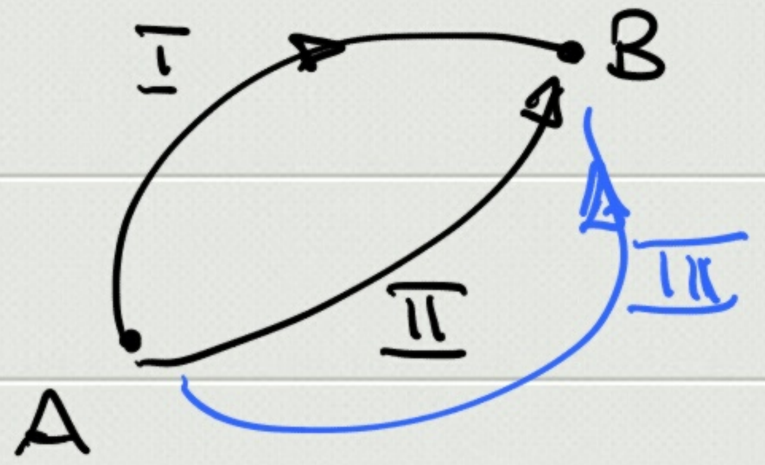
$$\boxed{\oint \frac{\delta Q}{T} \leq 0}$$



$$\oint \frac{\delta Q}{T} = 0 \quad \Rightarrow \quad \int_A^B \left(\frac{\delta Q}{T}\right)_{I} + \int_B^A \left(\frac{\delta Q}{T}\right)_{-II} = 0$$

$$\Rightarrow \int_A^B \left(\frac{\delta Q}{T}\right)_{I} = -\int_B^A \left(\frac{\delta Q}{T}\right)_{-II} = \int_A^B \left(\frac{\delta Q}{T}\right)_{II}$$

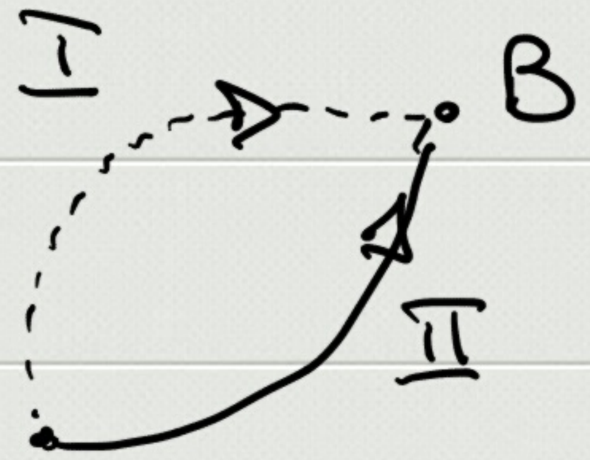
$$\Rightarrow \int_A^B \left(\frac{\delta Q}{T}\right)_{I} = \int_A^B \left(\frac{\delta Q}{T}\right)_{II} = \int_A^B \left(\frac{\delta Q}{T}\right)_{III} = \dots$$

$\Rightarrow$ L'integrale di stato : S (entropia)

$$\boxed{\int_A^B \left(\frac{\delta Q}{T}\right)_{rev} = S_B - S_A = \Delta S}$$

$$\Rightarrow \boxed{dS = \left(\frac{\delta Q}{T}\right)_{rev}}$$

$$\oint \left(\frac{\delta Q}{T}\right)_{irrev} < 0$$



$$\int_A^B \left(\frac{\delta Q}{T}\right)_{I,irrev} + \int_B^A \left(\frac{\delta Q}{T}\right)_{-II,rev} < 0$$

$$\Rightarrow \int_A^B \left(\frac{\delta Q}{T}\right)_{I,irrev} < -\int_B^A \left(\frac{\delta Q}{T}\right)_{-II,rev} = \int_A^B \left(\frac{\delta Q}{T}\right)_{II,rev} =$$

$$= S_B - S_A = \Delta S$$

$$\Rightarrow \Delta S = S_B - S_A = \int_A^B \left(\frac{\delta Q}{T}\right)_{rev} > \int_A^B \left(\frac{\delta Q}{T}\right)_{irrev.}$$

Sistemi termodinamici adiabatici

$$\Rightarrow \delta Q = 0$$

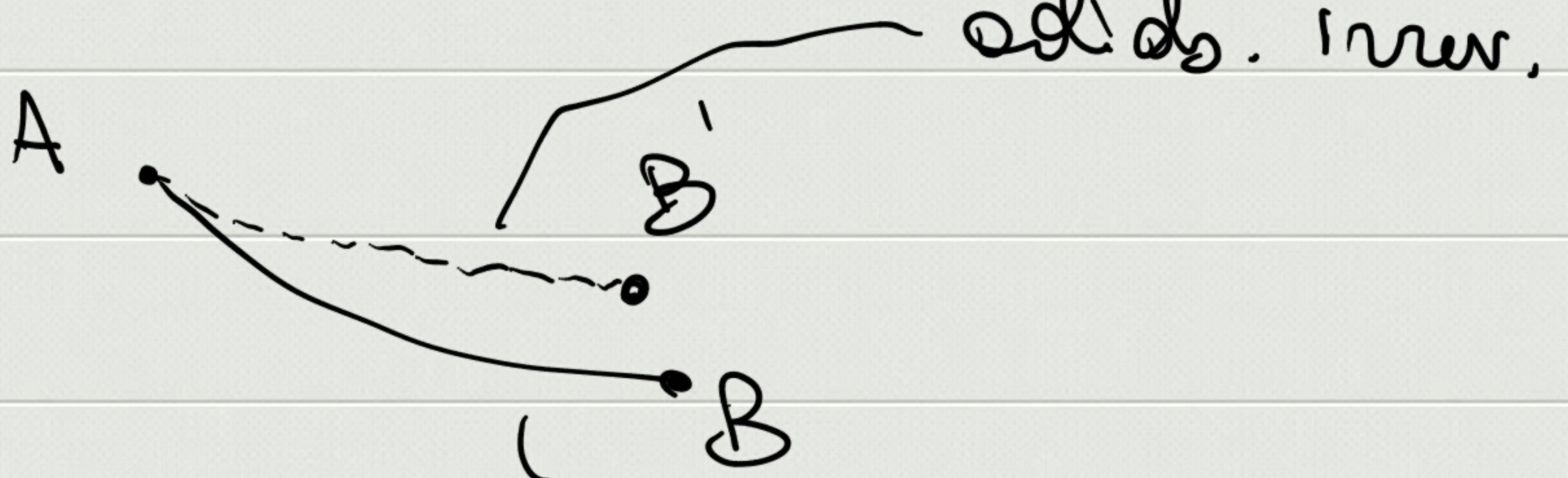
$$\Delta S = \int_A^B \left(\frac{\delta Q}{T}\right)_{rev} \Rightarrow \int_A^B \left(\frac{\delta Q}{T}\right)_{irrev.}$$

adiab. rev. $\Rightarrow \delta Q_{rev} = 0 \Rightarrow \boxed{\Delta S = 0}$

$\Rightarrow S_B = S_A = \text{costante}$

adiab. irrev. $\Rightarrow \delta Q_{irrev} = 0 \Rightarrow \boxed{\Delta S > 0}$

$\Rightarrow \boxed{S_B > S_A}$



$$S_B - S_A = \int_A^B \left(\frac{\delta Q}{T}\right)_{rev} > \int_A^B \left(\frac{\delta Q}{T}\right)_{irrev}$$

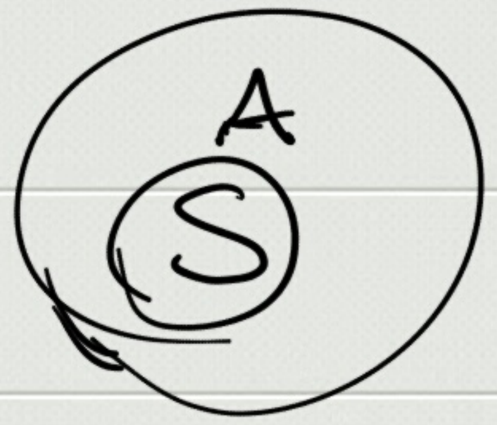
$$\boxed{dS = \left(\frac{\delta Q}{T}\right)_{rev} > \left(\frac{\delta Q}{T}\right)_{irrev.}}$$ disuguaglianza di Clausius

Sistema termicamente isolato

$\boxed{dS \geq 0}$ $\begin{cases} = 0 & \text{rev} \\ > 0 & \text{irrev.} \end{cases}$

↑

espressione matematica del 2° principio

Universo termodinamico → 

è adiabatico

$\Rightarrow \boxed{\Delta S_U \geq 0}$

$\Rightarrow \Delta S_U = \Delta S_{sist} + \Delta S_{amb} \geq 0$

Reversibile $\Rightarrow \Delta S_U = 0 \Rightarrow \Delta S_{sist} = -\Delta S_{amb}$

Irreversibile $\Rightarrow \Delta S_U > 0 \Rightarrow \Delta S_{sist} \neq -\Delta S_{amb}$

Sistema = macchina (ciclo) $\Rightarrow \boxed{\Delta S_{sist} = 0}$

$\Delta S_U = \Delta S_{amb} \geq 0$

$\begin{cases} rev \Rightarrow \Delta S_U = \Delta S_{amb} = 0 \\ irrev \Rightarrow \Delta S_U = \Delta S_{amb} > 0 \end{cases}$