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Macroscopic Effects of Quantum Entanglement CASLAV BRUKNER, Institute of Experimental Physics, University of Vienna, Boltzmanngasse 5, 1090 Vienna, Austria, VLATKO VEDRAL, The School of Physics and Astronomy, University of Leeds, Leeds, LS2 9JT, UK, ANTON ZEILINGER, Institute of Experimental Physics, University of Vienna, Boltzmanngasse 5, 1090 Vienna, Austria — It is commonly believed that for the understanding of the behaviour of large, macroscopic, objects there is no need to invoke any genuine quantum entanglement - Einstein's "spooky action at a distance." We show that this belief is fundamentally mistaken and that entanglement is crucial to correctly describe some macroscopic properties of solids. We demonstrate that macroscopic thermodynamical properties - such as internal energy, heat capacity or magnetic susceptibility - can detect quantum entanglement in solids in the thermodynamical limit even at moderately high temperatures. We identify the parameter regions (critical values of magnetic field and temperature) within which entanglement is witnessed by these thermodynamical quantities. Finally, we demonstrate that two different experiments performed in 1963 and in 2000 clearly and conclusively indicate that entanglement exits in macroscopic samples of Cooper Nitrate at temperatures below 5 Kelvin. We interpret our results as indicating that entanglement may play a broad generic role in macroscopic phenomena.

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