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DYNAMICS OF FLUXONS IN FIELD-COOLED HIGH-T_c SUPERCONDUCTORS

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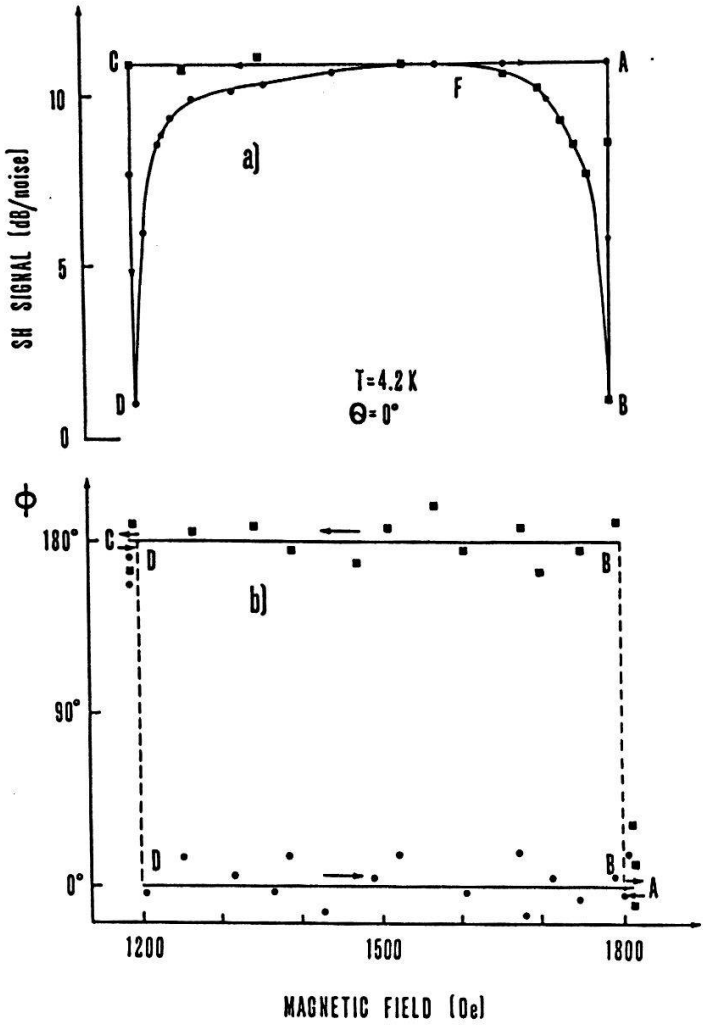
Abstract: Evidence is given that for increasing and decreasing applied fields critical states are developed in field-cooled high-T_c ceramic superconductors. In samples in the critical state a microwave magnetic field parallel to the applied field induces a magnetization with odd as well as even Fourier components.

The interaction of microwave fields with field-cooled (FC) single-phase ceramic $YBa_2Cu_3O_7$ has been studied by investigating the second-harmonic (SH) response to the driving field.

The experiments have been performed by exposing the samples to a dc field $\underline{H}_o$ and an ac field $\underline{H}(\omega)$ at an angle θ with respect to $\underline{H}_o$. The SH signal radiated by the samples has been investigated. It depends on both H_o and θ. The signal is phase coherent. The phase as a function of H_o and θ has also been investigated.

Fig.1a shows the SH signal intensity as a function of H_o in the range of fields 1200-1800 Oe. The intensity is independent of H_o as long as H_o is increased (or decreased) steadily. Minima are observed when the magnetic field sweep is reversed, independently of the values of H_o in which the inversions are operated. Fig.1b shows the phase of the SH signal as a function of H_o. The phase, at a given value of H_o, may differ by 180° depending on the way H_o has been attained, at increasing or decreasing fields. On increasing H_o the phase remains constant as long as H_o is increased, from D to A. It remains still constant at the same value when H_o is decreased from A to B, while a 180° variation is observed on crossing B. If the field is further decreased the phase remains constant at the new value until point D is reached.

The results are consistent with the assumption that a critical state



is developed in FC Y-Ba-Cu-O by an increasing (or decreasing) applied field. Supposing valid the Bean's assumption of constant J_c in superconductors[1], because of the rigidity of the fluxon lattice the response of the sample, in a critical state, to a microwave field is expected to be uneven during a period of the wave: for increasing fields the induction flux is essentially influenced only during the negative semiperiod, so that a magnetization with both odd and even Fourier components results[2]. According to this picture a theory has been developed[2] which accounts quite well for i) SH signal intensity independent of H_o for constant field sweep; ii) minima at the inversion points of the field sweep; iii) 180° phase variation at those values of H_o in which the critical state is removed (e.g., points B and D of Fig.1); iiii) angular dependence of both intensity and phase of the SH signal.

References

(1) C. P. Bean, Rev. Mod. Phys. 36, 31 (1964).

(2) I. Ciccarello, C. Fazio, M. Guccione and M. Li Vigni, Physica C, submitted.