SEARCH FOR ELECTRICAL CURRENT RESONANCE AND CURRENT ECHOES

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It has been recently suggested [1,2] that an electrical current flowing through a conducting medium can resonantly absorb energy from an oscillating magnetic field, in a fashion similar to nuclear moments in Nuclear Magnetic Resonance, giving rise to transient effects called free current decays and current echoes. We have designed experiments to detect the Electrical Current Resonance (ECR) in two distinct systems: in metals and in an electron beam. In order to minimize the effect of the skin-depth, thin films approximately 200$\AA$ thick of Cu, Ag and Au have been grown for the experiment with metals. The magnitude of the effect is estimated to be of $\approx$ 10% for relaxation times of $\approx$ 1-2 ns at 4.2 K. An AC field of $\approx$ 20 gauss is produced by a pair of Helmholtz coils and applied perpendicularly to a static field, both on the plane of the sample. The resonance frequency [$\nu_c = (q/2\pi m^*)B_o$] is set between 0.5 and 1 GHz. The experiments are carried out at 4.2 K. In a second experiment we try to observe ECR in an electron beam. The beam is generated in an Tektronix V859/T503 oscilloscope tube. Static (B_o) and oscillating (B_1) fields are generated by two mutually perpendicular pairs of Helmholtz coils, with $B_o \approx 250$ gauss and $B_1 \approx 20$ gauss. The inhomogeneity of the static field was calculated numerically. The complete experimental setups and applications of the effect are discussed. We also discuss possible connections between ECR and the low-frequency resonant modes in metals, known as *helicons*. [1] I.S. Oliveira, A.P. Guimarães and X.A. da Silva, Phys. Rev. E 55 (1997) in press [2] I.S. Oliveira, Phys. Rev. Lett. 77 (1996) 139