State Equations

- Relationship between TD properties
  - can find one TD properties based on values of some number of other properties

- Example
  - \( p(\rho,T) \) or \( p(v,T) \) or \( T(p,v) \) or …
  - relation between \( p, v, T \) sometimes known as “the” EOS for a substance
  - hard to write “universal” EOS for a substance, e.g., different phases

Equilibrium TD Property Diagram

- “Typical”
Example EOS

- Complex example: Virial EOS
  \[ \frac{P_v}{RT} = 1 + \frac{B(T)}{v} + \frac{C(T)}{v^2} + \ldots \]
  - essentially Taylor series expansion in v
- Simple example – Ideal Gas
  \[ \frac{P_v}{RT} = 1 \]
  - only good approximation over limited range of conditions
- Others: see for example Appendix H in text

\[
Z = \frac{P_v}{RT} = \frac{P}{P_{\text{crit}}} \\
T_R = \frac{T}{T_{\text{crit}}} \\
P_R = \frac{P}{P_{\text{crit}}}
\]