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Search for New Superconductors in Extraterrestrial Materials Using Magnetic Field Modulated Microwave Spectroscopy

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The discovery of new superconductors could have potentially a large technological impact on energy and high power applications. Since material synthesis is the bottleneck in the search for new superconductors, we have extended our searches beyond artificially prepared materials to those found in nature, as originally proposed by H. Weinstock (private communications). Extraterrestrial materials are particular interesting, because they contain materials grown under very extreme conditions that are difficult or sometimes even impossible to realize in a laboratory. We have established a very sensitive, selective, and non-destructive microwave absorption technique to screen a wide range of different materials for superconductivity. This technique allows for the detection of minute amounts of superconducting material in a non-superconducting matrix and is an ideal tool for searching for superconducting phases in materials found in nature. Magnetic Field Modulated Microwave Spectroscopy (MFMMS) uses a customized X-band Electron Paramagnetic Resonance (EPR) apparatus. At the onset of a superconducting transition, a small change in the externally applied magnetic field changes the superconducting charge carrier density ns considerably, which in turn changes the microwave absorption. This causes superconducting materials to exhibit a characteristic peak in MFMMS, which in turns, may be used to determine the transition temperature Tc by locating the peak onset. We tested a variety of different extraterrestrial materials for superconductivity like meteorites, micrometeorites collected from the water well at the Amundsen-Scott South pole station and lunar rocks. In this talk the MFMMS-response of these materials will be discussed. Additionally, we will present complementary MFMMS-procedures to distinguish the response of a superconducting material phase from a non-superconducting phase.

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