Pauli paramagnetism

Let's assume there was no orbital motion in an electron gas in a magnetic field. Then all the magnetic effects come from electron spins.

$$\Omega(\mu) = \frac{1}{2}\Omega_0(\mu + \mu_B H) + \frac{1}{2}\Omega_0(\mu - \mu_B H)$$

$$\approx \Omega_0(\mu) + \frac{1}{2}\mu_B^2 H^2 \frac{\partial^2 \Omega_0(\mu)}{\partial \mu^2}$$

$$\chi_{para} = -\frac{\mu_B^2}{V}\frac{\partial^2 \Omega_0}{\partial \mu^2} = \frac{\mu_B^2}{V}\left(\frac{\partial N}{\partial \mu}\right)_{T,V} =$$

$$= \frac{\mu_B^2 k_F m}{\pi^2}$$

If the effective electron mass matched the fundamental electon mass, then we would arrive at

$$\chi_{dia} = -\frac{1}{3}\chi_{para}$$

Landau diamagnetism

In reality, however, $m^* \ll m$ usually