R H Bing

October 20, 1914 – April 28, 1986

R H Bing, President of the AMS in 1977 and 1978, died at age 71 at his home in his study in Austin, Texas. A major contributor to geometric topology, especially with his work on 3-manifolds, he saw many of his basic ideas and techniques used by others in recent major breakthroughs in higher dimensional manifolds. He was the retired "Mildred Caldwell and Baine Perkins Kerr Centennial Professor Emeritus in Mathematics" at The University of Texas at Austin. From 1947 to 1973 he was on the faculty at the University of Wisconsin, where he was "Rudolph E. Langer Research Professor of Mathematics" during the last nine of these years.

R H Bing was a long time member of the National Academy of Sciences and a former member of the National Science Board. He was also President of the Mathematical Association of America (MAA) in 1963 and 1964, and is one of only four people who have, since the forties, served both the Society and the Association as President.

He was former Chairman of the Conference Board of the Mathematical Sciences, former Chairman of the Mathematics Section of the National Academy of Sciences and of the Division of Mathematical Sciences of the National Research Council, and former Chairman of Section A and Vice-President of the American Association for the Advancement of Science. He served on countless committees for many organizations. In 1974 he received the MAA award for Distinguished Service to Mathematics. Few mathematicians in our lifetime have served our community so well and with such distinction.

He was justly proud of his collection of thirty-five doctoral students at Wisconsin and Texas. Many are in important academic positions throughout the country, and many are active in current research. Participation with him in a seminar or class was a lively, rewarding, and stimulating experience. He had great influence on many young mathematicians who came into contact with him at Wisconsin or at Texas, at the Institute for Advanced Study or at the University of Virginia where he held visiting positions, or in his many travels in this country and abroad. He presented invited lectures at over two hundred colleges and universities with locations in nearly every state of the Union and in seventeen foreign countries. He was the Hedrick Lecturer for the MAA in 1961 and the Colloquium Lecturer for the AMS in 1970. His book on the geometric topology of 3-manifolds was recently published by the AMS.

R H, as he was known to many of us, had, in an old southern tradition, no given names to go with his initials. On occasion, he was required to list his name as R (only) H (only) Bing: hence, his sometime nickname *Ronly Honly Bing*. He was born in Oakwood, Texas, where his father was superintendent of schools. His mother, who was widowed when R H was five, taught school in Texas while rearing R H and his sister. At an early age, he was instilled with a love of learning, of doing, of competing, and of achieving. To R H, mathematics was like a big game in which he competed mightily against the unrevealed geometric truths of mathematics. He loved that game among all others and played it very hard. He won some and he lost some. But in the final reckoning he had won a truly impressive number.

Bing graduated from high school as one of the state-wide winners in what is known as the University Interscholastic League Contests in Texas, a series of contests by grade level on number sense, estimation, and mental arithmetic—eighty problems in ten minutes.

After high school, he went to Southwest Texas State Teachers College at San Marcos (now Southwest Texas State University), graduating at twenty in 1935. As an undergraduate, R H prepared to be a high school mathematics teacher. So he became one, along with becoming a football and track coach at Palestine, Texas. (Can anyone hear some of his students, or their parents, complaining because the football coach was their geometry teacher?) Bing may well be the only high school football coach who ever made it to the National Academy of Sciences in mathematics.

In 1938, while working toward a master's degree in mathematics education at the University of Texas, he took a summer geometry course from R. L. Moore and decided (correctly) that if some of those other people in the course could be doctoral students in mathematics, then so

could he. There is some doubt as to whether Moore was particularly impressed with Bing during that first summer. There is no doubt that Moore was very impressed after Bing started serious graduate work in mathematics in 1942 and then solved, along with several other problems, the Kline sphere characterization problem by the time he completed his doctoral degree in 1945. Bing became Moore's standard of comparison for future students from then on. He stayed on as a young faculty member at Texas until 1947 when he went to the University of Wisconsin to begin his long, distinguished career there.

The authors first knew R H, his wife Mary, and their oldest child Robert when we both got out of the Navy and came back to Texas to continue graduate work after the war. And we have known him well and admired him and his mathematics ever since. As a person, R H was friendly, open, cheerful, and enthusiastic. He was also very hard working, often rising at five in the morning and getting right at his research. Our paths have crossed his many times and we are the richer for it.

In his last few years R H had suffered from cancer and other declines in health, but neither his vitality nor his zest for life and mathematics had deteriorated. Those of us who knew him well thought it particularly fitting that he died "at his desk with his boots on." That is the way he would have wanted it.

R H was a dedicated family man. He and his devoted wife Mary had four children: Robert, Susan, Gay, and Mary Pat. The first three are now married and have given the Bings six grandchildren, the youngest just a few months old. The family has always been close and supportive. It has been our pleasure to know them well over the years. R H and Mary were also dedicated to their activities with the Presbyterian Church where R H served as an elder.

While a more detailed account of his mathematical work is expected to be published later, a few comments are in order now.

Bing made perhaps his most lasting research contributions to topology during the decade of the fifties. When Moise (also a graduate student at Texas before and after the war) triangulated 3-manifolds and proved the Hauptvermutung at the beginning of that decade, Bing became intensely interested in the subject and gave alternative proofs of these important results based on his polyhedral approximation theorem for spheres. This led to his involvement in the study of 3-manifolds, especially their pathology, throughout the remainder of his life. In the mid-fifties, he developed two of his most far-reaching results—his side approximation theorem for 2-spheres in Euclidean 3-space and an example, now generally known as the "dogbone space," of a cellular decomposition of Euclidean 3-space that does not yield a manifold. (Shortly thereafter, he showed that the Cartesian product of this nonmanifold with a line is Euclidean four-space.) The side approximation theorem led to extensive work, during the sixties and early seventies, on tame and wild embeddings of 2-manifolds in 3-manifolds and on some generalizations to higher dimensions. In the paper describing the dogbone space, together with another important paper in which he showed that the 3-sphere S^3 results from canonically sewing two solid Alexander horned spheres together along their boundaries, he developed what has since become known as "Bing Shrinking." This procedure has become important in showing whether a cell-like decomposition of a manifold yields a manifold.

In the mid-seventies, Edwards and Cannon showed that various phenomena of the type studied and identified by Bing could be generalized as sufficient conditions to characterize manifolds among all cell-like images of manifolds. With his shrinking criteria and other results, Bing somehow had introduced key phenomena in the pathology of higher dimensional manifolds while studying 3-manifolds. "Bing Shrinking" was at the heart of Torunczyk's characterizations of Q-manifolds and ℓ_2-manifolds among ANR's. More recently, it was used by Freedman in his remarkable proof of the four-dimensional Poincaré conjecture in the topological category, a key step in opening up four-dimensional topology.

Of those mathematicians closely identified with Texas who have had a great impact on topology and mathematics, two stand out: R. L. Moore in the first half of this century and R H Bing in the second.

Mathematics and mankind are the better for the life of R H Bing.

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