TITLE:- High Velocity Particle Impact simulation on Autonomous Dyson Node Systems

AUTHOR:- ARJUN A.K.A HEET TRIVEDI
EMAIL:- heettrivedi02@gmail.com

Why This Scenario Matters:- Space isn't empty – it's filled with high speed particles and microscopic Debris, Travelling at 10 - 70 km/s . These Micro-Meteorite are;

- ★ *Smaller than (1 mm).*
- ★ *Too fast to Avoid.*
- ★ *Invisible to basic Sensors.*
- ★ *Capable of piercing Unshielded System, causing;*
    1. *Capacitor Disruption*
    2. *Insulation Cracking*
    3. *Radiator Puncture*
    4. *Memory Corruption*

Simulation Objectives: -

- ★ *Emulate Random Micro-meteorite hits on a node surface.*
- ★ *Log in Impact Event, Damage Severity, and System Response.*
- ★ *Simulate Self-repair, fallback, or permanent failure.*

Scientific Premise:- Based on ESA & NASA Shielding Models, most LEO Satellites face 1 - 10 Micro-Impact per month, causing;

★ *Surface Etching*
★ *Panel Degradation*
★ *Short Circuits*
★ *Data Loss if memory is Unshielded.*

The Node must;

★ *Detect Impact*
★ *Log it*
★ *Isolate damaged Subsystem*
★ *Attempt minor Rerouting or fallback if critical paths are affected.*

Physics Model:-

(i) Impact Probability

↠ *Simulate rare random impacts every n Cycles;*

$$P(i) = Poisson\ Distributed\ Events\ or$$

$$Simply\ every \sim 1000\ Cycles,\ One\ Impact.$$

(ii) Damage severity Index(DSI)

↠ *Assign a Severity Score;*

$$DSI = 0.1 + random() * 1.5$$

System Level Questions :-

(1) Can the node identify and Categorize physical trauma?
(2) Can it contain a failure without Triggering full System fallback?
(3) Does it log Impact Intelligence for AI Learning ?
(4) Can it Self- Correct Minor Hits, or must it always Isolate?

Simulation Mechanics:-

Range	*Classification*	*System Response*
0.1 -0.4	*Minor*	*Log only*
0.5 - 1.1	*Moderate*	*Subsystem Isolation*
1.2+	*Critical*	*Trigger Full Fallback*

Response Matrix:-

Impact Zone	*DSI < 0.5*	*DSI < 1.2*	*DSI ≥1.2*
Thermal System	*Log*	*Disable Radiators*	*Fallback: Overheat Risk*
Memory Core	*Log*	*ECC Recovery*	*Fallback: data corruption*
Shield Layer	*Log*	*Degrade protection*	*Schedule repair mode*
CPU Cluster	*Log*	*Logic Reroute*	*Emergency fallback*