Fundamental of Statistical and Thermal Physics by Reif - Chapter 2

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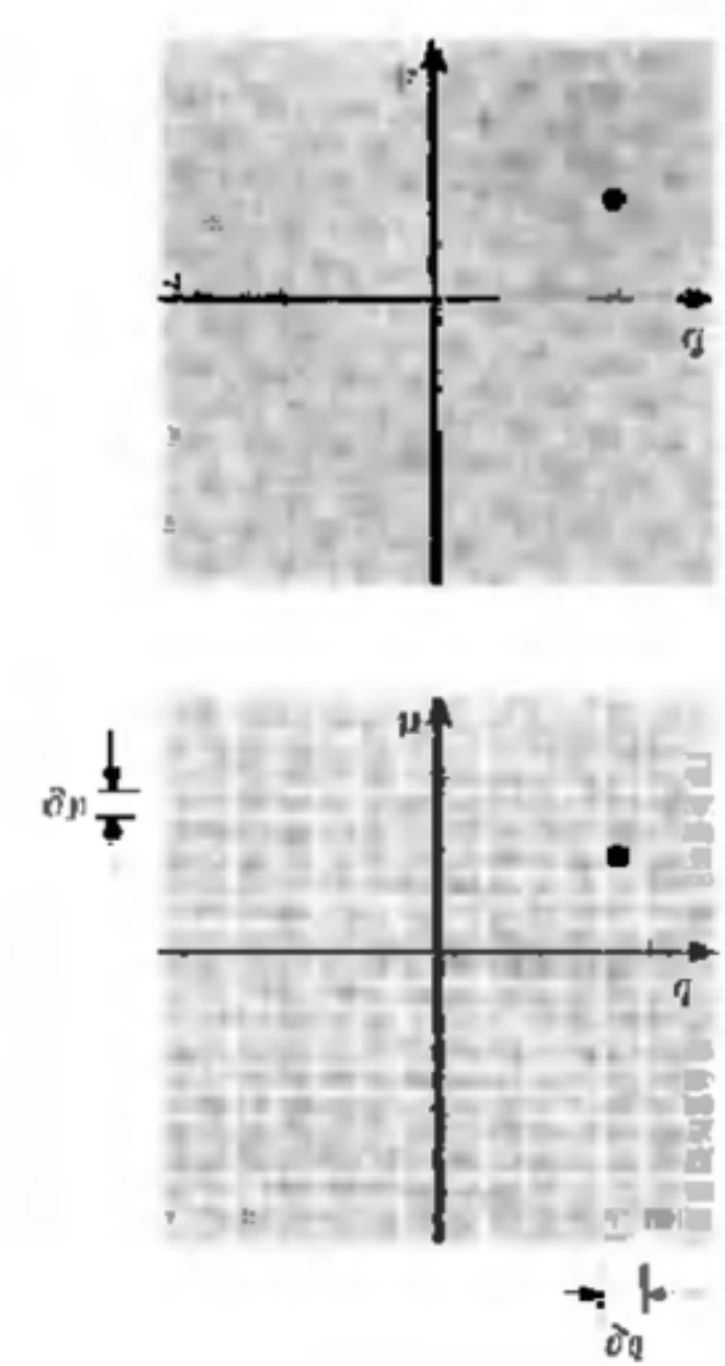
What is **microstates**



- A point in phase space
- *External parameters* - Define the energies of microstates

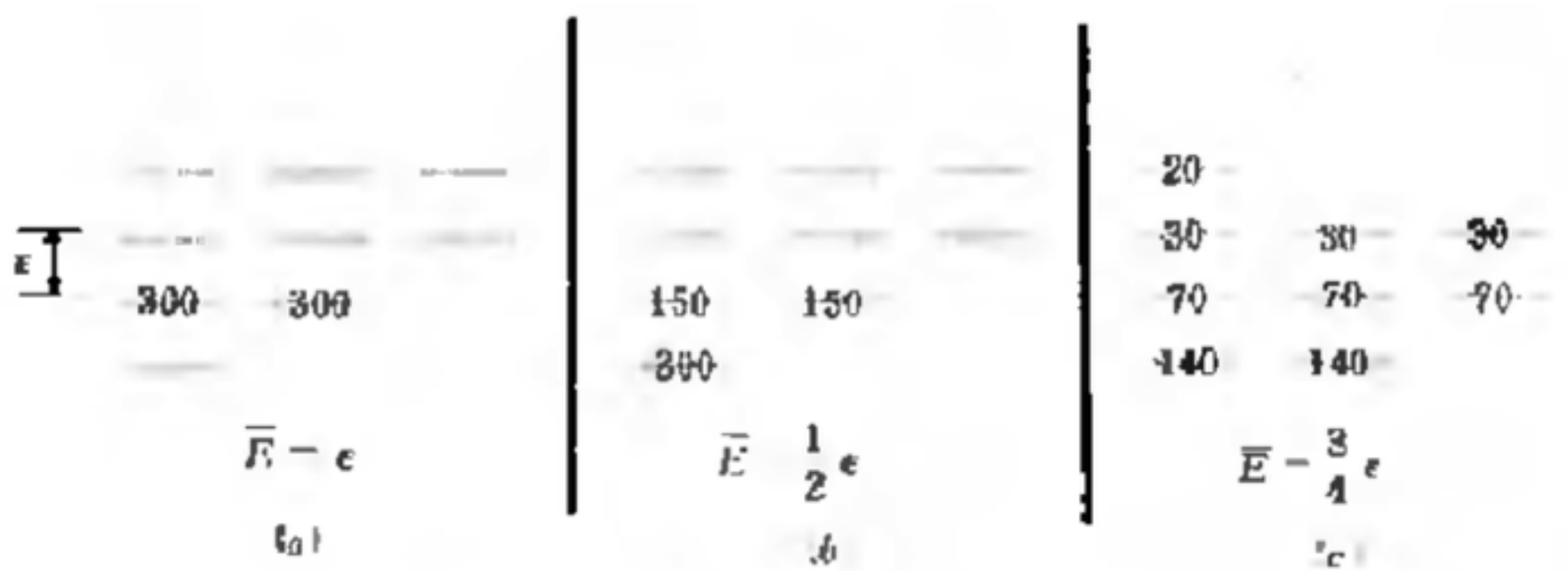
What is **ensemble**

- The **population**
- *representative ensemble* - states accessible to the system

State index r	Quantum numbers m_1, m_2, m_3	Total magnetic moment	Total energy
1	+ + +	3μ	$-3\mu H$
2	+ + −	μ	$-\mu H$
3	+ − +	μ	$-\mu H$
4	− + +	μ	$-\mu H$
5	+ − −	$-\mu$	μH
6	− + −	$-\mu$	μH
7	− − +	$-\mu$	μH
8	− − −	-3μ	$3\mu H$

What is **equilibrium**

- [Postulate / Assumption] An isolated system in equilibrium is equally likely to be in any of its accessible states
- Does **not** change with **time**
- *Relaxation time* - time needed from non-equilibrium to equilibrium



What is **density of states**

- With respect to **energy**
- Energy level is characterised by *external parameters*
- How **big** is the total number of states derived from density of states > ln n = order of f

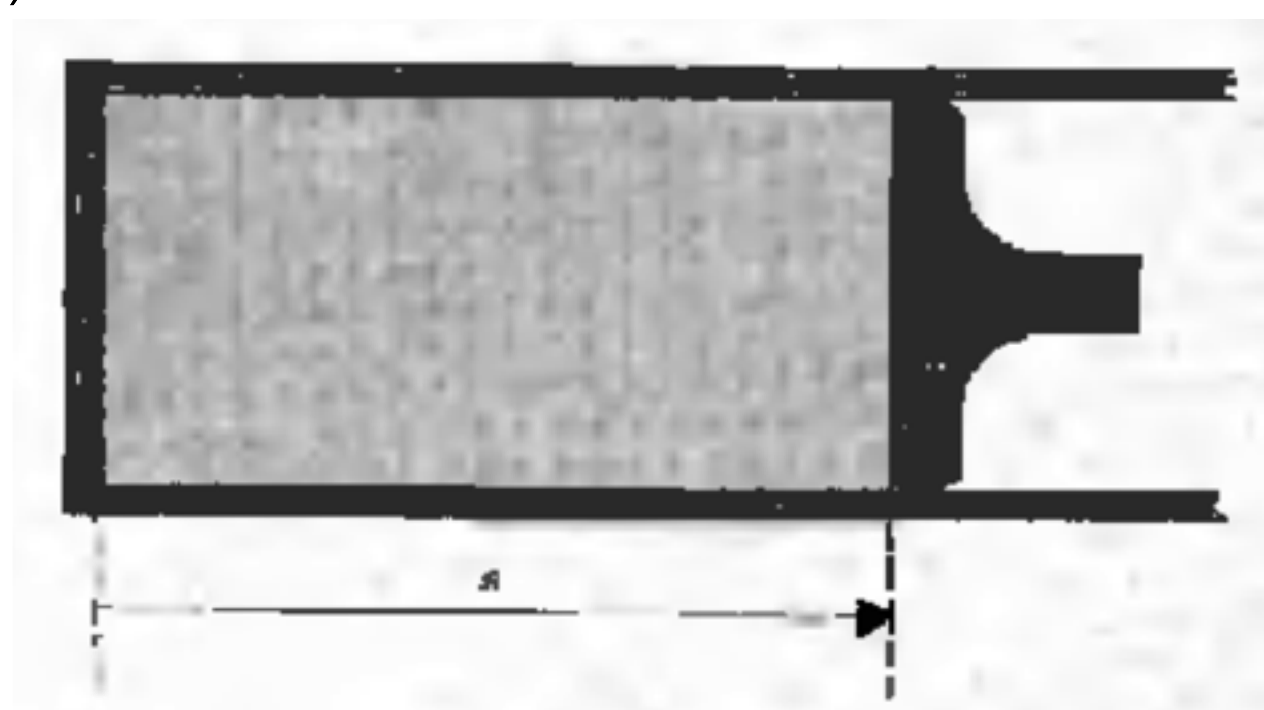
$$\Omega \approx \Phi_1{}^f \propto E^f$$

Interaction between macroscopic systems - Thermal interaction

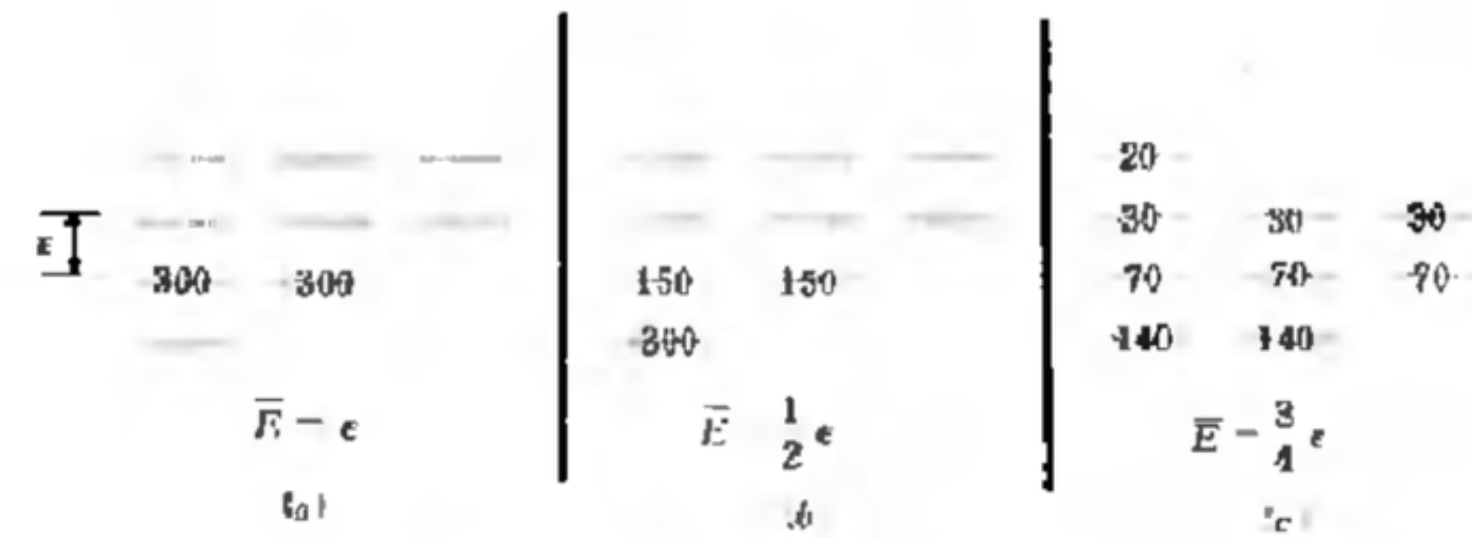
- Take an isolated system as example
  - Specification of macrostate (volume and energy) gives the representative ensemble
  - Corresponding to this given macrostate, the system can be in any one of the very large number of possible micro states
- So what if two macrostate interact so that they can exchange energy?
  - Assuming the total energy is constant, i.e. the combined system is isolated
  - Assuming no *external parameters* (e.g. volume) are changed
  - Purely thermal interaction

Interaction between macroscopic systems - Mechanical interaction

- Same case as previous slide
    - Now the *external parameters* (volume) is changed > work is done
    - Energy levels (of the possible microstates) are shifted by different amounts for different states (even if the total energy remains the same)



Interaction between macroscopic systems - General interaction

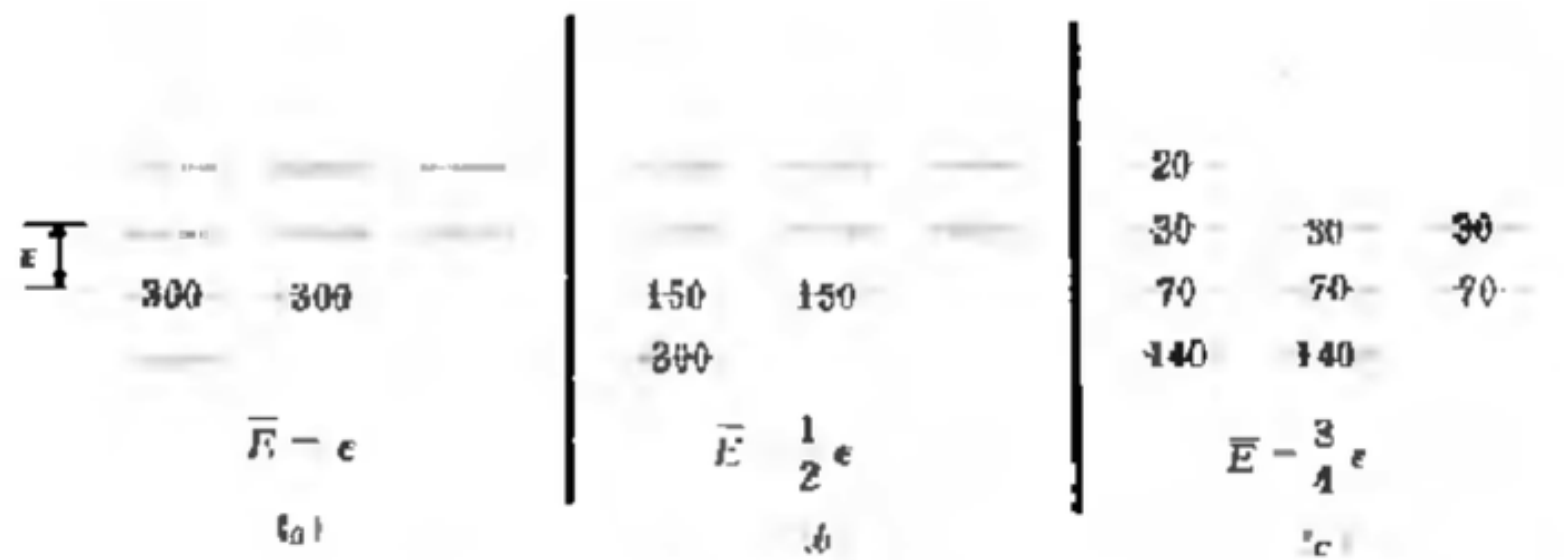


- We have conclude that both **thermal transfer** and **work done** could affect the *mean energy* of a system

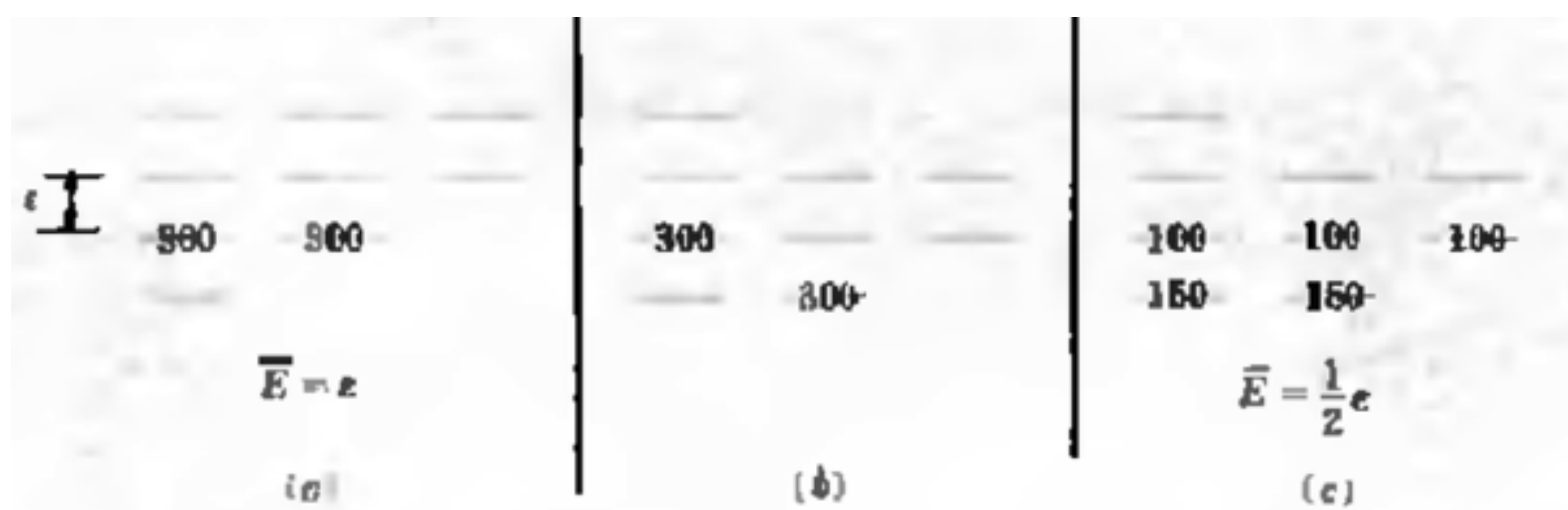
  - But two cases differ in whether the energy levels are shifted

$$\Delta \bar{E} = \Delta_x \bar{E} + Q = \mathcal{W} + Q$$

Quasi-static processes

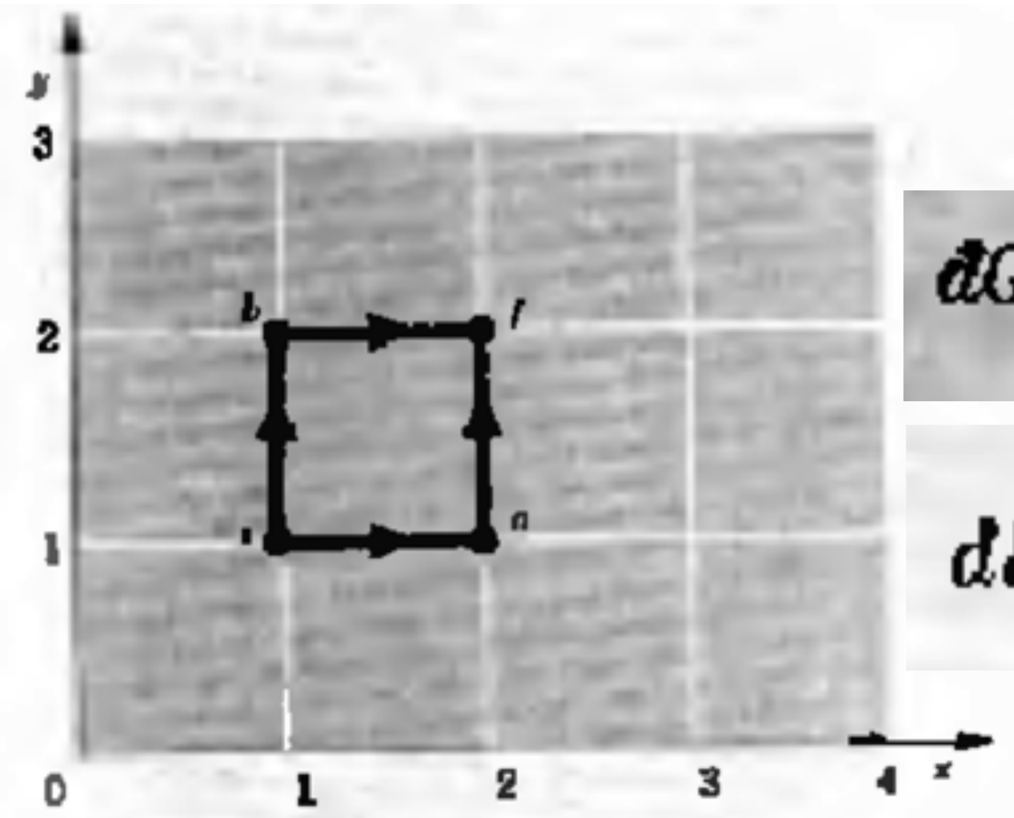


General interaction



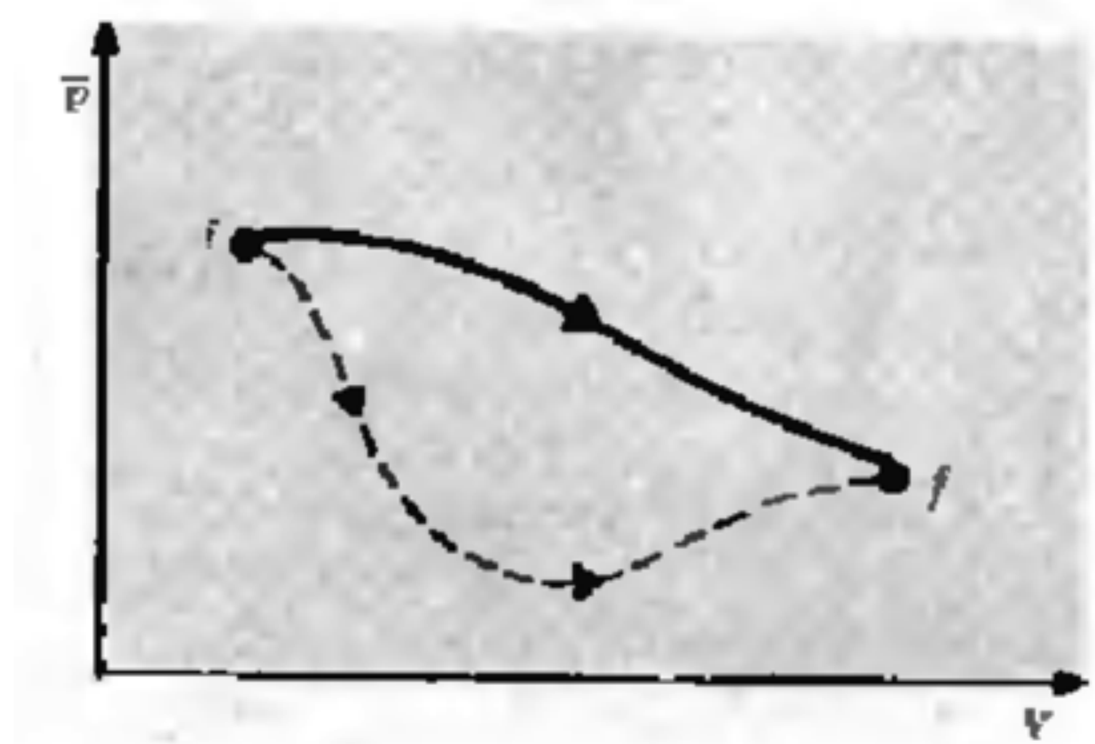
Quasi-static

Path dependency



$$dG = \alpha\, dx + \beta \frac{x}{y} dy = \alpha\, dx + \beta x\, d(\ln y)$$

$$dF = \frac{dG}{x} = \frac{\alpha}{x} dx + \frac{\beta}{y} dy$$



The End of Chapter 2