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DC and AC Magnetic Properties of the Thin Walled Superconducting Niobium Cylinder

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Nucleation of the superconducting phase in a thin surface sheath in a decreasing magnetic field parallel to the sample surface was predicted by Saint-James and de Gennes fifty years ago. This prediction was confirmed in a short time after the paper's publication. Nevertheless, the model for the ac losses in bulk samples in magnetic fields above H_{c2} are still absent. Experiments with thin-walled superconducting cylinders can provide an essential simplification of this problem. Thin-walled hollow cylinders with macroscopic diameter have some advantages in research. It was demonstrated that a large diameter permits to monitor the magnetic moment of the current circulating in the walls and estimate ac conductivity of film in the mixed state in swept magnetic field. I shall present in this talk our new data on the dc and ac magnetic properties of thin-walled superconducting Nb cylinders. The magnetization curves at various temperatures are measured. Surprisingly, at 4.5 K for magnetic fields much lower than H_{c1} avalanche-like jumps of magnetization were observed. The position of the jumps is not reproducible and changes from one experiment to another, resembling the vortex lattice instabilities usually observed for magnetic fields larger than H_{c1}. AC response is measured in constant and swept dc magnetic fields. A phenomenological model that describes ac response of the surface superconducting states is proposed. This model assumes that the observed ac response in the dc fields larger than H_{c2} is due to the relaxation of surface superconducting states with nonzero current in the walls to the state with zero current, and the existence of a critical current below which this relaxation is absent.