Rudolf Ahlswede
1938-2010

by Christian Deppe

We, his friends and colleagues at the Department of Mathematics at the University of Bielefeld are terribly saddened to share the news that Professor Rudolf Ahlswede passed away in the early hours of Saturday morning 18th December, 2010.

Rudolf Ahlswede had after an excellent education in Mathematics, Physics, and Philosophy almost entirely at the University of Göttingen and a few years as an Assistant in Göttingen and Erlangen received a strong push towards research, when he moved to the US, taught there at the Ohio State University in Columbus and greatly profited from joint work in *Information Theory* with the distinguished statistician Jacob Wolfowitz at Cornell and the University of Illinois during the years 1967-1971 (see the obituary [A82]).

The promotion to full professor in Mathematics followed in 1972, but only after Rudolf Ahlswede convinced his faculty by his work in Classical Mathematics. Information Theory was not yet considered to be a part of it.

A problem in p-adic analysis by K. Mahler found its solution in [AB75] and makes now a paragraph in his book [M81].

For a short time concentrating on Pure Mathematics and quitting Information Theory was considered. But then came strong responses to multi-way channels [A71] and it became clear that Information Theory would always remain a favorite subject – it looked more interesting to Rudolf Ahlswede than many areas of Classical Mathematics. An account of this period is given in the books [W78], [CK81], and [CT06].

However, several hard problems in Multi-user Information Theory led Rudolf Ahlswede to *Combinatorics*, which became the main subject in his second research stage starting in 1977.

Writing joint papers, highly emphasized in the US, helped Rudolf Ahlswede to establish a worldwide network of collaborators.

Finally, an additional fortunate development was an offer from the Universität Bielefeld in 1975, which for many years was the only research university in Germany with low teaching obligations, implying the possibility to teach only every second year.

In a tour de force within half a year Rudolf Ahlswede shaped a main part of the Applied Mathematics Division with Professorships in Combinatorics, Complexity Theory (first position in Computer Science at the university), and Statistical Mechanics.

Among his students in those years were Ingo Althöfer (Habilitationspreis der Westfälisch-Lippischen

Rudolf Ahlswede

Universitätsgesellschaft 1992), Ning Cai (IEEE Best Paper Award 2005), Gunter Dueck (IEEE Best Paper Award 1990; Wirtschaftsbuchpreis der Financial Times Deutschland 2006), Ingo Wegener (Konrad-Zuse-Medaille 2006), Andreas Winter (Philip Leverhulme Prize 2008) and Zhen Zhang.

In the second stage 1977-87 the AD-inequality was discovered, made it into many text books like [B86], [A87], [AS92], [E97], and found many generalizations and number theoretical implications [AB08].

We cite from the book [B86] §19 The Four Function Theorem:

"At the first glance the FFT looks too general to be true and, if true, it seems too vague to be of much use. In fact, exactly the opposite is true: the Four Function Theorem (FFT) of Ahlswede and Daykin is a theorem from "the book". It is beautifully simple and goes to the heart of the matter. Having proved it, we can sit back and enjoy its power enabling us to deduce a wealth of interesting results. "

Combinatorics became central in the whole faculty, when the DFG-Sonderforschungsbereich 343 "Diskrete Strukturen in der Mathematik" was established in 1989 and lasted till 2000.

The highlight of that third stage is among solutions of several number theoretical and combinatorial problems of P. Erdős [A01]. The most famous is the solution of the $4m$-Conjecture from 1938 of Erdős/Ko/Rado (see [E97], [CG98]), one of the oldest problems in combinatorial extremal theory and an answer to a question of Erdős (1962) in combinatorial number theory "What is the maximal cardinality of a set of numbers smaller than n with no $k+1$ of its members pairwise relatively prime?".

As a model most innovative seems to be in that stage Creating Order [AYZ90], which together with the Complete Intersection Theorem demonstrates two essential abilities, namely to shape new models relevant in science and/or technology and solving difficult problems in Mathematics.

In 1988 (with Imre Csiszar) and in 1990 (with Gunter Dueck) Rudolf Ahlswede received the Best Paper Award of the IEEE Information Theory Society. He received the Claude Elwood Shannon Award 2006 of the IEEE information Theory Society for outstanding achievements in the area of the information theory (see his Shannon Lecture [A06]).

A certain fertility caused by the tension between these two activities goes like a thread through Rudolf Ahlswede's work, documented in 235 published papers in roughly 4 stages from 1967-2010.

The last stage 1997-2010 was outshined by Network Information Flow [ACLY00] (see also [FS07a], [FS07b], [K]) and GTIT-updated [A08], which together with Creating Order [AYZ90] was linked with the goal to go from Search Problems to a Theory of Search.

The seminal paper [ACLY00] founded a new research direction in the year 2000, with many applications especially for the internet. It has been identified by Essential Science Indicators^{SM} as one of the most cited papers in the research area of "NETWORK INFORMATION FLOW". Research into network coding is growing fast, and Microsoft, IBM and other companies have research teams who are researching this new field. The most known application is the Avalanche program of Microsoft.

Rudolf Ahlswede had just started a new research project about quantum repeaters to bring his knowledge about physics and information theory together. Unfortunately he cannot work for the project anymore.

We lost a great scientist and a good friend. He will be missed by his colleagues and friends.

Rudolf Ahlswede

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