Entropia

Macrostato e microstati

1 sistema macro	=	N componenti micro
1 STATO macro	=	Ω STATI micro

Esempio: 1 micro-stato = 1 configurazione
(N posizioni + N velocità)

Ω = ...

- Particelle *debolmente* interagenti
- Particelle **fortemente** interagenti

- **meccanica classica**
- **meccanica quantistica**

Equilibrio

Equilibrio ⇔ micro-stati equiprobabili

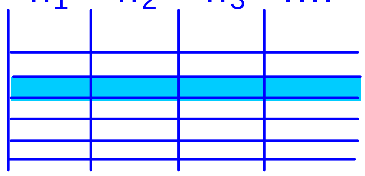
interazioni tra particelle → **transizioni tra microstati**

1 macrostato

$\sum n_i E_i = E_{tot}$

Partizioni

$n_1 \quad n_2 \quad n_3 \quad \ldots.$



Ω microstati

Partizione k-ma = Ω_k microstati

Partizione più probabile = Ω_{max} microstati

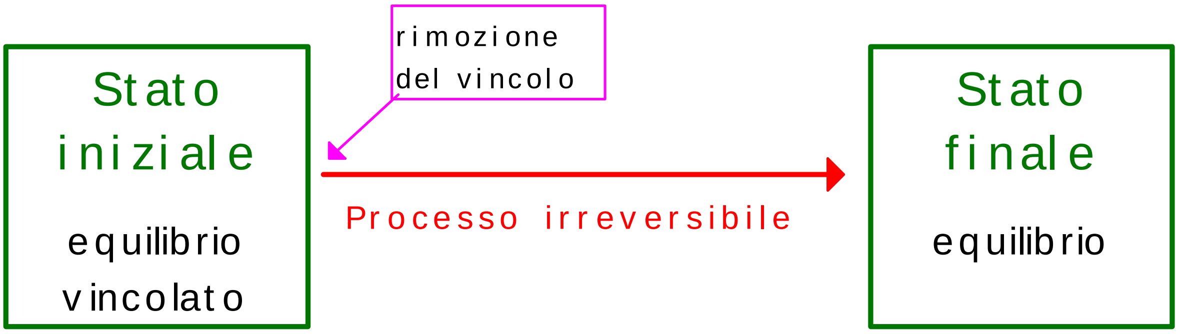
↓

N grande ⇒ Partizione predominante

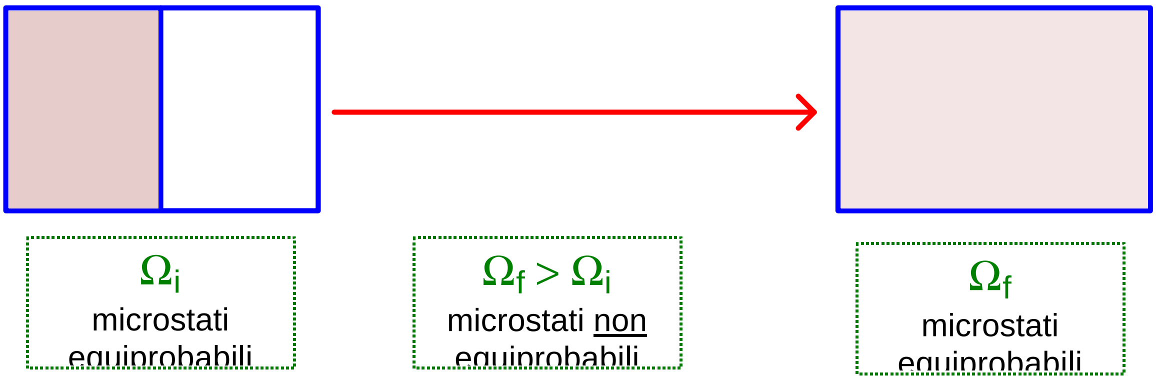
↓

Distribuzione di equilibrio

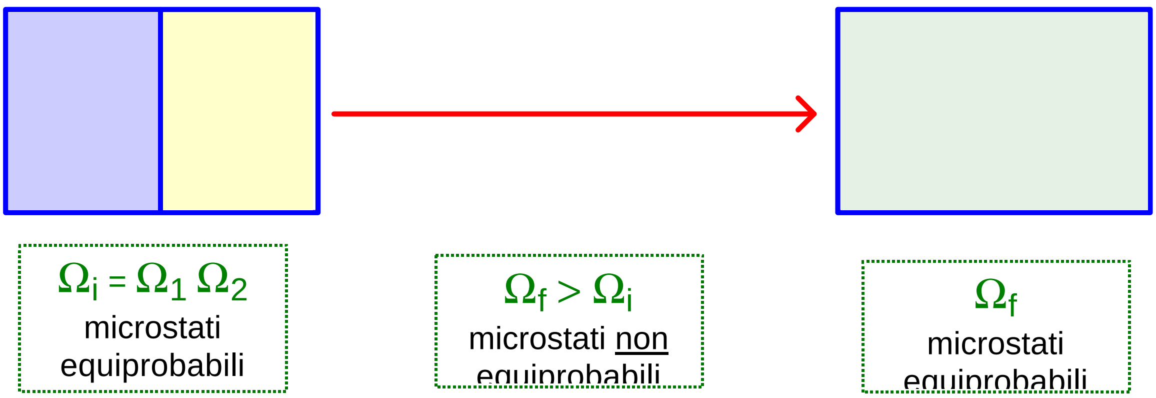
Processi termodinamici



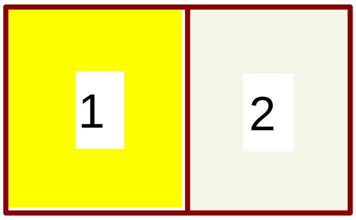
- **Espansione libera**

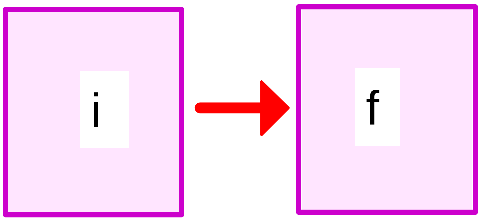


- **Mescolamento di due gas diversi**



Entropia e microstati





micro $\quad \Omega = \Omega_1 \, \Omega_2 \qquad \Omega_i \rightarrow \Omega_f > \Omega_i$

macro $\quad S = S_1 + S_2 \qquad S_i \rightarrow S_f > S_i$

≈

$$S = k_B \ln \Omega_{max}$$

Distrib. d'equilibrio predominante

$\Omega >> N \approx 10^{23}$

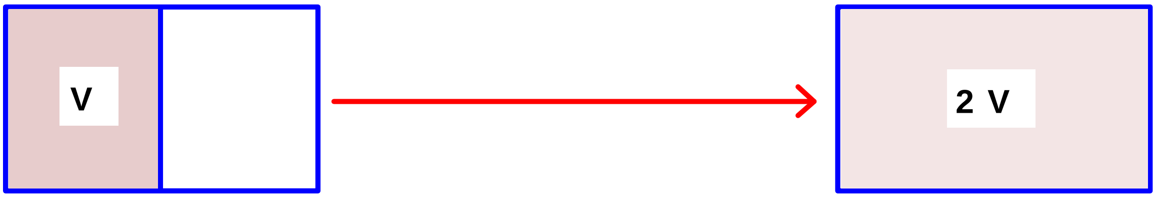
$$\ln \Omega_{max} \approx \ln \Omega$$

$$S \approx k_B \ln \Omega$$

• Un esempio: espansione libera

N molecole, $V \rightarrow 2V$, $Q = 0$

Gas ideale $\Rightarrow$ $W = 0$, $\Delta U = 0$, $\Delta T = 0$, $p \rightarrow p/2$



Microstati iniziali e finali

$$\Omega_i \quad \rightarrow \quad \Omega_f = \Omega_i \, 2^N$$

Variazione di entropia S

a) calcolo microscopico

$$\Delta S = k_B \ln \Omega_f - k_B \ln \Omega_i = k_B \ln \frac{\Omega_f}{\Omega_i} = k_B \, N \ln 2$$

b) calcolo macroscopico

$$\Delta S = nR \ln \frac{V_f}{V_i} = nR \ln 2$$