TITLE:- MODELING ELECTROMAGNETIC CHARGE SATURATION, AND AI DRIVEN FAULT TOLERANCE IN ORBITING DYSON NODES

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Abstract:- Solar Wind Consists of high-energy protons and Electrons from the Sun. During Solar FLux or CME(Coronal Mass Ejections), Particle Density Increases Exponentially , Causing;

- ★ *EMI(Electromagnetic Interference)]*
- ★ *Static Charge Accumulation*
- ★ *Component Burnout*
- ★ *Data Corruption in memory Buses.*

Nature of Solar Winds:-

Features	*Typical Value*
Particle Energy	*1 - 10 KeV*
Speed	*300 - 800 km/s*
Burst Frequency	*Random/ Flare Triggered*
CME Intensity	*1000x Background Levels*

The interaction with node Hardware occurs primarily, through Induction, Surface Charging and Electrons Disruption in Signal Buses.

Electromagnetic Modeling:- Let;

★ Φ_{sw} = *Particle Flux(particle/m^2 * s)*

★ $I_{induced}$ = *Induced Current due to particle Interaction*

★ C_{node} = *Node's Charged Tolerance*

We simulate;

$$I_{induced} = k * \Phi_{sw} * A * \cos(\theta)$$

Where., A = *Area of Exposure*

θ = *Impact Angle*

K = *Material Constant*

Fallback occurs when.,

$$Q_{node} > Q_{max}$$

Node Charge Balanced Architecture:-

SubSystem	*Charge Tolerance*
CPU Logic	*50* μ*C*
RAM Controller	*30* μ*C*
FLux Panels	*80* μ*C*
Capacitor Unit	*100* μ*C*

Shielding Status (ON/ OFF) modifies Tolerance using;

$$Q_{eff} = Q_{raw} * (1 - S)$$

Where., S is Shielding Efficiency

Error & Noise Propagation:- High Flux Value Causes;

★ *Signal Decay Spikes(ΔT)*

★ *Memory Read / Error Write*

★ *CRC Failure*

★ *Thermal Spikes in Inductive Loops*

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References:- ★ *NASA Goddard: Space Weather Impact (2023)*

★ *ESA Solar particle Interaction models (2022)*

★ *EMI & Fault Tolerance in Space Nodes, "MIT AI LAB, 2024"*