of Mapping Spaces.*
- J. Neisendorfer**     *On the Weak Rational Homotopy Type of  
Tiny Bubbles.*
- P. Goerss**             *Homotopy Fixed Points for Galois Groups.*
- D. Davis**              *$v_1$ -Localizations of Finite Torsion Spectra  
and Spherically Resolved Spaces.*
- \* **J. Jones**             *Floer's Infinite Dimensional Morse Theory  
and Homotopy Theory.*

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<sup>1</sup>The titles are in chronological order. \* indicates a plenary talk.

- \* **W.Dwyer** *Homotopy Theories.*  
**N. Minami** *The Kervaire Invariant One and the Double Transfer.*  
**A. Suci** *Complements of Hyperplane Arrangements.*  
**J. McClure** *K-theory and Andre-Quillen Homology.*  
**H. Sadofsky** *Tate Homology and  $v_n$ -periodicity.*  
**C. N. Lee** *Homotopy Decomposition of the Classifying Space of Virtually Torsion Free Groups and Application.*  
**V. Franjou** *Extension Between Simple Functors.*  
**J. Turner** *Dyer-Lashof Operations in Second Quadrant Spectral Sequences.*  
**O. Cornea** *Critical Point Theory and Cone-Decompositions.*  
**C. Casacuberta** *Anderson Localization from a Modern Point of View.*  
**K. Xu** *Spaces with Algebraically Closed Fields.*  
\* **D. Ravenel** *Telescopes, Past, Present and Future.*  
\* **E. Farjoun** *Cellular Inequalities and the Symmetric Product of Spaces.*  
**M.Hovey** *A BP Analogue of Hopkins' Zeta Conjecture.*  
**M.Boardman** *The Cohomology of a Point (and Some Other Spaces).*  
**E. Getzler** *Operads and Moduli Spaces of Riemann Surfaces.*  
**M.Winstead** *Another Look at Adam's Definition of the T-function.*  
**C. Peterson** *Geometric Cohomology of Steenrod Algebra.*  
**B. Gray** *Costable Homotopy.*  
**H. Marcum** *Partial Whitehead Products.*  
**E. Campbell** *Upper Triangular Invariants as a Module over the Dickson Invariants.*  
**D. Stanley** *An Implication of Moore's Conjecture.*



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- 125 **F. Thomas Bruss, Thomas S. Ferguson, and Stephen M. Samuels, Editors**, Strategies for sequential search and selection in real time, 1992

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**The Čech Centennial**  
Mila Cenkľ and Haynes Miller, Editors

This book contains the refereed proceedings of the Čech Centennial Homotopy Theory Conference, organized to commemorate the 100th anniversary of the birth of Eduard Čech and held at Northeastern University in June 1993. Focusing on the theme of stable and unstable homotopy theory, the conference attracted more than one hundred mathematicians from around the world. With recent results by some of the leaders in the field, this book will provide readers with a look at important directions in current research in homotopy theory.

ISBN 0-8218-0296-8



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