13.8 GALACTIC BLACK HOLES (ADIABATIC APPROXIMATION)

The core hyperdensity calculations of Chapter 10 provide compelling evidence that the material in black holes is in a degenerate state similar to that of a neutron star, albeit at a higher gravitational potential. The other possibility is plasma, and it is fairly easy to show that a black hole's material is not in this state. Gravitational potential near a black hole is given by Equation (5.19):

$$\Phi_g = m_0 c^2 \left(\sqrt{1 - \frac{2GM}{c^2 r}} - 1 \right)$$

Its magnitude at a distance of 5 Schwarzschild radii ($R_S = 2GM/c^2$) is ~ –0.1. Freely moving particles with kinetic energy of only 90% of their rest mass achieve a distance of 4 R_S beyond their veneer. Thus if the material inside a black hole were in a state of hot plasma, its kinetic energy would transport it outside of its veneer, where it would freely radiate. This is not viable. *Black holes are composed of degenerate matter confined by gravitation and nuclear potential*.

Ψ THEOREM 13.12 - BLACK HOLE COMPOSITION {Ψ5.6}

BLACK HOLES ARE COMPOSED OF DEGENERATE NUCLEAR MATTER, RESTRAINED BY GRAVITATION AND NUCLEAR POTENTIAL

Plasma would thermalize a black hole's veneer and in so doing radiate profuse amounts of energy. This might be a transient condition for a few of the particles on a black hole's surface, but is certainly not a stable global configuration.

Before any attempts are made to describe a black hole's unfathomably harsh interior, we must decide:

a) how much energy its material lost as a result of gravitational capture.

b) whether or not this loss is relevant to a black hole's properties and cosmic functionality.

There are two reasons to suspect that this energy loss is significant. First, the Virial Theorem⟨6.26⟩ tells us that any gravitationally-bound system loses half of its gravitational potential to radiation. A black hole with a near-unity gravitational potential represents a huge energy deficit. Second, the intense radiation given off by accretion disks, though as yet not unambiguously observed, has been well documented in terms of basic physics.

As it turns out, however, radiative loss during accretion has no bearing on a black hole's primary function: cosmic equilibrium. The key and only consideration is the Maxfield criterion. A black hole can exchange elementary particles with the rest of the universe if and only if they regain their full complement of rest energy. Regardless of how much energy a proton does or does not lose on its journey down a black hole's gravitational well, it can only reemerge with its free-space rest energy fully intact. For this reason, the contents of a black hole will be viewed as an adiabatic collection of degenerate material, where the total energy present is defined by the number and species of its elementary particles.

Applying a gravitational field to a nuclear matrix induces core expansion, thereby increasing inter-core separation and lowering material density. If this occurs adiabatically, 100% of the field energy lost by expansion is recaptured as kinetic energy. This means that *the effective material density of a gravitationally expanded substrate is purely a function of its increased core size.* The adiabatic relationship between gravitational potential and material density is given by Equation (13.24), the relationship between free and expanded core size:

$$\rho = \left(\frac{R_p}{R_{xc}}\right)^3 \rho_{n_0} = \left(\sqrt{1-\frac{2GM}{c^2 r}}\right)^3 \rho_{n_0} = \left(\frac{\Phi_g}{m_0 c^2}+1\right)^3 \rho_{n_0} \qquad (13.25)$$

where ρ_{n_0} is electrically neutral nuclear density at zero gravitational potential and zero pressure, given by Equation (10.16):

$$\rho_{n_0} = \frac{m_n}{12 R_p^3}$$

The density of atomic nuclei on a neutron star's surface ($\Phi_g/m_0c^2 \sim -0.2$), for instance, is about half that of the same nuclei on Earth.

Pressure compresses particle cores while gravitational potential expands them. Indeed, the only agents that can counter the incredible pressure inside a black hole are *core integrity and gravitational potential*. Cores exposed to this potential expand accordingly, so the interior density profile of a massive compact object has the form:

$$\rho = \left(\sqrt{1-\frac{2GM}{c^2 r}}\right)^3 \rho_{bn}(r) \qquad (13.26)$$

where $\rho_{bn}(r)$ is the baseline nuclear density at the pressure that exists at radius r. This, like ρ_{n_0}, represents an electrically neutral degenerate matrix.