One of the most important problems in materials science solved

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Together with three colleagues Professor Peter Oppeneer of Uppsala University has explained the hitherto unsolved mystery in materials science known as 'the hidden order' - how a new phase arises and why. This discovery can be of great importance to our understanding of how new material properties occur, how they can be controlled and exploited in the future. The findings are now being published in the scientific journal *Nature Materials* and of great importance to future energy supply.

For a long time researchers have attempted to develop the superconducting materials of the future that will be able to conduct energy without energy losses, something of great importance to future energy supply. But one piece of the puzzle has been missing. There are several materials that evince a clear phase transition in all thermodynamic properties when the temperature falls below a certain transitional temperature, but no one has been able to explain the new collective order in the material. Until now, this has been called the hidden order.

"The hidden order was discovered 24 years ago, and for all these years scientists have tried to find an explanation, but so far no one has succeeded. This has made the question one of the hottest quests in materials science. And now that we can explain how the hidden order in materials occurs, in a manner that has never been seen before, we have solved one of the most important problems of our day in this scientific field," says Professor Peter Oppeneer.

Four physicists from Uppsala University, led by Peter Oppeneer and in collaboration with John Mydosh from the University of Cologne, who discovered the hidden order 24 years ago, show through large-scale calculations how the hidden order occurs. Extremely small magnetic fluctuations prompt changes in the macroscopic properties of the material, so an entirely new phase arises, with different properties.

"Never before have we seen the so-called 'magnetic spin excitations' produce a phase transition and the formation of a new phase. In ordinary materials such excitation cannot change the phase and properties of the material because it is too weak. But now we have shown that this is in fact possible," says Peter Oppeneer.

What explains in detail all of the physical phenomena in the hidden order is a computer-based theory. Among other applications, it can be used to better understand high-temperature superconducting materials and will thus be important in the development of new superconducting materials and our future energy supply.

More information: *Nature Materials* (22 Feb 2009), doi: 10.1038/nmat2395, www.nature.com/nmat/journal/va … nt/abs/nmat2395.html

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