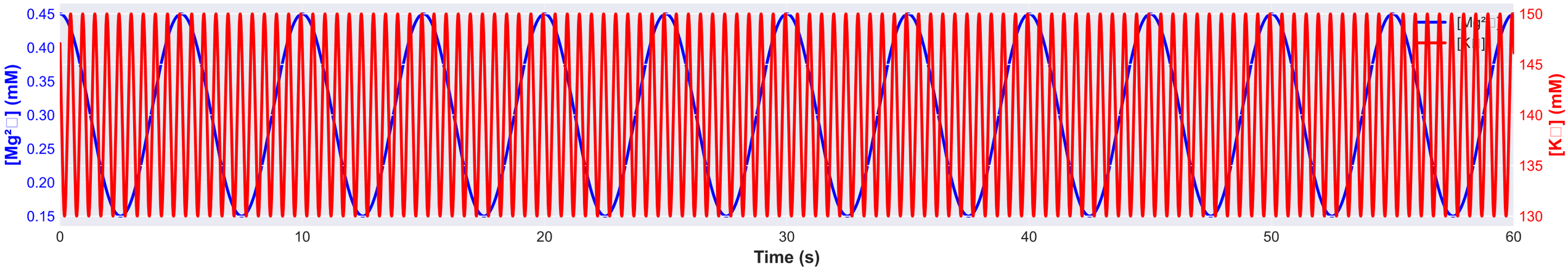
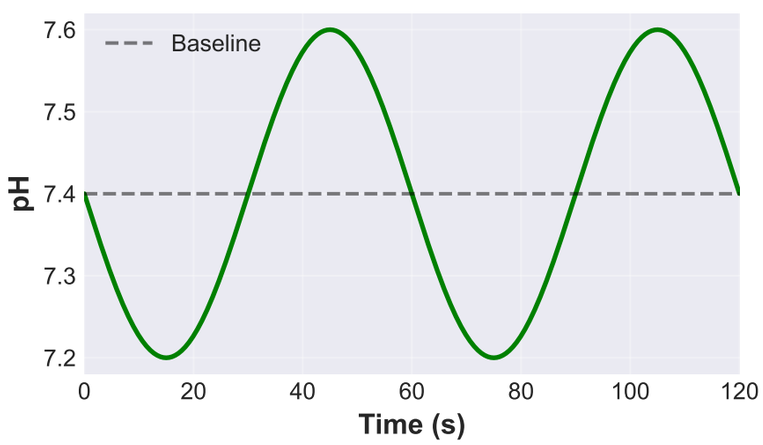
Metabolic Charge Oscillations and Electrostatic Regulation

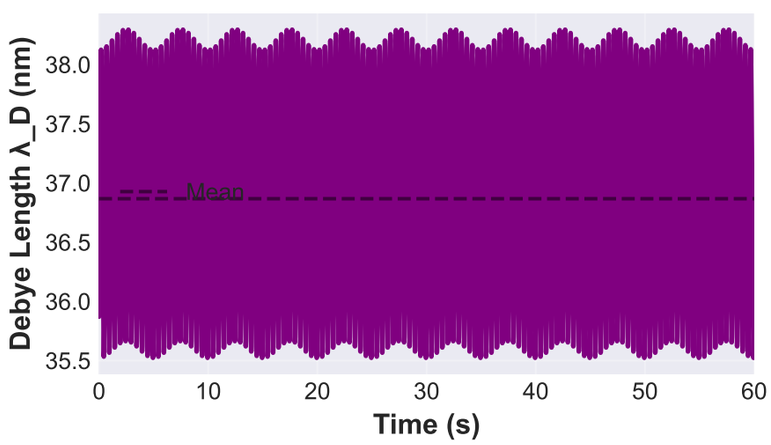
A. Metabolic Ion Oscillations



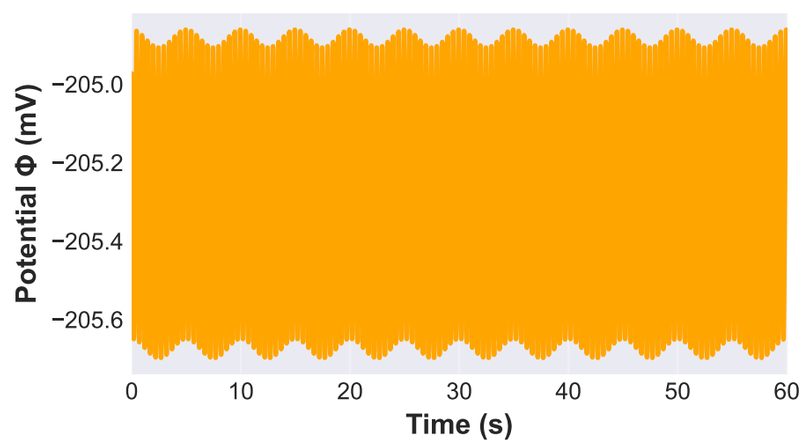
B. pH Oscillations (Glycolysis)



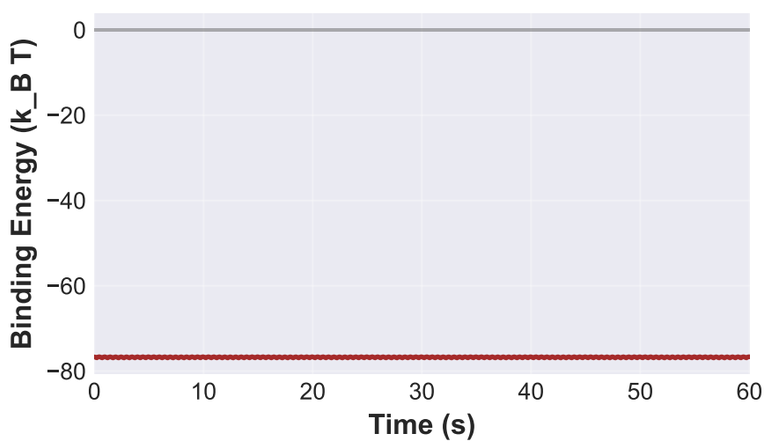
C. Charge Screening Length Oscillations



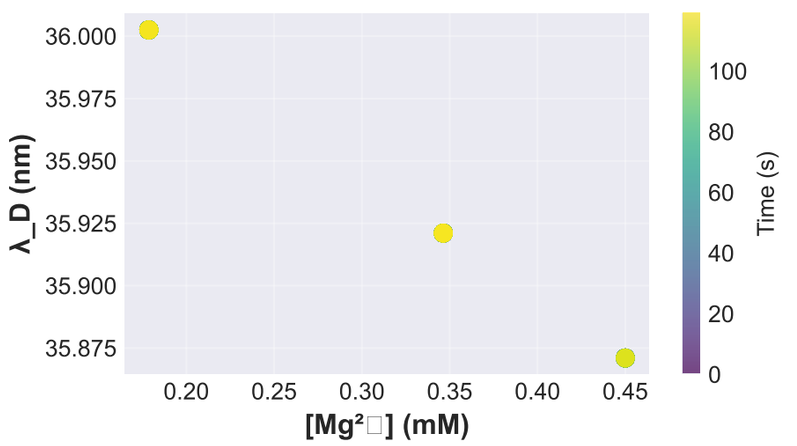
D. DNA Surface Potential (r=2nm)



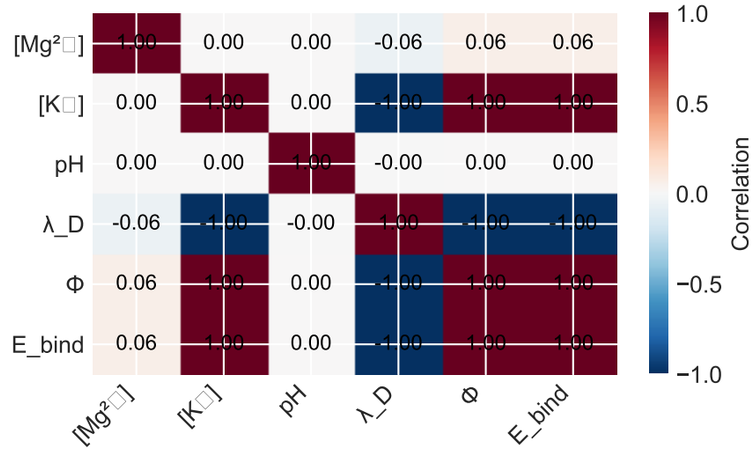
E. TF Binding Energy Oscillations



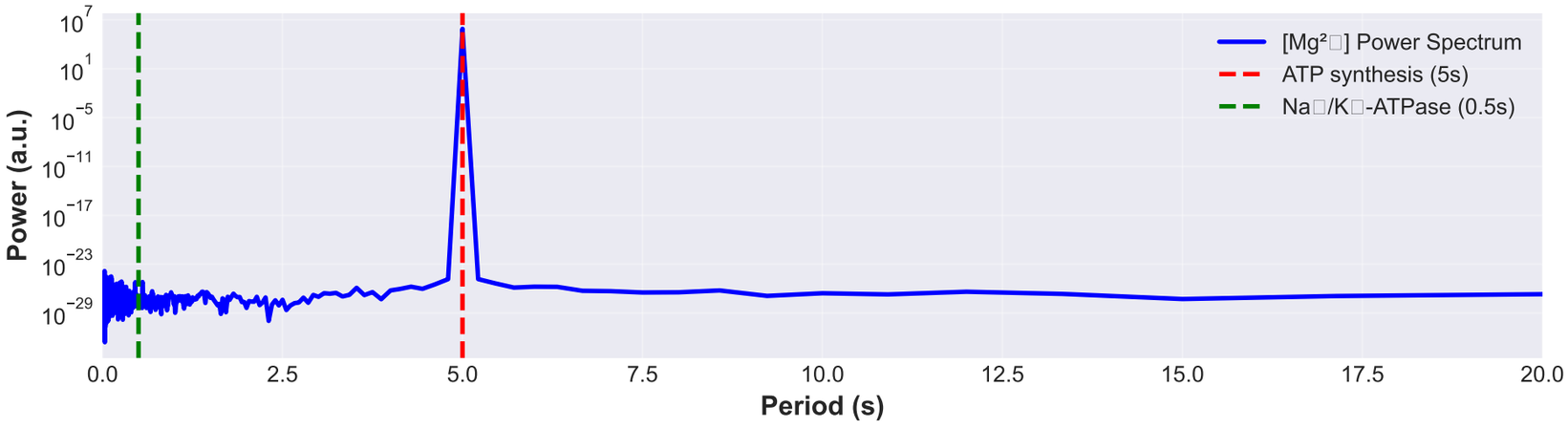
F. Phase Space: [Mg²□] vs λ_D



G. Correlation Matrix



H. Frequency Analysis: Dominant Oscillation Periods

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SUMMARY STATISTICS

Ion Oscillations:
• [Mg²⁺]: 0.300 ± 0.106 mM
• [K⁺]: 140.0 ± 7.1 mM
• pH: 7.40 ± 0.14

Charge Screening:
• λ_D: 36.867 ± 0.926 nm
• Oscillation: 2.5%

Electrostatic Effects:
• Φ(2nm): -205.3 ± 0.3 mV
• E_bind: -76.8 ± 0.1 k_BT
• Modulation: 0.1%

Dominant Frequencies:
• ATP synthesis: ~5 s period
• Na⁺/K⁺-ATPase: ~0.5 s period
• Glycolysis: ~60 s period

Correlations:
• [Mg²⁺] vs λ_D: r = -0.060
• λ_D vs Φ: r = -1.000
• Φ vs E_bind: r = 1.000
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