CAUSALITY AND HORIZONS

(A conceptual model for building these spaces, centered on ion stars and exotic propulsion systems) The object of study is to design unknown spaces for models with Python and alternative logics for galactic structures (such as your “Penrose-Hole cone ionic magnetar”), we can establish new physical rules that replace or alter those of our current cosmology.

RELATIONSHIPS BETWEEN CONCEPTS

1. Base Concept Related Element Purpose or Hypothesis
2. Gravitation (Book Gravitation) Penrose holes, fractal structures Spaces of exotic curvature or gravitational bypass with multi-universal bifurcations

3. Magnetar   Ionic plasma, gravity fractals Natural hyper-concentrated energy source – could power reactors or spacecraft if its structure is replicated
4. Plasma Magnetar structure, containment field   Basis for propulsion, shield, or creation of new space-time
5. Solar Structure Parker Probe   Composites, materials that withstand extreme heat   Basis for building a reactor or spacecraft that approaches a mini black hole without disintegrating
6. Hassan Bimetric Theory Undetectable galaxies, unlocalized structures   Physical realities with rules incompatible with our universe, possible parallel or dissociated universes
7. Merlin D1 (SpaceX thruster) Ion reactor, artificial magnetic field Could be adapted or modified to handle magnetar plasma as nuclear space fuel
8. Frolov, Alcubierre bubble   Superquantum propulsion, algorithms that modulate space metrics   Space-warping technologies that could rely on exotic structures like magnetars or Penrose holes

INVERSE SCENARIOS AND ALTERNATIVE DIMENSIONS

1. Inversion of Galactic Physics: twin galaxy with opposite rules

In this universe, black holes do not collapse but instead inflate regions of space like expanding quantum bubbles. Ion plasma stars replace neutron stars and repel gravity instead of attracting it: they are used to maintain cosmic structures stable without collapsing.

Gravity acts as pressure from outside inward (opposite to ours).
Application: Reactor powered by "expansive antigravity" that can form inverted Penrose tunnels (exit tunnels instead of entry tunnels).

ENGINE STRUCTURES AND EXOTIC PROPULSION SYSTEMS

// Section 3.1 – Jet Engine Design and Internal Flow

Jet engines are internal combustion thermal machines that transform the chemical energy stored in fuel into kinetic energy of a high-speed gas flow. This kinetic output generates thrust, enabling the aircraft to move forward.

Definition:
A thermal engine is any machine that converts chemical or thermal energy into mechanical work. In jet engines, the internal combustion process occurs within the engine, differentiating it from external combustion engines.

Main advantages of jet propulsion over propellers:
- Superior thrust-to-weight ratio.
- Higher efficiency at transonic and supersonic speeds.
- Capability to operate beyond atmospheric layers, provided oxidizer (not just fuel) is onboard.

The following components define the core structure of a jet engine:
1. **Intake Diffuser**: Captures incoming air and reduces its velocity to increase static pressure.

2. **Compressor (Axial/Centrifugal)**: Mechanically compressed air, raising pressure and temperature, powered by the turbine downstream.
3. **Combustion Chamber**: Injects fuel and ignites the air-fuel mixture, producing high-energy exhaust gases.
4. **Turbine**: Extracts kinetic energy from exhaust gases to drive the compressor and other accessories.
5. **Nozzle**: Expels gases at high velocity, converting pressure into additional thrust.

Each stage supports the next, forming a tightly coupled energy chain. Turbomachinery such as axial compressors and turbines dominate due to their efficiency and linear flow alignment.

Supersonic nozzle geometries (convergent-divergent designs) are applied to achieve high Mach outputs.

// Section 3.2 – Ion-Based Stellar Structures and Analogous Propulsion

The architecture of an ion-star, a hypothetical class of celestial object composed of dense, ionized plasma flows, shares analogies with engineered propulsion systems.

Ion stars would theoretically:
- Generate thrust-like radiation via high-velocity ejection of plasma.
- Maintain a layered structure similar to staged compression and release cycles.
- Use magnetic confinement (akin to plasma compressors) to channel ion flows.

Hypothetical Structure:
1. **Ion Diffusion Layer** – Acts like a stellar intake, where interstellar medium is funneled.
2. **Magnetic Compression Fields** – Compress incoming ions via Lorentz forces (analogue to axial compressors).
3. **Fusion Ignition Core** – Combustion analog; initiates energy release through ion fusion.
4. **Plasma Exhaust Jet** – Propels matter at relativistic speeds, echoing the function of a reaction nozzle.

Scientific Implications:
- Ion stars might be candidates for exotic propulsion templates.
- Their plasma dynamics could inform next-gen ion thrusters or magneto-plasma drive systems.
- Such systems blur the line between stellar astrophysics and aerospace engineering.

Figure 3.A – Turbine–Ion Core Analogy
[Insert schematic image comparing jet engine structure vs. theoretical ion-star layers]

The merging of jet propulsion mechanics and stellar plasma dynamics presents a hybrid field: **astrophysical engineering**, where concepts from engine thermodynamics inspire the modeling of high-energy astrophysical bodies.

2. Fractal space with multiple bifurcations
At magnetar scales or higher, space fragments into layers or fractal nodes where gravity does not act linearly but through "jumps."

Each bifurcation generates a reality bubble with slightly different physical laws, some allowing local superluminal speed.

Propulsion algorithms calculate "chains" of bifurcation to navigate between cosmic nodes.

Inspired by: Hassan Bimetric Theory + gravitational fractal structures + Penrose.

3. Superquantum lakes (the inverted lake analogy)
Instead of seeing a hole as something dense, you see it as a "negative density lake."

A magnetar becomes a "reservoir of ionized plasma," where instead of collapsing, it stores exothermic matter states. If introduced within a field created by a Penrose-like fractalized structure, time slows internally, allowing a ship to travel thousands of years in seconds externally.

Narrative or engineering application: A time bubble that you can control from within (a functional version of the Alcubierre drive + Hassan fractal field).
Fusion of Penrose Holes with Magnetar An "energy tunnel self-powered" by an ion plasma star is constructed, generating a Penrose geometry field.

This structure is not visible in our electromagnetic spectrum and therefore does not appear in telescopes like James Webb.
From within, it looks like a floating energy city; from outside, it is only "gravitational background noise."
Inspired by: Ionic magnetar + structures invisible to the spectrum + alien energy.

Alien technology that generates its own physics
Technology that does not rely on our particles but on entities that obey local rules that alter space metrics. What we perceive as dark matter is only the weak projection of a super quantum alien infrastructure that uses physical distortion algorithms to avoid interacting with our universe.

- Design a Python code schematic that simulates Penrose-type structures within a magnetar's electromagnetic field using numerical simplifications.

- Use this as a starting point to write a paper, a novel, or create a new space navigation algorithm.

Models & Structures are:
-Ion stars (magnetar, anionic)
-Gravitational twist visible as spiral fields or curved jets
-Binary propulsion with twisted ion trails

-Penrose-Hole-like structures warping space
-Fractal nebulae representing non-Euclidean space
-Zones of temporal discontinuity as bubbles of distorted light
Alien civilizations or stations connected to these cores
- Discussion limited to asymptotically flat, time-oriented manifolds.
- Aim: (1) define horizons, (2) deduce global geometric properties of horizons,
  (3) prove the second law of black-hole dynamics.
- Time-oriented means each event in spacetime has a continuous choice of future and past light cones.

Definitions of causality:
- $q > p$ ("q precedes p") means a smooth, future-directed timelike curve exists from q to p.
- A causal curve is smooth and never spacelike (timelike, null, or constant).
- $p < q$ ("p causally precedes q") means a future-directed causal curve exists from p to q.
- $J^-(p)$: causal past of p; all events causally preceding p.
- $J^+(p)$: causal future of p; all events causally following p.
- $J^-(S)$, $J^+(S)$: causal past and future of a spacetime region S.
- $j^+(S)$, $j^-(S)$: boundaries of causal future and past of S.
- Future/past and their boundaries defined similarly using "precede" and "follow".

Spacetime and black holes:
- Select an asymptotically flat region ("external universe").
- External universe has future/past timelike infinities, spacelike infinity, future/past null infinities.
- Black holes form by collapse; their surfaces ("future horizons") separate the external universe from black-hole interiors.
- Definition: Union of all future horizons = $j^-(\mathcal{I}^+)$, boundary of domain that sends causal curves to future null infinity.
- Past horizons $j^+(\mathcal{I}^-)$ exist but are of limited astrophysical interest (primordial origin).

Horizons on spacelike slices:
- A spacelike slice intersects $j^-(\mathcal{I}^+)$ in disjoint, closed 2-surfaces — the horizons of black holes at that time.

GLOBAL STRUCTURE OF HORIZONS (Penrose's theorem):
- $j^-(\mathcal{I}^+)$ is generated by null geodesics with no future endpoints.
- Generators are null geodesics lying on $j^-(\mathcal{I}^+)$.
- Generators never leave $j^-(\mathcal{I}^+)$ once entered, except at caustics going into past.
- At caustics, generators may leave $j^-(\mathcal{I}^+)$ entering $J^-(\mathcal{I}^+)$.
- Generators intersect only at caustics.
- Through each non-caustic event passes exactly one generator.

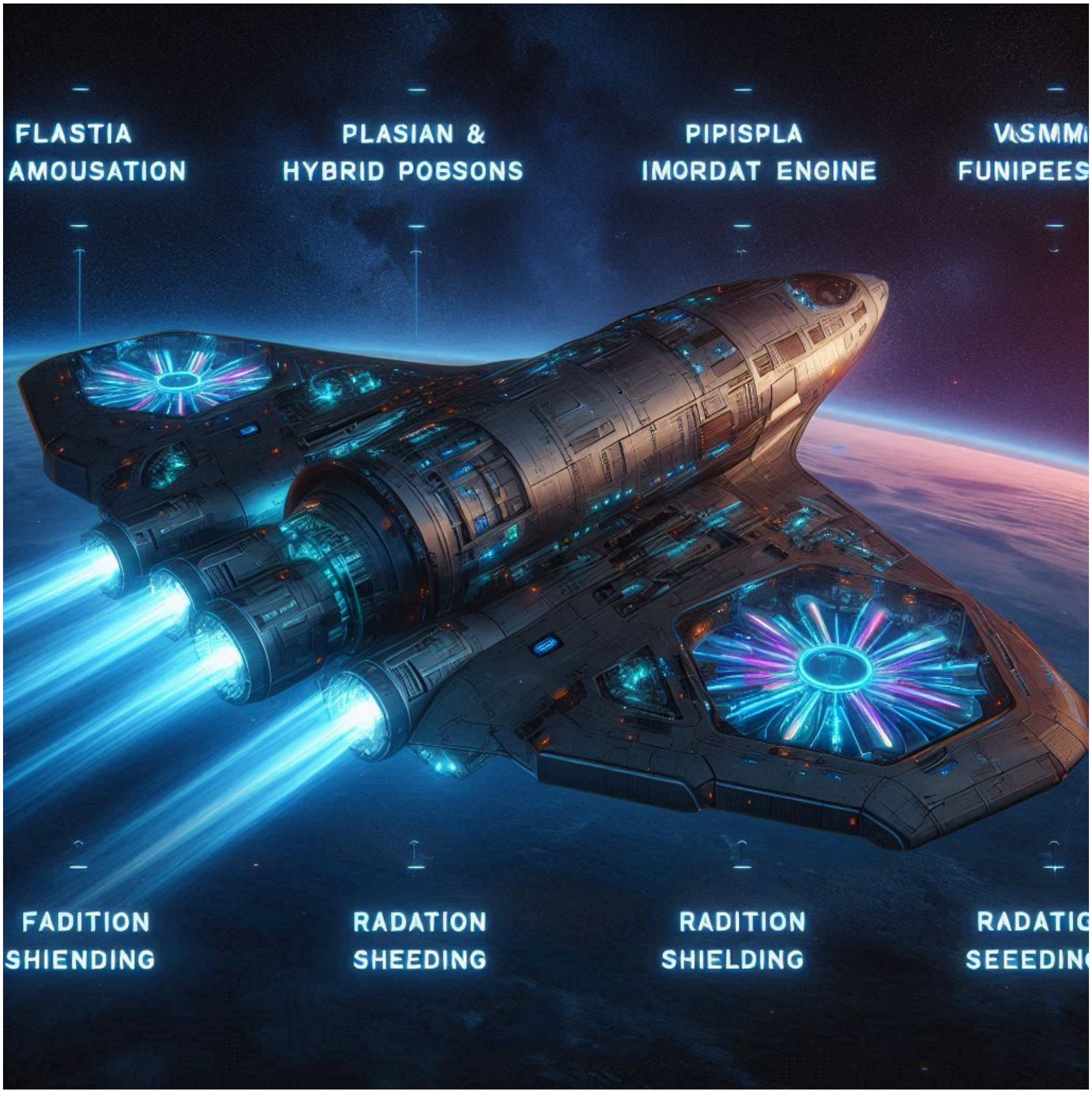
Examples:
- Schwarzschild black hole: generators are radially outgoing photons at horizon radius $r=2M$.
- Kerr-Newman black hole: generators are "barber-pole-twist" null geodesics on the horizon.

Box 34 (Penrose 1968a) Lemma:
- If two causal future-directed curves e1 and e2 join at event q with no timelike segment in union, then e1 and e2 are null geodesics and tangent vectors coincide at q.
- Proof uses topology and local Lorentz frame arguments.

Summary:
- Horizons are generated by non-terminating null geodesics (future horizons).
- The structure is robust, applies to dynamic or static black holes in any asymptotically flat, time-oriented spacetime.

Riemann is convenient for coordinate-free methods, as in the curvature operator M(u, v) above, in the curvature 2-forms (equation 14.19), and for matrix computations (exercise 14.9), The definitions of Ricci and Einstein with the signs adopted above are those that make their eigenvalues (and R [RIJ.IJ](RIJ.IJ).)

$$\boxed{\nabla_u \nabla_u n^\mu = R^\mu_{\ \nu\rho\sigma} u^\nu n^\rho u^\sigma}$$



RIEMANN CURVATURE TENSOR
A. Motivation via Tidal Gravitational Forces

Variables:
u^μ = tangent vector to a geodesic (4-velocity),
n^μ = deviation vector between nearby geodesics.
Compute the relative acceleration between geodesics due to curvature in Python.

1. Begin with second covariant derivative of n^μ along u^μ:

$$\nabla_u \nabla_u n^\mu$$

2. Use commutator identity for covariant derivatives:

$$[\nabla_n, \nabla_u] u^\mu = R^\mu{}_{\nu\rho\sigma} u^\nu n^\rho u^\sigma$$

So we get:

$$\nabla_u \nabla_u n^\mu = R^\mu{}_{\nu\rho\sigma} u^\nu n^\rho u^\sigma$$

=> This is the **Geodesic Deviation Equation**:

$$\text{Relative acceleration} = \nabla_u \nabla_u n^\mu$$
$$= R^\mu{}_{\nu\rho\sigma} u^\nu n^\rho u^\sigma$$

3. Interpretation:
- The term $R^\mu{}_{\nu\rho\sigma}$ represents **spacetime curvature**.
- The expression quantifies how **tidal gravitational forces** cause test particles to accelerate relative to one another.
  Spacetime curvature ⇒ Tidal forces ⇒ Relative acceleration

This motivates the definition:
Riemann(..., C, A, B) = $[\nabla_A, \nabla_B]C$.
[empty slot for inserting a one-form]

B. Failure of this Definition
(2)
1. Definition acceptable only if Riemann(..., C, A, B) is a linear operator, independent of how A, B, C vary from point to point.
2. Check, in part: change variations of C, but not C itself, at event W_0:
   $C_{new}(W) = f(W) \cdot C_{old}(W)$,
   [arbitrary function except $f(W_0) = 1$]
3. Does this change $[\nabla_A, \nabla_B]C$? Yes! Exercise 11.1 shows so.

C. Modified Definition of Riemann:
1. The term causing trouble, $C_{old} \cdot \nabla_{[A,B]}$, can be disposed of by subtracting a "correction term" resembling it from Riemann—i.e., by redefining:
   Riemann(..., C, A, B) ≡ $\mathcal{R}(A, B)C$,
   $\mathcal{R}(A, B) \equiv [\nabla_A, \nabla_B] - \nabla_{[A,B]}$

2. The above calculation then gives a result independent of the "modifying function" f.

D. Is the Modified Definition Compatible with the Equation for Tidal Gravitational Forces?
1. One would like to write:
$\nabla_u \nabla_u n + \text{Riemann}(\ldots, u, n, u) = 0$
2. This works just as well for the modified definition of Riemann as for the original, because:

§11.3. TIDAL FORCES AND RIEMANN TENSOR

$\mathcal{R}(n, u) = [\nabla_n, \nabla_u] - \nabla_{[n, u]} = [\nabla_n, \nabla_u]$,
$\neq 0$ because $n = \partial/\partial\eta$ and $u = \partial/\partial\lambda$ commute

Geodesic deviation and tidal forces cannot distinguish between $\mathcal{R}(n, u)$ and $[\nabla_n, \nabla_u]$, nor, consequently, between the old and new definitions of Riemann.

E. Is the Modified Definition Acceptable?
I.e., is $\text{Riemann}(\ldots, C, A, B) = \mathcal{R}(A, B)C$ a linear operator whose output is independent of how A, B, C vary near the point of evaluation? YES! (See Exercise 11.2.)

Take stock, first, of what is already known about the Riemann curvature tensor:
(1) Riemann is a tensor; despite the appearance of ∇ in its definition (11.9), no derivatives actually act on the input vectors A, B, and C.
(2) Riemann is a (1,3)-tensor; its first slot accepts a 1-form; the others, vectors.
(3) Riemann is determined entirely by ∇, or equivalently by the geodesics of spacetime, or equivalently by spacetime's parallel transport law; nothing but ∇ and the input vectors and 1-form are required to fix Riemann's output.
(4) Riemann produces the tidal gravitational forces that pry geodesics (test-particle trajectories) apart or push them together; i.e., it characterizes the "curvature of spacetime":
$\nabla_u \nabla_u n + \text{Riemann}(\ldots, u, n, u) = 0$ (11.10)

(This "equation of geodesic deviation" follows from equations 11.6, 11.8, and 11.9, and the relation $[n, u] = 0$.)

All these facets of Riemann are pictorial (e.g., geodesic deviation; see Boxes 11.2 and 11.3) or abstract (e.g., equations 11.8 and 11.9 for Riemann in terms of ∇).
Riemann's component facet (11.11) is related to the component form of ∇ by the following equation, valid in any coordinate basis $\{e_\alpha\} = \{\partial/\partial x^\alpha\}$:
(11.12)

(See Exercise 11.3 for derivation, and Exercise 11.4 for the extension to non-coordinate bases.)
These components of Riemann, with no sign of any derivative operator anywhere,

may leave one with a better feeling in one's stomach than the definition.