Theory of the Cyclotron Resonance in Al, Pb, Zn and Cd
SHIGEJI FUJITA, ROHIT SINGH, ROBERT SIMION, University of Buffalo, SEIICHI WATANABE, Hokkaido University, Japan, SALVADOR GODOY, UNAM, Mexico — A quantum theory of the cyclotron resonance is developed. For a face-centered-cubic (fcc) metal the obvious candidates for the Cyclotron Planes (CP) in which the conduction electron (“electron”, “hole”) circulates are the three families of planes \{100\}, \{110\} and \{111\}. Following Dresselhaus-Kip-Kittel (DKK, 1955) we assume a quadratic energy-momentum ($\hbar k$) relation with the effective mass ($m_1, m_2, m_3$) and analyze the angle-dependent resonance peaks in terms of Shockley’s formula (a generalization of the DKK formula). For aluminum Al (fcc) an “electron” ellipsoid with the major axes in [111] with $(m_1, m_2, m_3) = (0.108, 0.156, 1.96)m$ is obtained. For lead Pb (fcc) a hyperboloid in [110] with $(m_1, m_2, m_3) = (1.18, 0.244, -8.71)m$ and an “electron” sphere with $m^* = 1.30m$ associated with the CP \{100\} are obtained. For a hexagonal-closed-pack (hcp) metal the CP is the hexagonal base plane. The effective mass $m_b$ for the basal-plane motion and the mass $m_c$ along the c-axis for zinc Zn [cadmium Cd] (both hcp) are $(m_b, m_c) = (1.04, 0.212)m$ [$(1.14, 0.217)m$], which characterize the spheroids with the major axis along the c-axis.

Shigeji Fujita
University of Buffalo

Date submitted: 22 Nov 2005