

## Professor Joram Lindenstrauss

Joram was born in 1936 to Ilse and Bruno Lindenstrauss, lawyers who immigrated to Palestine from Germany in 1933. He started to study mathematics at the Hebrew University of Jerusalem in 1954, in parallel with his military service. He received his Master's degree in 1959 and his Ph.D. in 1962, for a thesis on extensions of compact operators written under the guidance of Aryeh Dvoretzky and Branko Gruenbaum. He did postdoctoral research at Yale University and the University of Washington in Seattle from 1962 to 1965. In 1965 he returned to the Hebrew University as senior lecturer and this was where he worked, except for sabbaticals, until his death. He became an associate professor in 1967, a full professor in 1969, and the Leon H. and Ada G. Miller Memorial Professor of Mathematics in 1985. Twelve mathematicians received the Ph.D. under his guidance.

He wrote 124 articles and seven research books, the last of which appeared a short time before his death. The two volumes on Banach Spaces which he wrote with Lior Tzafriri are considered fundamental books in the field. He also wrote four textbooks in Hebrew. Two were written with Amnon Pazy and Benjamin Weiss after the Yom Kippur War to help the students who were absent from their studies because of their military service, and were dedicated to the students of the mathematics department who fell in that war.

Beyond his own research, it was important for Joram to promote the Institute of Mathematics at the Hebrew University and mathematical research in Israel. He was an editor of the Israel Journal of Mathematics and did his best to establish it as an important journal. He was also editor of Crelle journal, Forum Mathematicum and Ann. Acad. Sci. Finland.

Joram gave an invited lecture at the International Mathematical Congress in Nice in 1970. He won the Israel Prize in Mathematics in 1981 and was elected as a member of the Israel Academy of Sciences in 1986. In 1997 he was the first non-Polish mathematician to receive the Banach Medal from the Polish Academy of Sciences. In 2000 he was elected as foreign member of the Austrian Academy of Sciences and in 2001 he received an honorary doctorate from Kent State University in Ohio. He died in 2012.

### His research:

In his thesis and also a little after that Joram considered the classification and characterization of real Banach spaces whose conjugate is  $L^1$  on a measure space. The unit ball of (separable) spaces of this kind is the closure of the union of a chain of  $n$ -dimensional cubes ( $n=1,2,3,\dots$ ). The fact that there are many possibilities for an isometric embedding of an  $n$ -dimensional cube in an  $(n+1)$ -dimensional cube gives the great variety of spaces of this type, and explains their importance in analysis. These spaces are called Lindenstrauss spaces in the literature.

Together with Alexander Pelczynski from Warsaw, Joram contributed to the understanding of the Alexander Grothendieck's work on tensor products. They found several important applications of Grothendieck's results, especially to the theory of summing operators between Banach spaces, and formulated an important inequality that stands at the center of the theory (and is known as Grothendieck's inequality).

Together with Dan Amir of Tel Aviv University, Joram developed a method for investigating important classes of non-separable spaces (for example reflexive non-separable spaces). The main point of the method is the reduction of the study of these spaces to the separable case using the existence of suitable projections. In this way several conjectures on the

structure of the unit ball in these spaces have been proved. The method also has important implications for non-separable set topology.

Joram investigated "almost" Euclidean subspaces in finite-dimensional Banach spaces in continuation of Dvoretzky's theorem about the existence of such sections in any Banach space. Together with Vitali Milman of Tel Aviv University and Tadek Figiel of Gdansk, Poland they found exact estimates on the dimensions of these sections in important spaces. Together with Lior Tzafriri from the Hebrew University he found, with the help of Dvoretzky's theorem, a proof for the well known conjecture that only in Hilbert space there is a bounded projection onto every closed subspace.

In 1975-1977, Lior Tzafriri and Joram wrote two volumes on classical Banach spaces and on bases in these spaces. These books are considered fundamental books in the theory of Banach spaces. Joram published a number of papers on the structure of convex sets in finite- and infinite-dimensional spaces. In the framework of this research he found a new and simple proof of the Liapunov theorem, a fundamental theorem in measure theory.

Joram developed the foundations of the research of the non-linear theory of Banach spaces and proved, with others, results about the possibility of producing from a Lipschitz isomorphism between Banach spaces (and, more generally, a uniformly continuous isomorphism between such spaces) a linear isomorphism. Based on this research, he and Yoav Benyamini from the Technion wrote a book dealing with the non-linear geometry of Banach spaces.

While studying this non-linear theory, Joram wrote a joint paper with W. B. Johnson of Texas A&M University about extensions of functions satisfying a Lipschitz condition. In this paper there is a lemma that shows that every  $n$  points in a Hilbert space can be embedded, while "almost" conserving the distances between them, in a Euclidean space of dimension  $c \log n$ , where the constant  $c$  depends only on the degree of accuracy required in conserving the distances. This lemma, which is known as the Johnson-Lindenstrauss lemma, has many applications in computer science.

Joram and W. B. Johnson edited two volumes entitled Handbook of Banach Space Theory. These books survey the important results in the field that were known in 2000. He also participated in writing two chapters in this book. In the last years he dealt with the difficult question of the existence of a derivative in the strong sense of Lipschitz maps between Banach spaces. A book he wrote with David Preiss of Warwick University and Jaroslav Tiser from Prague on Frechet differentiability of Lipschitz functions and porous sets in Banach spaces appeared in 2012.