R.H. Bing

American topologist **R H Bing** (October 20, 1914 – April 28, 1986) was a man of strong character and integrity, who liked to understand things for himself. He never claimed to understand a theorem until he personally knew a proof of it. He wrote seminal papers in both general and geometric topology. His methods used in the study of the geometric topology of 3-dimensional space were so distinctive that this area of mathematical research is frequently referred to as Bing-type topology. Bing gave a solution to the problem of transforming a sphere into an object without an interior, and thus without any volume. The solution is limited by the rules that there can be no self-intersection and no folding the surface back onto itself. He served as president of both the Mathematical Association of America (1963-64) and the American Mathematical Society (1977-78).

Bing was born in Oakwood, Texas where his father Rupert Henry Bing was a teacher who later became Superintendent of the Oakwood School District, and his mother Lula May Thompson was a primary school teacher. If readers guess that R H Bing was named for his father they would be mistaken. No one knew what the initials R H stood for. When someone finally asked what they represented, Bing replied, “I was named for my uncle.” “And what was your uncle’s name?” he was asked. “R H Bing”, he replied. His father died when Bing was five, forcing his mother to return to teaching to support her son and daughter. She was the one who most influenced Bing’s interests and character, and he attributed his love of mathematics to her influence. Bing enrolled at Southwest Texas State Teachers College, where he worked in the college cafeteria to help pay his expenses. Later he was honored as the second distinguished alumnus of his alma mater. The first was Lyndon Baines Johnson. Realizing that

his mother's modest salary would not support two children in college, Bing took extra courses each semester, allowing him to graduate after two and a half years, about the time his sister entered college.

In 1935 Bing taught mathematics at the high school in Palestine, Texas, and also coached the football and track teams. Learning that the legislature established a policy that a teacher with a master's degree could earn more than one with only a bachelor's degree, he took summer courses at the University of Texas. One summer he took a course from the legendary R.L. Moore, who believed that students who spent time teaching in the schools rather than going directly to graduate school wouldn't amount to much mathematically; but R.H. proved, at least in his case, Moore was wrong. Bing met Mary Blanche Hobbs in a class they took together at the university. They married in 1938, the year he earned his Master of Education degree. The marriage produced a son and three daughters. He continued teaching high school mathematics and taking summer courses at the University of Texas. In 1942, Moore arranged for him to get a teaching position with the university, giving him more time to concentrate on his graduate studies.

Bing was awarded his doctorate in mathematics from the University of Texas in 1945 for a thesis supervised by Moore on planar webs, topological objects no longer studied. Nevertheless, the quality of Bing's thesis earned its inclusion in the *Transactions of the American Mathematical Society.*
Years later, Bing commented: "… the *Transactions* sent me fifty reprints at the time and if anyone is interested they could have some because I still have forty-nine or so left." Also in 1945, Bing proved the *Kline Sphere Characterization Conjecture*, a famous, long-standing unsolved problem. Some established mathematicians were skeptical that an unknown young mathematician had resolved this old Moore replied, "Yes, Bing had." Later students of Moore recalled that he judged them against the standard of Bing – rarely to their advantage.

After spending two more years as an instructor at Texas, Bing was offered positions at both Princeton and the University of Wisconsin. The choice was made easier for Bing when Solomon Lefschetz of Princeton made the offer of a position contingent on Bing's giving up research in topology. For some reason, the leading topologist of the time felt there was no future in the field. Bing taught at Wisconsin from 1947 to 1973 and was appointed Rudolph F. Langer Professor in 1968. In 1973, he returned to the University of Texas at Austin as the Mildred Caldwell and Blaine Perkins Kerr Centennial professor of mathematics, holding the position until his retirement. During his career Bing had 35 doctoral students and published 116 papers. He wrote articles on general topology, particularly on metrization, on the topological classification of the 2-sphere, the 3-sphere, continua theory, and Hilbert Space. Maurice Fréchet introduced metric spaces in his work "Sur quelques points du calcul fonctionnel" in 1906. In such spaces the metric function must satisfy the intuitive notions of the concept of "distance." That is, the distance between two distinct points is positive; the distance between two points is the same no matter which of the two directions is taken, and the "triangle inequality holds. This means that for three points *P*, *Q*, and *R*, the distance between *P* and *Q* plus the distance between *Q* and *R* is greater than or equal to the distance between *P* and *R* [Figure 10.10].

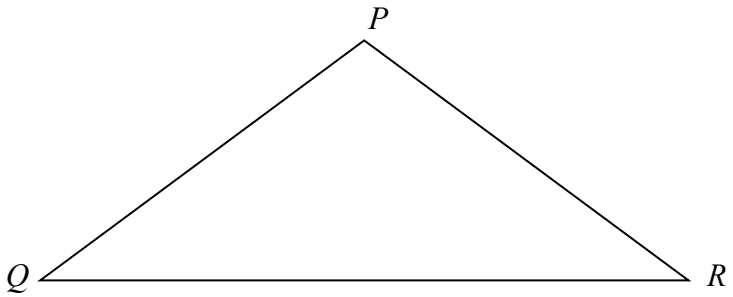

Figure 10.10

A *metrizable space* is a topological space that is homeomorphic (topologically equivalent) to a metric space. Metrization theorems are ones that give the necessary and sufficient conditions for a topological

space to be metrizable. One of the important unsolved general topology problems was finding a topological characterization of the metrizability of spaces. In 1951 Bing gave such a characterization in a paper "Metrization of Topological Spaces." As frequently happens in the case of significant unsolved problems, about the same time, Nagata and Smirnov proved similar results, and so the theorem is now referred to as the Bing-Nagata-Smirnov theorem.

Bing's landmark theorems raised a lot of related questions, providing plenty of work for himself and his students. He emphasized the importance of raising questions in one's papers and encouraged his students and colleagues to do likewise. He habitually constructed counterexamples to demonstrate that each hypothesis in a theorem was necessary. This carried over to his work on the Poincaré conjecture. He regularly spent two weeks trying to prove it, followed by two weeks trying to find a counterexample. He believed that mathematics should be fun, and opposed the idea of forcing students to sit through mathematical lectures that they neither understood nor enjoyed. Influenced by his mentor and the Moore Method, he believed that students should be given the opportunity to work problems and prove theorems by themselves. Bing had a boisterous, gregarious personality, which was made all the more charming by his slow Texas drawl. During his last years, he suffered from cancer and heart problems, dying at Austin on April 28, 1986.

Quotation of the Day: "… the true spirit of topology lies in proving theorems rather than in oddities." – R H Bing