# Research Proposal

## Entropy-Modulated Neuroregulation in Autism Spectrum Conditions: A Thermodynamic Biofeedback Approach

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## I. Background and Rationale

Autism spectrum conditions are characterized by atypical connectivity, sensory processing differences, and altered metabolic profiles. Emerging evidence indicates:  
- Mitochondrial dysfunction in up to 80% of children with ASD  
- EEG coherence disruptions associated with altered cognitive and social function  
- HRV abnormalities reflecting autonomic nervous system imbalance  
  
These traits point toward a shared thermodynamic signature: elevated biological entropy. Applying the Thermodynamic Aging Framework to ASD may enable a new class of entropy-aware interventions that can restore coherence and function.

## II. Objectives

1. Quantify entropy-related biomarkers in ASD individuals across stress states and daily activities  
2. Develop closed-loop feedback algorithms that detect entropy shifts and deliver precision neuromodulation  
3. Pilot wearable prototypes integrating HRV, EEG coherence, and mitochondrial sensors with light and PEMF output  
4. Evaluate improvements in regulation, coherence, and sensory integration

## III. Methodology

### Phase 1: Entropy Profiling

- Recruit ASD and neurotypical control participants  
- Measure:  
 - HRV entropy  
 - EEG coherence  
 - ROS and mitochondrial membrane potential (via sweat or saliva biomarkers)  
 - Subjective dysregulation events (e.g., meltdowns, shutdowns)

### Phase 2: Intervention Development

- AI model trained using entropy spike patterns  
- Create adaptive modules for:  
 - Photobiomodulation  
 - Pulsed EM fields  
 - Sound/visual entrainment  
- Test comfort and efficacy in lab setting

### Phase 3: Wearable Prototype Trial

- Participants wear devices for 14–30 days  
- Measure:  
 - Reduction in entropy spikes  
 - Behavioral improvement  
 - Sensory overload mitigation  
 - Sleep and focus markers

## IV. Expected Outcomes

- Improved neuroregulation and cognitive coherence  
- Personalized entropy signatures for ASD subtypes  
- Scalable wearable-based intervention platform

## V. Significance

This work represents a paradigm shift: treating ASD not as a fixed neurological condition, but as a dynamic entropy state—one that can be measured, interpreted, and adaptively guided toward coherence.