Ferromagnetism plus superconductivity

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It seems impossible: Scientists from the Helmholtz-Zentrum Dresden-Rossendorf and the TU Dresden (Germany) were able to verify with an intermetallic compound of bismuth and nickel that certain materials actually exhibit the two contrary properties of superconductivity and ferromagnetism at the same time. A phenomenon that had only been demonstrated around the globe on a small number of materials and which might provide highly interesting technological opportunities in future.

Just in time for the 100th anniversary to commemorate the discovery of superconductivity by the Dutch physicist Heike Kamerlingh Onnes on April 8, 1911, scientists from the Helmholtz-Zentrum Dresden-Rossendorf and the TU Dresden published their research results in the journal *Physical Review B*.

Headed by Dr. Thomas Herrmannsdörfer, the team from the HZDR's High Magnetic Field Laboratory (HLD) examined a material consisting of the elements bismuth and nickel (Bi_3Ni) with a diameter of only a few nanometers – which is unique since it has not been achieved elsewhere so far. This was made possible through a new chemical synthesis procedure at low temperatures which had been developed at the TU Dresden under the leadership of Prof. Michael Ruck. The nano scale size and the special form of the intermetallic compound – namely, tiny fibers – caused the physical properties of the material, which is non-magnetic under normal conditions, to change so dramatically. This is a particularly impressive example of the excellent opportunities modern nanotechnology can provide today, emphasizes Dr. Thomas

Herrmannsdörfer. "It's really surprising to which extend the properties of a substance can vary if one manages to reduce their size to the nanometer scale."

There are numerous materials which become superconducting at ultralow temperatures. However, this property competes with ferromagnetism which normally suppresses superconductivity. This does not happen with the analyzed compound: Here, the Dresden researchers discovered with their experiments in high magnetic fields and at ultralow temperatures that the nanostructured material exhibits completely different properties than larger-sized samples of the same material. What's most surprising: The compound is both ferromagnetic and superconducting at the same time. It is, thus, one of those rarely known materials which exhibit this unusual and physically not yet completely understood combination. Perhaps bismuth-3-nickel features a special type of superconductivity, says Dr. Herrmannsdörfer. The physicist and doctoral candidate Richard Skrotzki, who has just turned 25, is making a vital contribution to the research results and describes the phenomenon as "the bundling of contrary properties in a single strand."

The TU Dresden and the HZDR are partners in the research alliance DRESDEN-concept which pursues the objective of making visible the excellence of Dresden research.

More information: "Structure-induced coexistence of ferromagnetic and superconducting states of single-phase Bi3Ni seen via magnetization and resistance measurements" by T. Herrmannsdörfer, R. Skrotzki, J. Wosnitza, D. Köhler, R. Boldt, and M. Ruck as "Rapid Communication" in *Physical Review B*, Vol. 83, No.14 DOI: 10.1103/PhysRevB.83.140501

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