Van der Waals equation of state

Atoms of gases interact via short-range force. The ideal gas equation of state, \( pV = nRT \), neglects the interaction completely. The van-der Waals equation of state takes it into account summarily:

\[
\left( p + \frac{an^2}{V^2} \right) (V - nb) = nRT,
\]

where \( a, b \) are empirical parameters.

- \( nb \): excluded volume due to the repulsive core of the interaction at short distances,
- \( -\frac{an^2}{V^2} \): pressure correction due to the attractive tail of the interaction at long distances.

\[\text{repulsive core} \quad \text{attractive tail} \]

\[\text{excluded volume} \quad \text{infinite-range attraction} \]

Van der Waals approximation