Normally one assumes that Matthiessen's rule holds and that $\Delta = 0$. Thus:

$$\varrho = \varrho_{ph} + \varrho_0 \tag{50}$$

and so:

$$\frac{\partial \ln \varrho}{\partial \ln V} = \frac{\varrho_{ph}}{\varrho} \frac{\partial \ln \varrho_{ph}}{\partial \ln V} + \frac{\varrho_0}{\varrho} \cdot \frac{\partial \ln \varrho_0}{\partial \ln V} \tag{51}$$

So if one measures $\dfrac{\partial \ln \varrho}{\partial \ln V}$ at the temperature of interest and $\dfrac{\partial \ln \varrho_0}{\partial \ln V}$ at some very low temperature, $\dfrac{\partial \ln \varrho_{ph}}{\partial \ln V}$ can be deduced from these values and those of ϱ and ϱ_0.

Now suppose that instead of equation (50) we use the correct equation (49):

$$\varrho_{meas} = \varrho_{ph} + \varrho_0 + \Delta \tag{52}$$

Then we get:

$$\frac{\partial \ln \varrho}{\partial \ln V} = \frac{\varrho_{ph}}{\varrho} \frac{\partial \ln \varrho_{ph}}{\partial \ln V} + \frac{\varrho_0}{\varrho} \frac{\partial \ln \varrho_0}{\partial \ln V} + \frac{\Delta}{\varrho} \frac{\partial \ln \Delta}{\partial \ln V} \tag{53}$$

In dilute noble-metal alloys (Dugdale and Basinski, 1967), it is found that with Au in Ag or Cu, Δ at the lowest temperatures is similar in magnitude or greater than ϱ_{ph}. This would mean that if one deduced $\partial \ln \varrho_{ph}/\partial \ln V$ from low-temperature measurements on such alloys, assuming Matthiessen's rule, the result would be a factor or two or more too large. Similar (though probably slightly smaller) errors would be found with other impurities.

An experimental example of how departures from Matthiessen's rule affect the deduced values of $\partial \ln \varrho_{ph}/\partial \ln V$ is seen in the measurements of Dugdale and Phillips (1965) on two samples of Rb of very different purity (see Table 5 of their publication.) The less pure specimen shows a much bigger apparent volume coefficient of phonon induced resistivity than the purer one.

V. Some Conclusions

In order to understand the effect of pressure on electrical resistivity at low temperatures ($T \lesssim \theta/3$) we have to know how the properties of the Fermi surface, the phonon velocities and electron–phonon