

# Discussions with Rudolf Haag in his last years

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Rudolf more or less drafted me some time in 2012. Because of his wife's poor health and his own impaired vision he was very much tied to his apartment in Neuhaus. He needed somebody to help him with reading literature and also with preparing papers he was still writing.

But even though I had never been a member of his circle, had only rudimentary knowledge of algebraic Quantum Field Theory and had never thought much about the foundations of Quantum Theory – his main interest at his advanced age – he drew me more and more into discussions about his idea, first formulated about twenty years ago, that standard Quantum Theory was lacking something. His view was that Quantum Theory needed an ontological foundation on the concept of *events*, spontaneously creating objective facts out of the the quantum theoretical potentialities and thereby exhibiting a fundamental arrow of time. His most convincing argument (in my mind) was that the statistical interpretation of Quantum Theory has to predict the statistics of *something* and this something could only be *events*, the concept at the basis of probability theory.

He was not content, however, with just adding something to the interpretation of Quantum Theory, rather he struggled with the question how events could be empirically localized in space and time. Typical was his question ‘When does an uranium nucleus decay?’ He was convinced that there must be a second time scale involved in such decays, different (and typically much shorter) than the average lifetime. Berge Englert then suggested that it might be easier to probe this idea in the decay of metastable atomic levels and got Gerd Leuchs and Luis Sanchez, laser physicists from the Max-Planck-Institute in Erlangen, interested in looking for ways to detect such a time scale.

During the last few years of his life and with some help from Berge Englert, Heide Narnhofer and myself he completed two papers in which he expounded his views: *On the Sharpness of Localization of Individual Events in Space and Time*, published in *Foundations of Physics* in 2013 and *Faces of*

*Quantum Physics*, published in the volume *The Message of Quantum Science* (edited by Ph. Blanchard and J. Fröhlich) in 2015.

From 2013 onward he was working on a paper *On Quantum Theory* that was to be the summary of his philosophical outlook on quantum physics and the world, but which he could not complete. It is available as a fragment (arXiv:1602.05426). Berge Englert and Heide Narnhofer were crucial discussion partners for this manuscript as well.

Rudolf and I had regular discussion meetings for which he invited me to spend a day at his home; these meetings increased in frequency after the death of his wife; even after the stroke he suffered a few months later, he insisted on continuing these visits at the same rate. Before his wife's death, his piano playing was an important means of communicating with her, and even afterwards he continued playing with his 'good' hand.

The precision of his memory was amazing: for instance he would send me upstairs to get von Neumann's book on the foundations of Quantum Mechanics, describing not only precisely where to find it, but also in which chapter to look for the discussion of irreversibility, or where to find, in his handwritten lecture notes of decades ago, the analysis of the entropy of mixtures.

His interest in learning new things was undiminished; he was very much interested, for example, in learning about experimental progress in manipulating individual atoms (Dehmelt et al) or counting photons (Haroche et al) or attosecond physics (Kraus et al). The sharpness of his mind in spite of his reduced physical health was impressive. He would still formulate print-ready sentences, but being extremely self-critical, he would reformulate them many times, finally saying, 'we can still change it later'.

Spending these days discussing physics and philosophy with him and enjoying his broad cultural knowledge as well as his gentle humor was an unforgettable gift. Our last meeting took place on December 18th last year, a little more than two weeks before his death; he was as alert as ever.