LSC 4.2 ULTRA – Input Data Block for Simulation

1. Goal and Scope

Model: LSC 4.2 ULTRA – Gravitationally Coupled Neutrino Oscillation.

Goal: Analyze PBH influence on neutrino oscillations and resonance conditions.

2. Effective Hamiltonian

H_eff = H_vac + H_matter + H_grav + H_LSC

2.1 Vacuum Term

H_vac = (1/2E) U M^2 U^†

$\Delta m^2 12 = 7.5e\text{-}5\ eV^2$, $\Delta m^2 31 = 2.5e\text{-}3\ eV^2$

$\theta 12 = 33°$, $\theta 23 = 45°$, $\theta 13 = 8.5°$

2.2 Matter Term

Ve = sqrt(2) GF ne(r)

ne = const = 1e10 cm^-3 OR ne(r) = n0 exp(-r/r0)

2.3 Gravitational Term

$\Phi(r) = -GM/r$

H_grav = (E/c^2) $\Phi(r)$

2.4 LSC Operator

H_LSC = α_LSC (GM/(r c^2)) F(E)

α_LSC = 1e-8

F(E) = E / 1 PeV

3. PBH Parameters

M = 1e14 – 1e17 g

r in [2rs, 50rs]

4. Energy Range

E = 1 TeV – 100 PeV

Test point: 220 PeV

5. Resonance Condition

$\Delta m^2 \cos(2\theta) = 2E (V_{matter} + V_{LSC})$

6. Evolution Equation

$i \, d/d\tau \, \nu = H_{eff} \nu$

7. Oscillation Probability

$P(\nu\alpha \rightarrow \nu\beta) = |\nu\beta(\tau)|^2$

8. GR Energy Shift

$E_{obs} = E_{emit} \sqrt{(1 - rs/remit)/(1 - rs/robs)}$

9. Approximations

Adiabatic evolution, radial trajectory, no spin effects