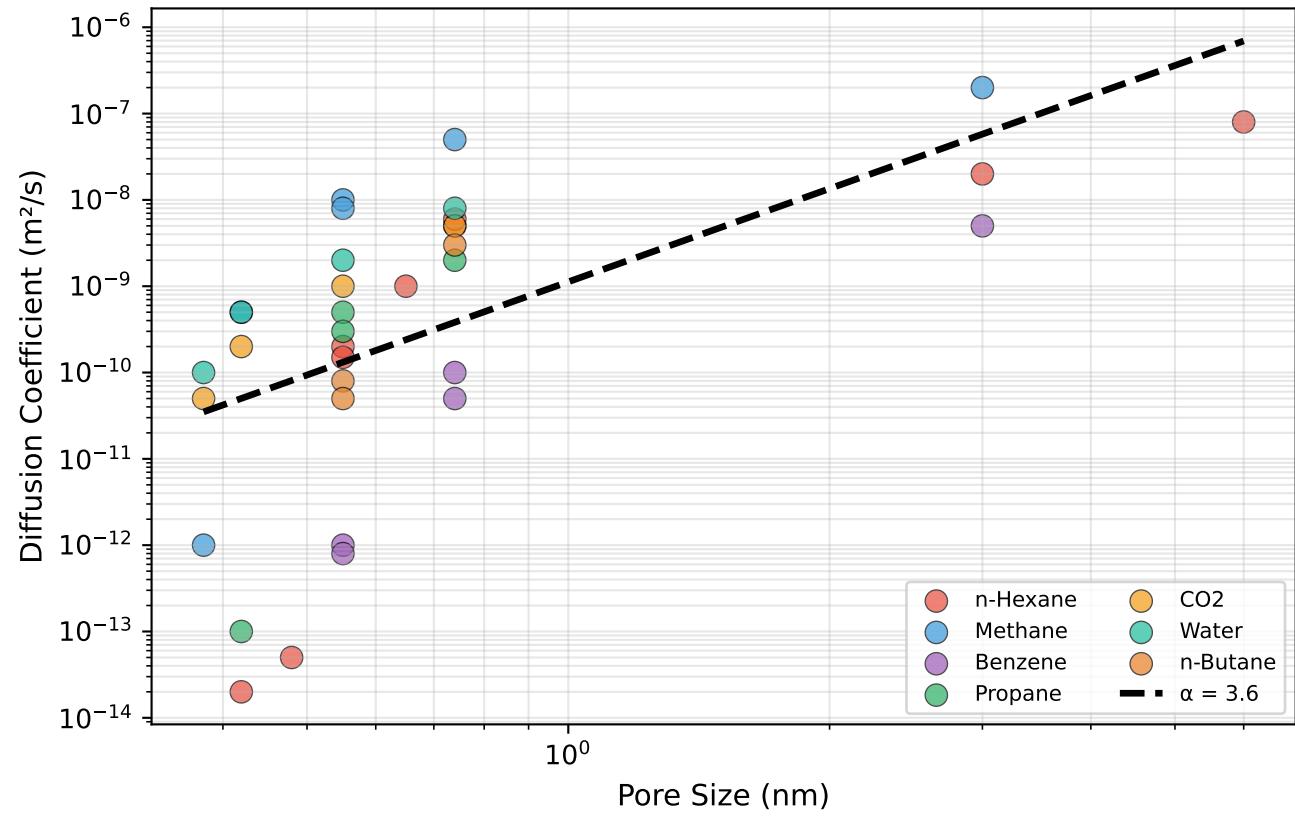


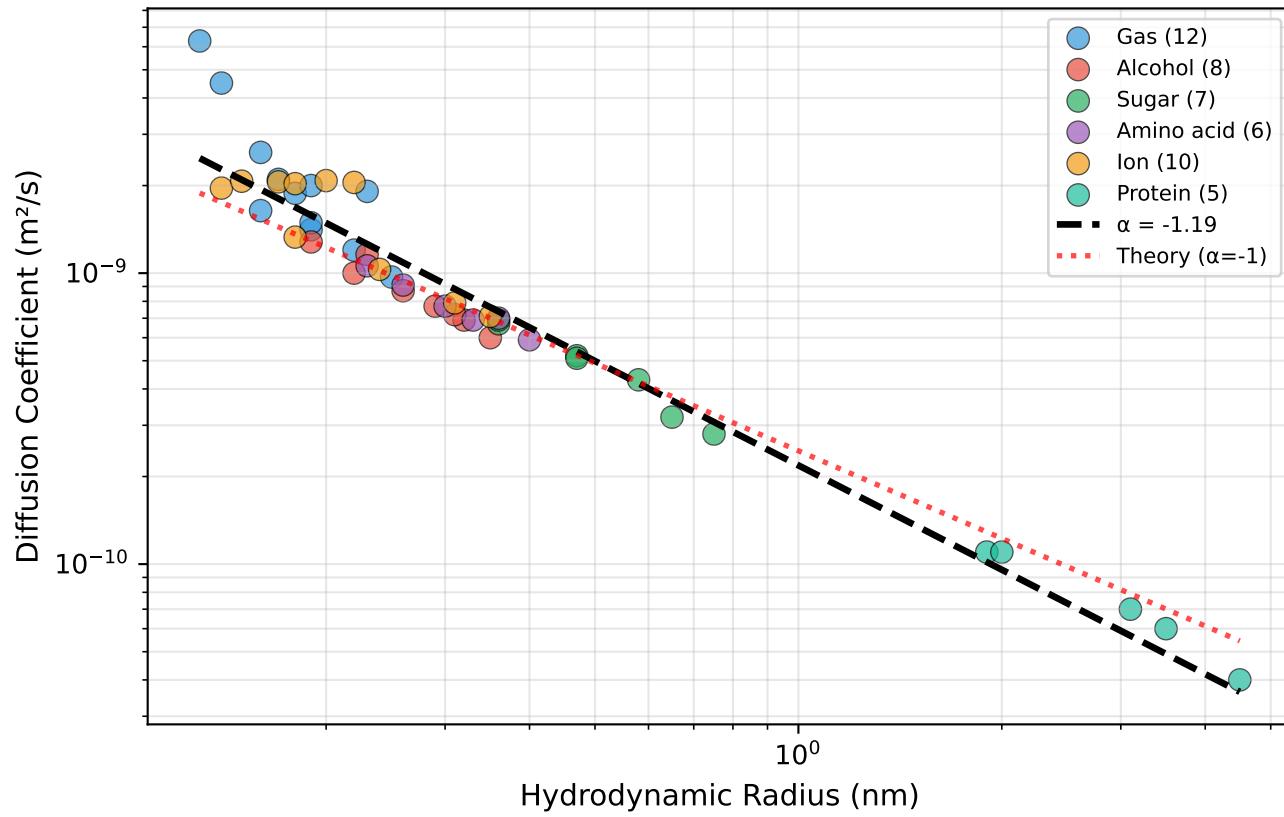
### CONFINED REGIME: Zeolite Diffusion

$\alpha = +3.6 \pm 0.9$  (n=35)

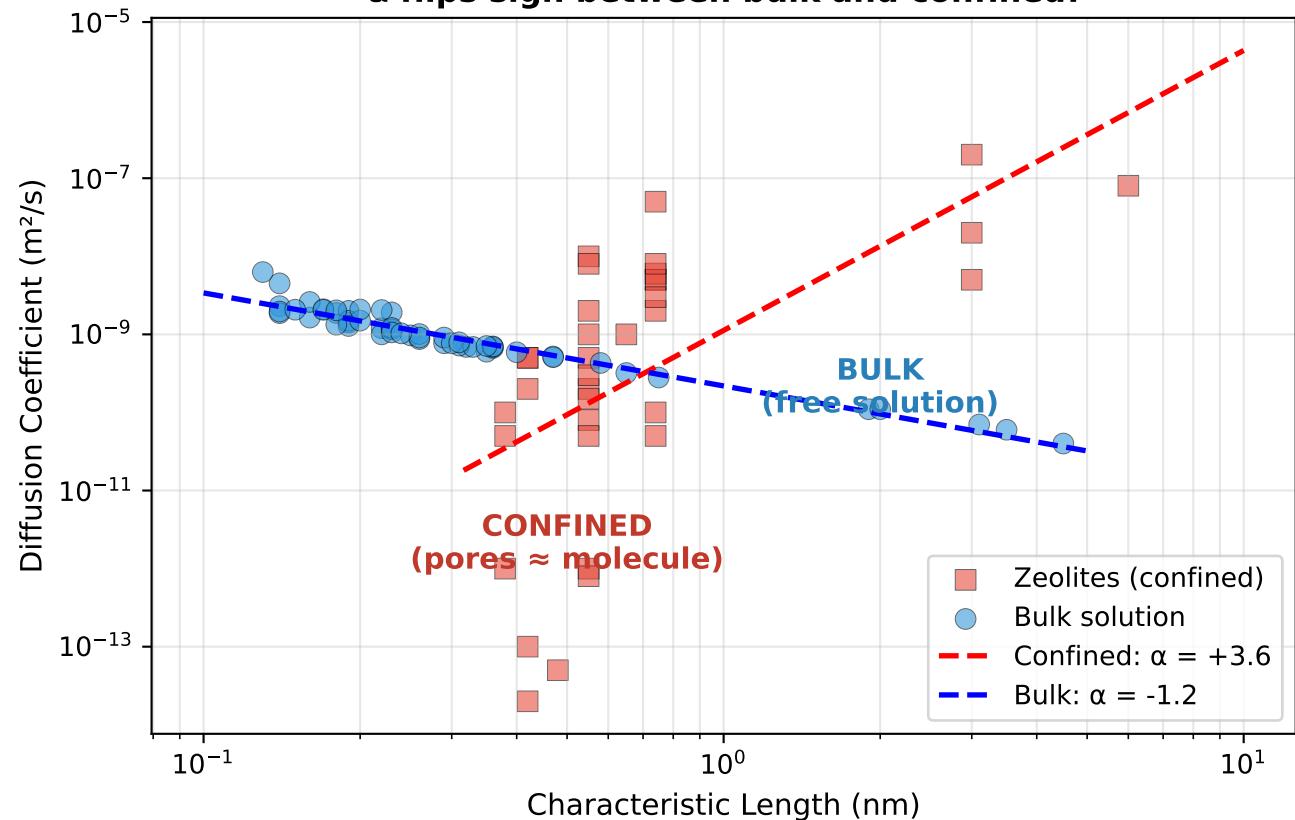


### BULK REGIME: Stokes-Einstein

$\alpha = -1.19 \pm 0.04$  (n=54)



### TWO REGIMES OF MOLECULAR DIFFUSION $\alpha$ flips sign between bulk and confined!



### RTM CHEMISTRY: TWO DIFFUSION REGIMES

#### ANALYSIS 1: ZEOLITE DIFFUSION (Configurational Regime)

- Data points: 35
- Materials: 11 zeolites (4A, 5A, ZSM-5, Y, X, MCM-41...)
- Guests: 7 molecules (hexane, methane, benzene, propane...)
- $\alpha = +3.6 \pm 0.9$  (overall)
- $\alpha = +9.2 \pm 2.5$  (microporous < 0.8 nm)
- $R^2 = 0.34$  (high scatter due to guest diversity)

Interpretation: EXTREME geometric sensitivity  
Small pore change → HUGE diffusion change

#### ANALYSIS 2: STOKES-EINSTEIN (Bulk Regime)

- Data points: 54
- Categories: gases, alcohols, sugars, amino acids, ions, proteins
- Size range: 0.13 - 4.5 nm ( $\times 35$  range)
- $\alpha = -1.19 \pm 0.04$
- $R^2 = 0.95$  (excellent fit)
- Theory predicts:  $\alpha = -1.0$  (Stokes-Einstein)

Interpretation: VISCOUS drag dominates  
Larger molecule → slower diffusion (inversely proportional)

#### KEY RTM INSIGHT: $\alpha$ SIGN FLIP

- Bulk:  $\alpha \approx -1$  (bigger = slower)
- Confined:  $\alpha \approx +4$  to  $+9$  (bigger pore = MUCH faster)

This sign flip marks the TRANSITION between transport regimes!