STARSHIP'S HOLOGRAPHIC AU DRIVE: DESIGN DETAILS

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Date: February 08, 2026

OPERATING PRINCIPLE

The holographic AU drive (Acta Universi-drive) is based on active modulation of the correlation tensor of the AU field-the quantum correlation structure of the vacuum, which is considered as a microscopic manifestation of dark energy in the framework of the holographic principle.

Fundamental equation of the AU field density

ρAU(x)=3c2MPl2 · 1Lcorr2(x) · Φ(Cμν(x))\rho_{\text{AU}}(x) = 3 c^2 M_{\text{Pl}}^2 \cdot \frac{1}{L_{\text{corr}}^2(x)} \cdot \Phi\bigl(C_{\mu\nu}(x)\bigr)ρAU(x)=3c2MPl2 · Lcorr2(x)1 · Φ(Cμν(x))

where:

- MPl M_{\text{Pl}} MPl — reduced Planck mass
- Lcorr(x) L_{\text{corr}}(x) Lcorr(x) — local correlation length (IR-cutoff)
- Φ(C)=1+δC+12β(δC)2+… \Phi(C) = 1 + \delta C + \frac{1}{2} \beta (\delta C)^2 + \ dots Φ(C)=1+δC+21β(δC) 2+... - nonlinear modulation function

Dynamic equation for the evolution of the correlation tensor

□Cμν+m2Cμν=λ Πμναβ(δSholoδCαβ)\Box C_{\mu\nu} + m^2 C_{\mu\nu} = \lambda \, \Pi_{\mu\nu}^{\alpha\beta} \left(\frac{\delta S_{\text{holo}}}{\delta C_{\alpha\beta}} \right)□Cμν+m2Cμν =λΠμναβ(δCαβδSholo)

Scientific link to existing holographic dark energy (HDE)models

The AU field is an engineering implementation of ideas that develop holographic dark energy models.

Key works and data for 2024-2025

- Li et al. (arXiv: 2411.08639, EPJC 2025 — - "Revisiting holographic dark energy after DESI 2024" Conclusion: interacting HDE (IHDE) with c>1 c > 1 c>1 agrees better with the combination of DESI BAO + SN Ia + CMB than standard HDE. The equation of state w w w does not intersect -1 at the level of 1σ.
- arXiv: 2412.09064 (JCAP 07 2025) - classification of HDES into four categories:
    1. alternative scales,
    2. advanced hubble scale,
    3. interacting models (IHDE),
    4. models with modified entropy (Tsallis, Barrow HDE).
- Other relevant areas: interacting Barrow HDE, generalized / Rényi HDE, models with particle creation.

The relation of the AU drive to HDE

In HDE/IHDE cosmology describes the passive acceleration of the universe.

In the AU drive, the correlation tensor is actively modulated locally with a resolution of 1012 elements and a frequency of 10^6 Hz. The parametric instability in the resonator corresponds to the interaction of the dark sector in IHDE. Capturing and amplifying vacuum fluctuations turns the cosmological field into a source of energy and thrust.

STRUCTURAL SECTIONS

1. DRIVE CORE (AU-CORE)

1.1. Correlation resonator

- Material: single crystal of diamond with NV centers (10^9 cm-3)
- Dimensions: Ø1 m × 2 m, weight 3500 kg
- Temperature: 10 mK (helium-3/4)
- Superconducting winding: MGB_2 (T_c = 45 K)
- Parameters: 1-1000 GHz, Q > 101^0, T_2 > 100 s

1.2. Quantum control processor

- 1000 superconducting qubits, 10 GHz, error < 10^{-5}
- Algorithms: quantum tomography, pattern optimization, surface code, RL navigation

1.3. Holographic projector

- 1012 correlation elements, 10^6 frames / s
- MEMS mirrors, LCD modulators, acousto-optic deflectors, quantum dots

2. POWER

SYSTEM 2.1. AU reactor-correlation capacitor, 1 GW peak / 100 MW average

2.2. Storage devices-graphene supercapacitors + superconducting magnets

3. MANAGEMENT SYSTEM

3.1. Neuro-AU interface-101^0 biological + 1012 artificial neurons

3.2. Navigation-AU-gradiometers, quantum gyroscopes, holographic lidars

MATERIALS SCIENCE SOLUTIONS

Component	Material	Properties	Reason for choice	HDE/AU
coupling Resonator housing	Carbon nanotubes in a diamond matrix	150 GPa, λ = 5000 W / m·K	Strength + thermal conductivity	Thermal noise minimization
Superconducting windings	MGB_2 with nanoinclusions	T_c = 45 K, J_c = 10 A A / cm2	High critical temperature	Resonance stability
Isolation	Graphene aerogel + vacuum	λ_eff = 10^{-4} W/m·K	Record low thermal conductivity	Maintaining a 10 mK
Window for the AU field	Diamond single crystal with NV centers	Transparency >99.9 %, Δn < 10^{-6}	Optical uniformity	Direct tensor modulation

PHYSICAL PARAMETERS AND CALCULATIONS

Output power

Pout=η · Gtotal · (∫ρvac dV) · (ΔCC0) · fmodP_{\text{out}} = \eta \cdot G_{\text{total}} \cdot \left(\int \rho_{\text{vac}} \, dV \right) \cdot \left(\frac{\Delta C}{C_0} \right) \cdot f_{\text{mod}}Pout=η · Gtotal · (∫ρvacdV) · (C0ΔC) · fmod

At n = 0.4, G_total ≈ 1021, V = 1.57 m3, $\Delta C/c_0 = 0.1$ → **P_out ≈ 628 MW**

Traction force

F=α · mres · Lcorr · (dCdt) · kF = \alpha \cdot m_{\text{res}} \cdot L_{\text{corr}} \cdot \left(\frac{dC}{dt} \right) \cdot kF=α · mres · Lcorr · (dtdC) · k

Examples:

Mode	DC/DT mode (s-1)	F (N)	Acceleration (1000 t)
Maneuver	103	3.5×10^6	0.0035 g
Cruising	10^5	3.5×10^8	0.35 g
Maximum	10^6	3.5×10^9	3.5 g
Extreme	10^7	3.5×10^{10}	g 35

ADVANCED RISK ANALYSIS

Heat load

Qheat=Ppump×(1−η)Q_{\text{heat}} = P_{\text{pump}} \times (1 - \eta)Qheat=Ppump×(1−η)

At P_pump = 5 MW, N = 0.99999 → Q_heat ≈ 50 W
Cooling power at 10 mK: 10-50 MKW → 10^5–10^6 times excess

Decoherence

Galactic cosmic rays: 7800-31 000 beats / s per resonator
Without protection: Γ ≈ 10-100 s-1
With protection + surface code: possible reduction to < 0.01 s-1

Design and construction risks

Risk	Stage	Probability	Severity	Main Countermeasures
Uncertainty models HDE / AU	Design	40-60 %	High	Parallel modeling of variants
NV resonator scaling	Production	70-85 %	Critical	Step-by-step size increase
Nanofabrication accuracy	Production	30-50 %	High	Redundant processes + AI control
Cryogenic assembly	Design	65-80 %	Critical	Pulse mode, multi-stage cooling
Integration errors	Assembly	50-70 %	High	N+2 redundancy, quantum tomography
Budget/deadline exceeded	All Phases	~70 %	High	Milestone-reports, Phased funding

STARSHIP INTEGRATION

- Module length: 50 m, diameter: 10 m, weight: ~50 t

- Location: center of mass, 10 isolation levels

DEVELOPMENT STAGES (briefly)

- Phase 0: 2025-2030-Models, simulations, prototypes
- Phase 1: 2030-2040-Components (1:10)
- Phase 2: 2040-2050-Full-scale prototype
- Phase 3: 2050-2060-Orbital testing
- Phase 4: 2060+ - Manned missions

FINAL CONCEPT

The holographic AU drive is an attempt to translate the fundamental ideas of holographic dark energy from cosmology into practical interstellar propulsion technology.
The technology is extremely ambitious and faces serious physical, materials science and engineering challenges.
Nevertheless, it remains one of the most consistent and detailed concepts of non-reactive drive based on modern (or close to modern) physical concepts.