

The Royal Society of Edinburgh

**Public lecture organised by the
International Centre for Mathematical Sciences (ICMS)**

The Black Hole War: The War That Made the World Safe for Quantum Mechanics

**Professor Leonard Susskind
Felix Bloch Professor of Theoretical Physics
at Stanford University**

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Chaired by RSE President Sir Michael Atiyah, this lecture, organised by ICMS with the support of the RSE, complemented a week-long international workshop at Edinburgh University, supported by the Engineering and Physical Sciences Research Council (EPSRC), the London Mathematical Society, the Edinburgh Mathematical Society and the Institute of Physics.

Professor Susskind invited the audience to consider that in 1976 Stephen Hawking imagined throwing a bit of information, a book, a computer, or even an elementary particle, into a black hole. Black holes, Hawking believed, were the ultimate traps, and the bit of information would be irretrievably lost to the outside world. This apparently innocent observation was hardly as innocent as it sounds; it threatened to undermine and topple the entire edifice of modern physics. Something was terribly 'out of whack'; the most basic law of nature – the conservation of information was seriously at risk. To those who paid attention, either Hawking was wrong, or the 300-year-old centre of physics wasn't holding. Hawking's claim set in motion a controversy that eventually radically changed the way we think about space, time, matter, and information – a war of ideas between Susskind, Hawking and Dutch theoretical physicist Gerard 't Hooft, co-recipient of the 1999 Physics Nobel Prize – although not in the way Hawking imagined. Instead of "A World Without Law," the new paradigm has become "The World as a Hologram."

The edifice of modern physics has been built upon the foundations of quantum mechanics, whose fundamental dynamical principle enshrines what Susskind called the conservation of information. Therefore the suggestion, borne out of Hawking's calculations about the dynamics of black holes, that information could be lost in a black hole would – if true – be capable of undermining our present approach to Physics. Susskind and 't Hooft believe that this could not be the case.

Susskind explained the nature of information in Physics, the notion of a black hole and of its horizon, and used a fish-pond and sink analogy as an example. He explained that around the sink there is an imaginary circle such that if a fish crossed it, it would be unable to swim back out, but nevertheless the fish would notice nothing extraordinary when crossing it. By further analogy, Susskind also explained how the horizon of a black hole can appear, depending on the observer, as a singularity to 'Bob', an external observer, or as nothing extraordinary to 'Alice', who is actually falling into the black hole. Susskind did not explain how quantum mechanics, and hence he and 't Hooft, won the war, but referred the audience instead to his forthcoming book, *THE BLACK HOLE WAR: My battle with Stephen Hawking to make the world safe for quantum mechanics*^[7] published in 2008.

The lecture concluded with a wide ranging and insightful question and answer session.

A photo gallery of this event can be found on the ICMS web page at:
<http://www.icms.org.uk/downloads/gravthermo/photogallery/>