The Janus State

A "quantum of quantum" route to ultra-ordered light

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Abstract. The *Janus state* coherently superposes (quantum) two squeezed vacua (quantum) in contrast to cat states where one superposes (quantum) two coherent states ("classical"). Interference between the components converts superbunching into highly ordered light. Our exact theory shows strong photon antibunching ($g^{(2)}(0) \to 1/2$) together with complete suppression of higher-order correlations ($g^{(k\geq 3)}(0) \to 0$).

Vision: establish Janus states as tunable non-Gaussian ancillae for fault-tolerant continuous-variable gate teleportation, sensing, and quantum networking.

Key discoveries

- **Emergent photon antibunching:** interference flips bunching to strong antibunching with a universal lower bound $g^{(2)}(0) = \frac{1}{2}$.
- **Higher-order switching:** complete suppression of multiphoton events ($g^{(k\geq 3)} \to 0$) while $g^{(2)}$ remains finite.
- **New analytics:** Introducing *Squeezed Polynomials*, and *Generalized Squeezed Polynomials*.

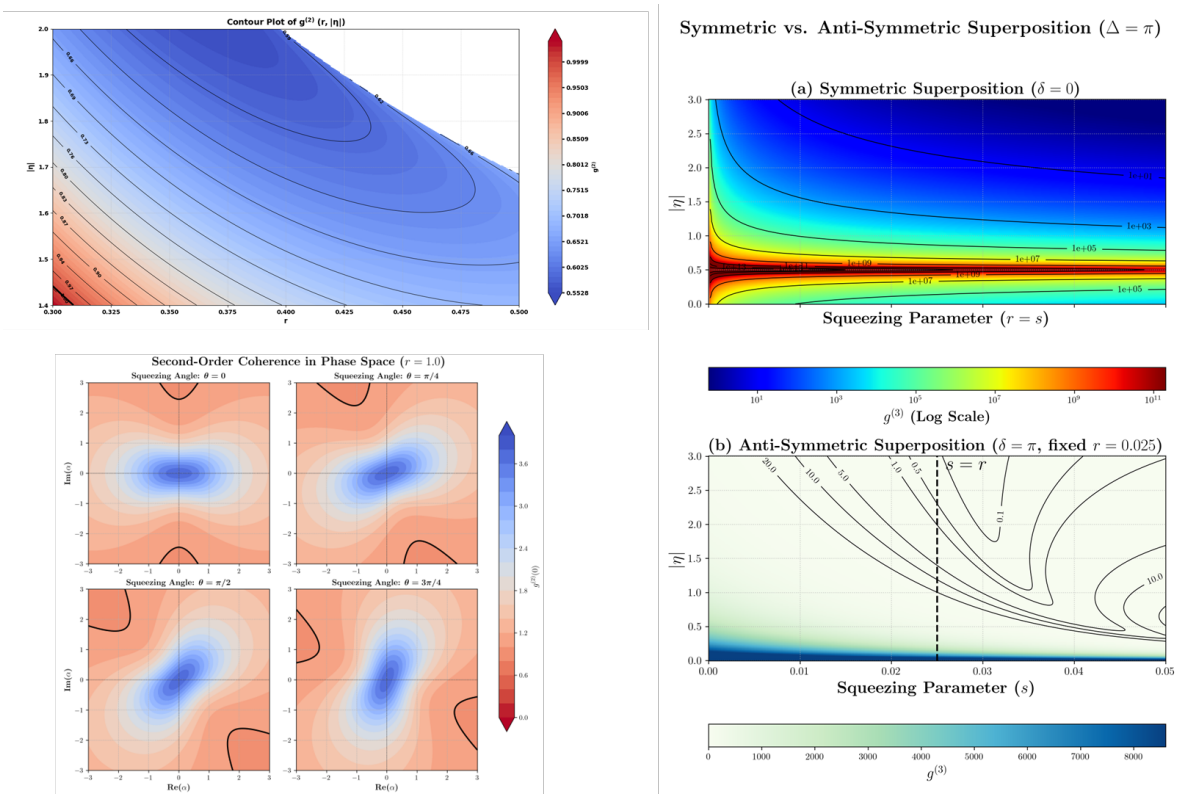

Figure 1: **Janus-state coherence overview.** Left: $g^{(2)}(0)$ landscape versus squeezing amplitude r and relative displacement $|\eta|$, revealing a broad antibunching valley and sweet-spot region. Bottom-left: phase-space maps of $g^{(2)}(0)$ at fixed $r = 1$ for squeezing angles $\theta = 0, \pi/4, \pi/2, 3\pi/4$, showing rotation of antibunching lobes. Right: $g^{(3)}$ for (a) symmetric superposition ($\delta = 0$, log scale) and (b) anti-symmetric superposition ($\delta = \pi$) at fixed $r = 0.025$; contours highlight phase-controlled suppression.

References

[1] A. Azizi, *Photon Antibunching from Superposed Squeezed Vacua via Quantum Interference*, arXiv:2506.06397 (2025).

[2] A. Azizi, *Complementarity ad Infinitum: A Hierarchy of Higher-Order Coherences in Janus States*, arXiv:2507.15890 (2025).

[3] A. Azizi, *Displaced Janus States and Generalized Squeezing Polynomials: Closed-form $g^{(k)}$, Wigner Negativity, and Quantum Fisher Information*, arXiv:2508.09234 (2025).