



Professor George Ellis
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George Ellis is Professor Emeritus of Applied Mathematics at the University of Cape Town. His professional research work was initially in relativity theory and cosmology, but has more recently been extended to complexity studies and the brain. He obtained his BSc (Hons) at the University of Cape Town and a PhD in the Department of Applied Mathematics and Theoretical Physics, Cambridge University. He has taught at Cambridge University, the University of Texas, the University of Chicago, University of Hamburg, Boston University, University of Alberta, International School of Advanced Studies (SISSA) in Trieste, and is the G C MacVittie Visiting Professor of Astronomy at Queen Mary, London University. He is a past President of the International Society of Relativity and Gravitation and of the Royal Society of South Africa, and was a Founder Member of South African Academy of Science and Member of the Inter-Academy Council (Amsterdam). He is a Fellow of Third World Academy of Science, elected 2005, and of the Royal Society of London (FRS), elected 2007. He is Joint Editor in Chief, *Journal of General Relativity and Gravitation*. His awards include the Gravity Research Foundation Essay Competition 1st Prize (1979), Herschel Medal of the Royal Society of South Africa (1984), South Africa Medal (Gold) of the South African Association for the Advancement of Science (1993), Star of South Africa Medal awarded by President Mandela (1999), National Science and Technology Forum lifetime contribution award (2005), Academy of Science of South Africa Gold medal (2005), and Order of Mapungubwe (Silver) awarded by President Thabo Mbeki (2006). He has four honorary doctorates and was awarded the SA Institute of Physics Gold Medal in 2010. Publications include over 300 scientific papers, mainly on relativity theory and cosmology, and a number of books, including *The Large Scale Structure of Space Time*, with S W Hawking (1973), *Dynamical systems and cosmology*, with J Wainwright (1996), *Is The Universe Open or Closed? The Density of Matter in the Universe*, with P Coles (1997), and *G F R Ellis, R Maartens and M A H MacCallum Relativistic Cosmology* (2011).

Plenary Lecture: Top Down Causation and the Emergence of Complexity

The emergence of true complexity (such as life and the human brain) on the basis of the underlying physics is enabled by top-down processes in the hierarchy of complexity. This talk will propose that there are five different types of top down causation that can all be shown by many examples to exist and be causally effective in the real world. There is room for them at the bottom both because of statistical and quantum randomness at lower levels, and because the nature of lower level elements is altered by top down effects. While the evidence for top-down effects is very strong in the life sciences, computers, and engineering systems, there may also be cases in physics where their influence is significant; examples are the arrow of time, the origin of inertia, and both state preparation and decoherence in quantum theory.