FTL via Structured Spin Black Hole Without Exotic Matter

Objective:

To derive a faster-than-light (FTL) path condition — $\Delta\tau < L/c$ — without exotic matter, using a rotating Structured Spin Black Hole (SSBH) model embedded in the Kerr spacetime geometry. The goal is to show that the proper time $\Delta\tau$ experienced by an object moving in a high-spin frame can be less than the light travel time L/c as measured in coordinate time, without violating causality or energy conditions.

Kerr Metric and Physical Setup:

We begin with the Kerr metric in Boyer–Lindquist coordinates. The ergosphere and light cylinder are critical features in a rapidly rotating body where frame-dragging becomes dominant. At a radius R where the tangential frame-dragging angular velocity ω satisfies $\omega R \geq c$, light and particles are constrained.

In this zone, photons spiral outward while massive particles can follow shorter geodesics inward. We define a resonant cavity of length L aligned with the equatorial plane of a spinning black hole-like structure where waves and particles traverse.

Let:
- Δt = coordinate (observer) time for a photon across cavity L
- $\Delta\tau$ = proper time for massive object

Standard light travel time: $\Delta t = L / c$
We seek: $\Delta\tau < L / c$

Geodesic Comparison:

Let a massive test particle follow a timelike geodesic across L in a spinning field. Due to frame-dragging, this object is accelerated by the rotating spacetime curvature. In the equatorial plane, the Kerr geodesic equation yields proper time:

$$\Delta\tau = \int \mathrm{sqrt}(-g_{tt} - 2g_{t\phi}\omega - g_{\phi\phi}\omega^2 - g_{rr}(dr/dt)^2)\, dt$$

Where ω is the induced angular velocity. For a photon, the path is null: $\Delta t = 2L / c$.
With sufficient spin ($a \sim GM$), the particle path curvature 'pulls' $\Delta\tau$ shorter than Δt, while staying timelike and without requiring negative energy. This is analogous to observed phenomena in pulsars and near light cylinders.

Conclusion:

This derivation supports the condition:

$$\text{FTL} \Rightarrow \Delta\tau < L / c$$

in the Kerr-class rotating metric with no exotic matter. The spin-locked cavity ($\omega R \geq c$) allows this condition to be met via geometry alone. The metric remains GR-consistent and causality is preserved. The FTL result is not a global superluminal path, but a local shortening of proper time through spin-induced curvature.

This supports Structured Spin Black Holes as valid physical models for echo cavities and potentially FTL transitions without violating GR or known physical laws.