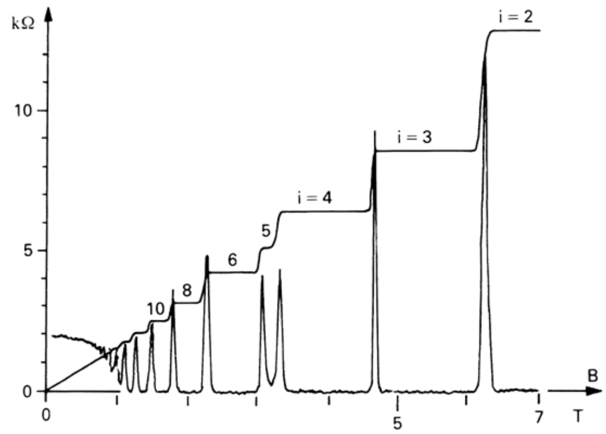
1.3.1 Integer Quantum Hall Effect

The first experiments exploring the quantum regime of the Hall effect were performed in 1980 by von Klitzing, using samples prepared by Dorda and Pepper[1]. The resistivities look like this:



This is the *integer quantum Hall effect.* For this, von Klitzing was awarded the 1985 Nobel prize.

Both the Hall resistivity ρ_{xy} and the longitudinal resistivity ρ_{xx} exhibit interesting behaviour. Perhaps the most striking feature in the data is the that the Hall resistivity ρ_{xy} sits on a plateau for a range of magnetic field, before jumping suddenly to the next plateau. On these plateau, the resistivity takes the value

$$\rho_{xy} = \frac{2\pi\hbar}{e^2}\frac{1}{\nu} \quad \nu \in \mathbf{Z} \tag{1.9}$$

The value of ν is measured to be an integer to an extraordinary accuracy — something like one part in 10^9. The quantity $2\pi\hbar/e^2$ is called the *quantum of resistivity* (with $-e$, the electron charge). It is now used as the standard for measuring of resistivity. Moreover, the integer quantum Hall effect is now used as the basis for measuring the ratio of fundamental constants $2\pi\hbar/e^2$ sometimes referred to as the von Klitzing constant. This means that, by definition, the $\nu = 1$ state in (1.9) is exactly integer!

The centre of each of these plateaux occurs when the magnetic field takes the value

$$B = \frac{2\pi\hbar n}{\nu e} = \frac{n}{\nu}\Phi_0$$

[1] K. v Klitzing, G. Dorda, M. Pepper, "*New Method for High-Accuracy Determination of the Fine-Structure Constant Based on Quantized Hall Resistance*", Phys. Rev. Lett. **45** 494.