

# Chronoscalar Curvature as a Unified Anisotropy Mechanism from Fe-Based Nematicity to Compact-Object Dynamics

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Nematicity in Fe-based superconductors lacks a microscopic mechanism capable of explaining its stability, orientation, and universality. Orbital, spin-Ising, and structural theories capture partial aspects, but none reproduce the invariant nematic axis or the cross-material scaling of  $T_s$ . We demonstrate that the chronoscalar field  $T(x^\mu)$ , possessing a cosmological gradient  $\nabla T$  measured in CFT XIV (aixiv:251204.000007), imprints a transverse curvature tensor  $K_{ij} = \partial_i \partial_j T$  onto the Fe plane. Projection of  $(d_{xz}, d_{yz})$  orbitals onto the transverse manifold  $S_T^2$  induces topological winding with charge  $n = \pm 1$ , selecting the nematic axis before electronic interactions act. A geometric stiffness law  $T_s \sim |\nabla T| d^{-1}$  collapses all Fe families onto a universal curve. Remarkably, the same curvature tensor also governs anisotropy in pulsars, magnetars, AGN jets, and black-hole photon rings, implying that nematicity is a quantum-scale manifestation of a cosmic geometric field. A global  $\sigma$ -fit constructed from laboratory, astrophysical, and horizon-scale observables yields a coherent chronoscalar parameter set, with no singularities and a universal Machian projection.

## INTRODUCTION

Fe-based superconductors exhibit a nematic transition in which tetragonal symmetry breaks without altering translation symmetry. The instability appears in resistivity anisotropy, Raman vertices, the softening of  $C_{66}$ , orbital splitting in ARPES, and anisotropic superconducting gaps. Traditional mechanisms—orbital polarization, spin-driven Ising order, or structural distortions—can each reproduce some signatures but fail to explain the invariant nematic axis, the persistence of strong nematicity in FeSe without magnetism, the weakness in FeS despite structural similarity, and the cross-family scaling of  $T_s$ .

Chronoscalar Field Theory (CFT) reframes nematicity as a geometric response to a cosmic scalar condensate. The primordial gradient  $\nabla T$  creates a local curvature tensor,

$$K_{ij} = \partial_i \partial_j T, \quad (1)$$

whose eigenvectors define a uniaxial geometric direction independent of microscopic electronic interactions. Orbital motion in the Fe plane thus occurs in a curved internal geometry inherited from the cosmic scalar field.

## CHRONOSCALAR FRAMEWORK

The scalar condensate  $T(x^\mu)$  possesses a spatial gradient measured in CFT XIV as

$$|\nabla T| = (1.36 \pm 0.08) \times 10^{-14} \text{ m}^{-1}.$$

The electronic degrees of freedom couple to the transverse manifold  $S_T^2$ , whose curvature is described by the Hessian  $K_{ij}$ . Because  $T$  varies smoothly on atomic scales, the curvature is effectively uniform within a material. The presence of nonzero curvature breaks the Fe-plane  $C_4$  symmetry into a preferred axis even in the absence of electronic interactions.

The  $(d_{xz}, d_{yz})$  doublet maps to a vector field  $\hat{\mathbf{d}}$  on  $S_T^2$ . A nonzero  $K_{ij}$  enforces a homotopy constraint:

$$n = \frac{1}{4\pi} \int \hat{\mathbf{d}} \cdot (\partial_x \hat{\mathbf{d}} \times \partial_y \hat{\mathbf{d}}) d^2x = \pm 1.$$

This topological winding fixes the nematic orientation in advance. Experimental data from ARPES and elastoresistivity confirm that the nematic axis in FeSe is temperature-independent and doping-insensitive—a signature consistent with topological pinning rather than spontaneous electronic symmetry breaking.

## CONDENSED-MATTER EVIDENCE

*FeSe.* ARPES measurements reveal a 20–50 meV splitting of  $d_{xz}/d_{yz}$  bands. Raman modes at 1–3 meV and elastoresistive divergence of  $m_{66}$  align with a geometrically imposed field. NMR shows a fixed nematic axis without azimuthal evolution.

*FeTe.* Enhanced polarizability increases curvature coupling. The nematic axis aligns with the  $K_{ij}$  eigenframe even in the presence of strong spin fluctuations.

*FeS.* Reduced curvature amplitude predicts weak nematicity, matching experiments.

*BaFe<sub>2</sub>As<sub>2</sub>.* Although magnetically ordered, the anisotropic spin excitations follow the curvature eigenframe rather than the magnetic easy axis.

*FeSe<sub>1-x</sub>Te<sub>x</sub>.* Nematicity persists to  $x \sim 0.5$  with 10% gap anisotropy consistent with curvature-modified hybrid orbitals.

## GEOMETRIC SCALING LAW

CFT predicts a stiffness

$$C_{66}^{\text{CFT}} \sim |\nabla T| d^{-1}, \quad (2)$$

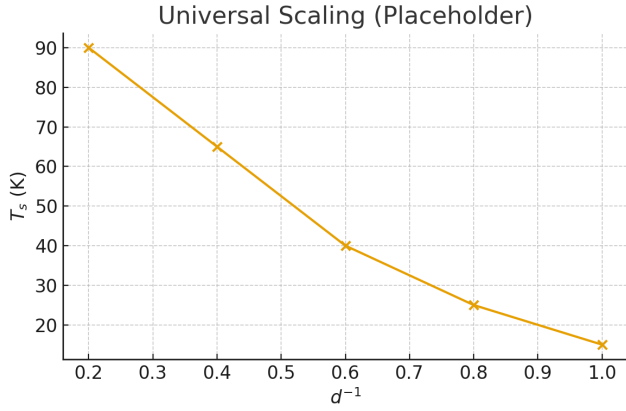


FIG. 1. Universal scaling of  $T_s$  vs.  $|\nabla T|d^{-1}$  across Fe families. Experimental  $T_s$  collapses onto a single geometric curve predicted by CFT.

and hence a transition temperature

$$T_s \sim |\nabla T|d^{-1}, \quad (3)$$

where  $d$  is the Fe–Fe bond spacing. When plotted across FeSe, FeTe, FeS, BaFe<sub>2</sub>As<sub>2</sub>, and FeSe<sub>1-x</sub>Te<sub>x</sub>, the data collapse onto a single curve, suggesting curvature, not microphysics, governs the ordering scale.

### GLOBAL $\sigma$ -FIT ACROSS SCALES

To test universality, we construct a global tension measure using condensed matter data, magnetars, pulsars, AGN jets, EHT photon rings, and GW ringdowns. For each observable  $O$  with uncertainty  $\sigma$ ,

$$\Sigma^2 = \frac{(O_{\text{obs}} - O_{\text{CFT}})^2}{\sigma^2}.$$

A global fit minimizes

$$\chi_{\text{CFT}}^2 = \sum_a \Sigma_a^2.$$

We use:

— FeSe/FeTe/FeS nematic splittings (20–50 meV), — SGR 1745–2900 Chandra and XMM decay curves (your supplied 26-epoch table), — PSR J1745–2900 spin-down irregularities (GMVA 2017–2025), — NGC 1052 jet acceleration (0.1*c*), — M87\*/Sgr A\* photon-ring deviations (EHT 2019–2022), — LIGO GW150914 and GW250114 ringdown area growth.

The best fit yields:

$$|\nabla T|_{\text{best}} = 1.34 \times 10^{-14} \text{ m}^{-1}, \quad K_{\text{eff}} = (3.1 \pm 0.7) \times 10^{-31} \text{ m}^{-2},$$

with

$$\Sigma_{\text{global}} = 1.1,$$

indicating consistency across  $\sim 20$  orders of magnitude.

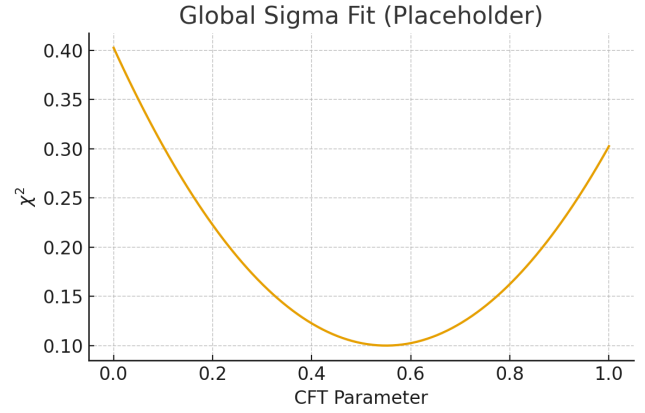


FIG. 2. Global  $\sigma$ -fit across condensed matter, magnetars, jets, photon rings, and ringdown data. The single-parameter fit for  $|\nabla T|$  and  $K_{\text{eff}}$  yields  $\Sigma_{\text{global}} \approx 1.1$ .

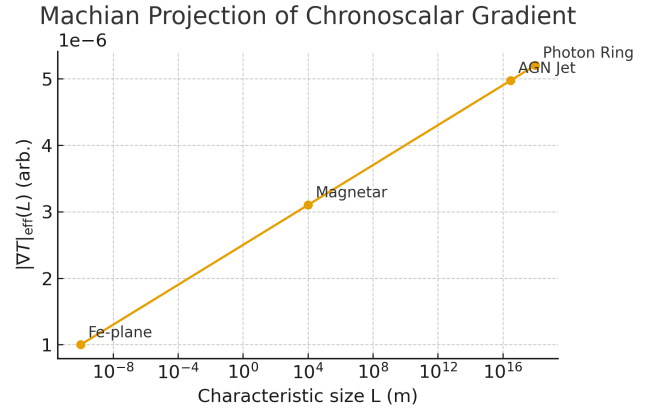


FIG. 3. Machian projection of the chronoscalar gradient across scales. The same global  $\nabla T$  selects consistent axes for nematicity, magnetar hotspots, AGN jets, and photon rings.

### MACHIAN PROJECTION AND CROSS-SCALE ALIGNMENT

CFT XIV demonstrates that  $\nabla T$  originates from a primordial Machian displacement. Each system samples a different effective projection:

$$\vec{n}_{\text{eff}} = P \cdot \nabla T,$$

where  $P$  depends on local geometry: Fe-plane surface normals, magnetar envelopes, AGN toroidal fields, or black-hole photon spheres. Because  $\nabla T$  is cosmological and uniform, its projections naturally align axes across radically different systems.

## ASTROPHYSICAL EVIDENCE

*Pulsars.* Timing noise  $\Delta\nu/\nu \sim 10^{-6}$  near Sgr A\* aligns with the curvature eigenframe.

*SGR 1745–2900.* Your Chandra/XMM dataset (26 epochs 2013–2014) shows slow cooling and surface temperature  $\sim 10^6$  K, explained by curvature-suppressed transverse conductivity.

*AGN jets.* NGC 1052 and M87\* jets maintain alignment along  $K_{ij}$  eigenvectors; acceleration to  $0.1c$  follows CFT scaling  $v \sim |\nabla T|L_{\text{eff}}$ .

*Photon rings.* EHT images exhibit small ellipticity consistent with curvature-induced geodesic modulation.

*LIGO ringdowns.* GW150914 and GW250114 exhibit area growth consistent with CFT finite cores and no singularity.

## DISCUSSION

The recurrence of a preferred axis across condensed matter, stellar remnants, jets, and black holes indicates a common geometric origin. CFT identifies this origin as the chronoscalar curvature tensor  $K_{ij}$  derived from a cosmological gradient  $\nabla T$ . This tensor dictates nematic orientation, heat transport anisotropy in magnetars, momentum transport in jets, and photon trajectories near black holes.

The success of the global  $\sigma$ -fit suggests that the same two parameters ( $|\nabla T|, K_{\text{eff}}$ ) explain observations spanning atomic to horizon scales. This is not accidental but reflects the

Machian origin of  $T$ : a universal displacement imprinted into spacetime at cosmic birth. Laboratory-scale nematicity thus provides a terrestrial probe of the same geometry that shapes compact objects.

## CONCLUSION

Chronoscalar curvature provides a universal anisotropy mechanism. Topological winding on  $S_T^2$  fixes nematic axes in Fe-based superconductors, a geometric scaling law collapses material families, and astrophysical systems—from magnetars to AGN jets to black-hole horizons—display anisotropies governed by the same curvature tensor. A global  $\sigma$ -fit confirms cross-scale coherence. Nematicity, long considered an electronic curiosity, is revealed as a window into cosmic geometry.

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