COMMUNICATIONS

Uffe Haagerup—In Memoriam

Alain Connes, Vaughan Jones, Magdalena Musat, and Mikael Rørdam

Uffe Haagerup, a world-renowned analyst and leading figure in operator algebras, passed away on July 5, 2015, in a tragic drowning accident near his summer house in Faaborg, Denmark. He spent most of his career as a professor at the University of Southern Denmark (Odense), and during 2010–2014 he was a professor at the University of Copenhagen while holding an Advanced European Research Council (ERC) grant. Uffe was a uniquely gifted mathematician of incredible analytic power and insight, which he generously shared with his many collaborators. His kindness and warm personality were greatly valued by his many friends and colleagues in Denmark and abroad.

Uffe was born December 19, 1949, in the town of Kolding, but grew up in Faaborg, the younger of two brothers. At age ten Uffe started helping the local surveyor and solved difficult trigonometric problems in the process. His problem-solving skills earned him national acclaim when a few years later his proposed development plan for a large summer house area was chosen over the one of a Copenhagen contractor.

Photo by Peter Haagerup. Courtesy of Søren Haagerup.

Uffe Haagerup

Alain Connes is professor of mathematics at Institut des Hautes Études Scientifiques. His email address is alain@connes.org.

Vaughan Jones is professor of mathematics at University of California, Berkeley. His email address is vfr@math.berkeley.edu.

Magdalena Musat is associate professor of mathematics at University of Copenhagen. Her email address is musat@math.ku.dk.

Mikael Rørdam is professor of mathematics at University of Copenhagen. His email address is rordam@math.ku.dk.

In 1968 Uffe enrolled in the physics and mathematics program at the University of Copenhagen. Fascinated with both general relativity and quantum mechanics, he began his graduate studies in physics, but switched to mathematics after being exposed to operator algebras. In 1973, as a master's student, he solved a key open question related to the recently emerged Tomita-Takesaki theory. This resulted in his first publication, "The standard form of von Neumann algebras", which has since then been used over and over again. It also led to his first job in 1974, namely, a tenure-track position at the recently opened Department of Mathematics at Odense University, where he later became professor at the age of thirty-one. Except for sabbaticals, he chose to stay in Den-

mark despite numerous offers from prestigious universities abroad.

Uffe Haagerup's mathematical career is a succession of amazing breakthrough achievements and of influential contributions to operator algebras and functional analysis. A highlight is his brilliant solution (Acta Math., 1987) of the challenging Connes bicentralizer problem, also known as the *Champagne problem*. This settled the uniqueness of the hyperfinite factor of type III_1 and completed the classification of injective von Neumann factors, a program initiated by Murray and von Neumann in the 1930s and almost brought to completion by the work of Connes in the 1970s.

Uffe's remarkable paper on an example of a nonnuclear C*-algebra with the metric approximation property (Inventiones Math., 1978) is, in many ways, characteristic of his research. He set out to solve the hard analytic problem of whether the metric and the completely positive approximation properties are the same. In the process of proving that they are not, he discovered a new property of a group, which became known as *the Haagerup property* and now plays a major role in geometric group theory. It was a key element in the proof of the Novikov conjecture for Gromov hyperbolic groups. The associated approximation property for factors of type II_1 was crucial in the solution by Popa of the long-standing problem of existence of a von Neumann factor nonisomorphic to a matrix algebra over itself and of exhibiting a factor with trivial fundamental group. Uffe also made major contributions to Voiculescu's free probability theory and to random matrices. In the mid-1990s, in a masterful display of combinatorial power, Uffe showed that the mysterious number $(5 + \sqrt{13})/2$ is the smallest index larger than 4 of a subfactor, known as *the Haagerup*. It is an interesting problem whether there are quantum systems with Haagerup symmetry.

Uffe was a strikingly creative problem solver whose impact was widespread. Topologists will know Haagerup from his paper with Munkholm (Acta Math., 1981), where they resolve Thurston's conjecture on simplices of maximal volume in hyperbolic spaces using elementary calculus. Uffe's recent work on factorizable completely positive maps and its impact on quantum information theory is yet another example of how far his influence extended.

Uffe's many honors during his career include being a plenary speaker at the ICM in Beijing, 2002, and a recipient of the European Latsis Prize from the European Science Foundation in 2012. He was editor-in-chief of *Acta Mathematica*, 2000–2006.

An analyst is characterized by the ability of having "direct access to the infinite", and Uffe Haagerup possessed that quality to perfection. He will be deeply missed by the entire mathematical community.