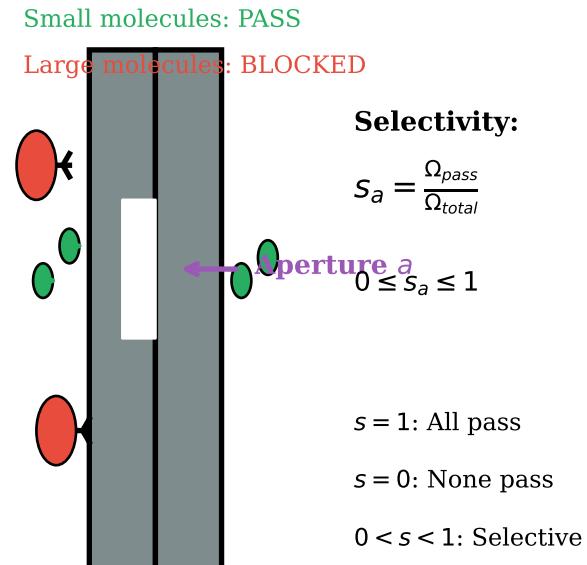
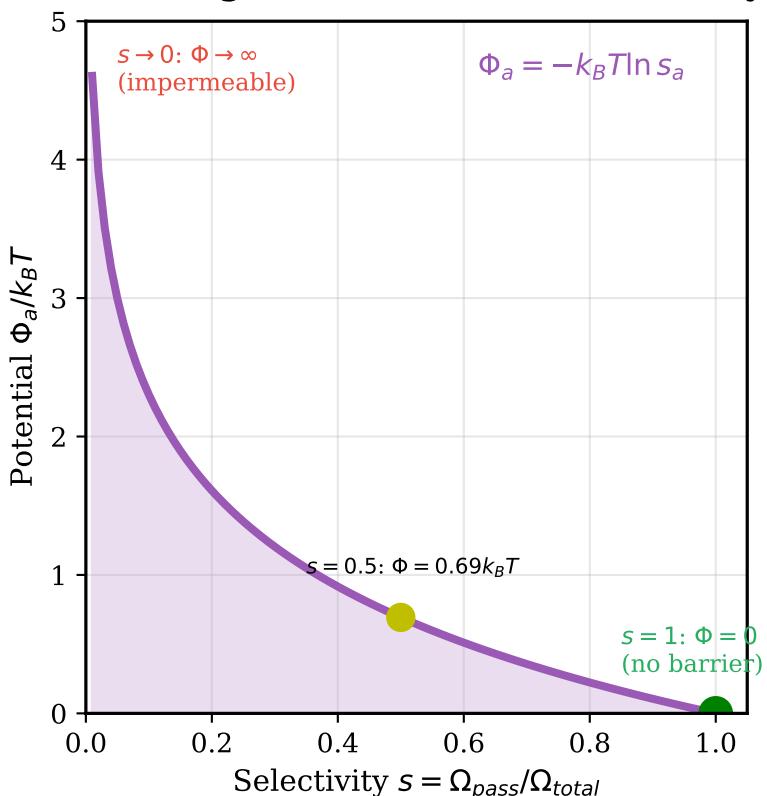


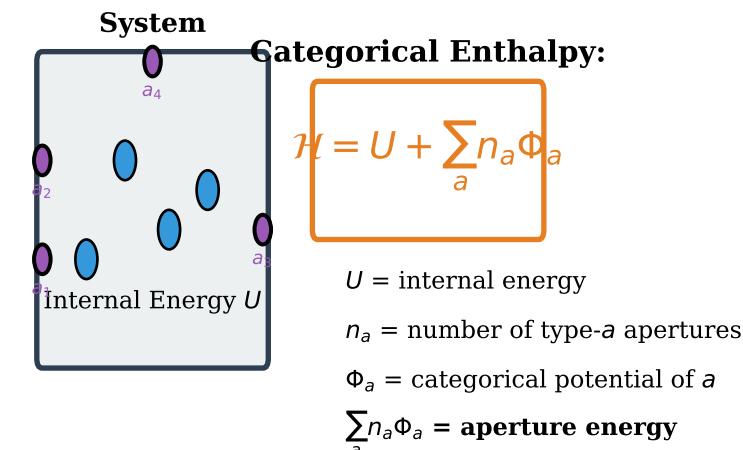
(A) Aperture: Selective Molecular Passage



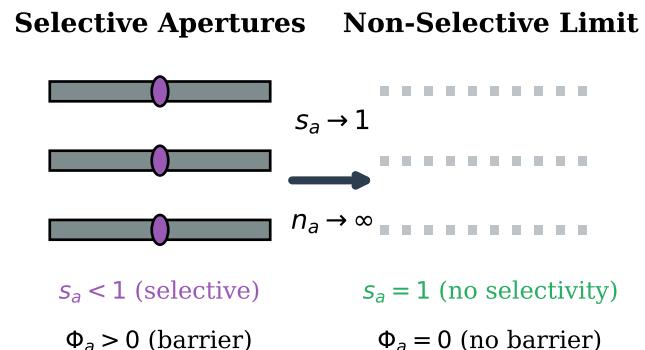
(B) Categorical Potential vs Selectivity



(C) Categorical Enthalpy Definition



(D) Classical Limit: Non-Selective Apertures



(E) Pressure: Emergent from Aperture Statistics

Aperture density: ρ_a per unit area

Each aperture has potential: $\Phi_a = -k_B T \ln s_a$

Total aperture contribution: $\rho_a \cdot A \cdot \Phi_a$

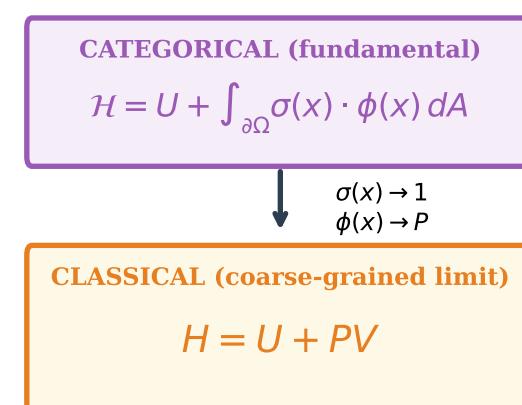
Taking limits: $s_a \rightarrow 1, \rho_a \rightarrow \infty$

Define: $P = \lim_{s_a \rightarrow 1} \rho_a \cdot (-k_B T \ln s_a)$

Key insight:

Pressure P = coarse-grained aperture potential density

(F) Enthalpy: From Categorical to Classical



Classical thermodynamics emerges as
the coarse-grained limit of categorical aperture dynamics

In the classical limit:

$$\sum_a n_a \Phi_a \rightarrow \int_{\partial\Omega} P dA = PV$$

$$\mathcal{H} \rightarrow U + PV = H_{\text{classical}}$$