connected graph: observable A_n

Heis. op. $A_n^H(t) \xrightarrow[t\to\infty]{} A^{Hs}$ const.

fix k to be some state: $A_n = \delta_{nk} = \begin{cases} 1 & \text{if } n=k \\ 0 & \text{if } n\neq k \end{cases}$

$$\vec{A}^H(t) = \vec{A}^T e^{\Omega t}$$

$$A_n^H(t) = \sum_m \underbrace{A_m}_{\delta_{mk}} \left(e^{\Omega t}\right)_{mn} = \left(e^{\Omega t}\right)_{kn}$$

$$\xrightarrow[t\to\infty]{} A_k^{Hs}$$ indep. of n (can depend on k)

$$\vec{p}(t) = e^{\Omega t}\,\vec{p}(0)$$

$$p_n(t) = \sum_m \left(e^{\Omega t}\right)_{nm} p_m(0)$$

$$\xrightarrow[t\to\infty]{} A_n^{Hs} \sum_m p_m(0) = A_n^{Hs}$$ const. indep. of time

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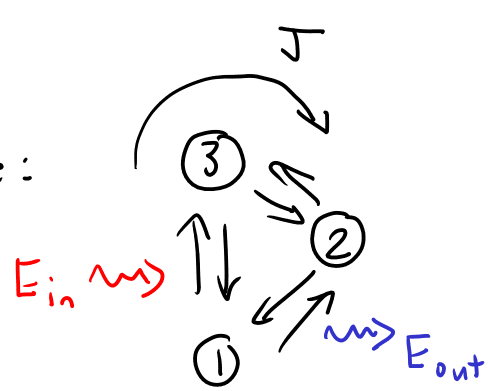
$$\Rightarrow \quad \dot{W} = P_{in} - P_{out} = \underbrace{T\dot{I}}_{P_{diss} > 0} \quad \text{as } t\to\infty$$

$P_{diss} > 0$ for NESS

example:



$t\to\infty$:

all currents $\to J$

$$J \propto \left(1 - e^{-\beta(E_{in} - E_{out})}\right)$$

if $E_{in} > E_{out} \Rightarrow J > 0$ NESS

$$\dot{W} = \frac{1}{2} \sum_{nm} J_{nm}(t) W_{nm}$$

$$= \frac{1}{2} \left(J_{13} W_{13} + J_{31} W_{31} + J_{12} W_{12} + J_{21} W_{21} + J_{23} W_{23} + J_{32} W_{32} \right)$$

$t \to \infty$:

$$J_{31} = J_{23} = J_{12} = J \qquad W_{23} = W_{32} = 0$$

$$J_{13} = J_{32} = J_{21} = -J \qquad W_{31} = E_{in} \quad W_{13} = -E_{in}$$

$$W_{12} = -E_{out} \quad W_{21} = E_{out}$$

$$\dot{W} = \underbrace{J E_{in}}_{P_{in}} - \underbrace{J E_{out}}_{P_{out}} = \underbrace{T \dot{I}}_{P_{diss}} > 0$$

when $E_{in} > E_{out}$