

Squeezed states of waveguided sources with varying brightnesses are partially distinguishable

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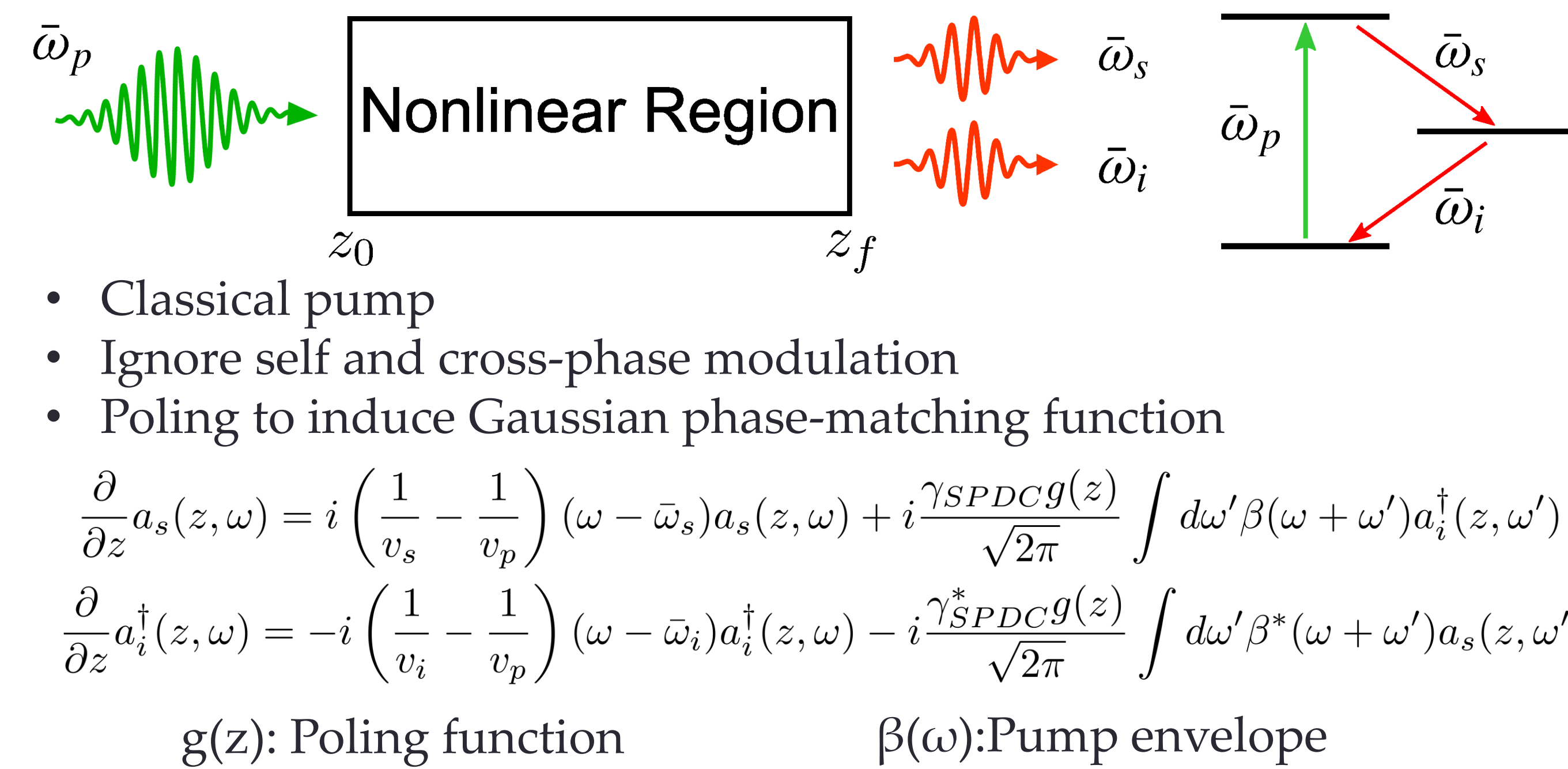
MOTIVATIONS

Recent Gaussian Boson Sampling experiments have set out to prove quantum computational advantage using squeezed light sources with mean number of photons ranging from $\langle N_S \rangle \sim 3$ to $\langle N_S \rangle \sim 10$.

We provide a physical mechanism to explain partial distinguishability as well as variations in mean photon number by investigate the temporal mode structure of squeezed light generated by :

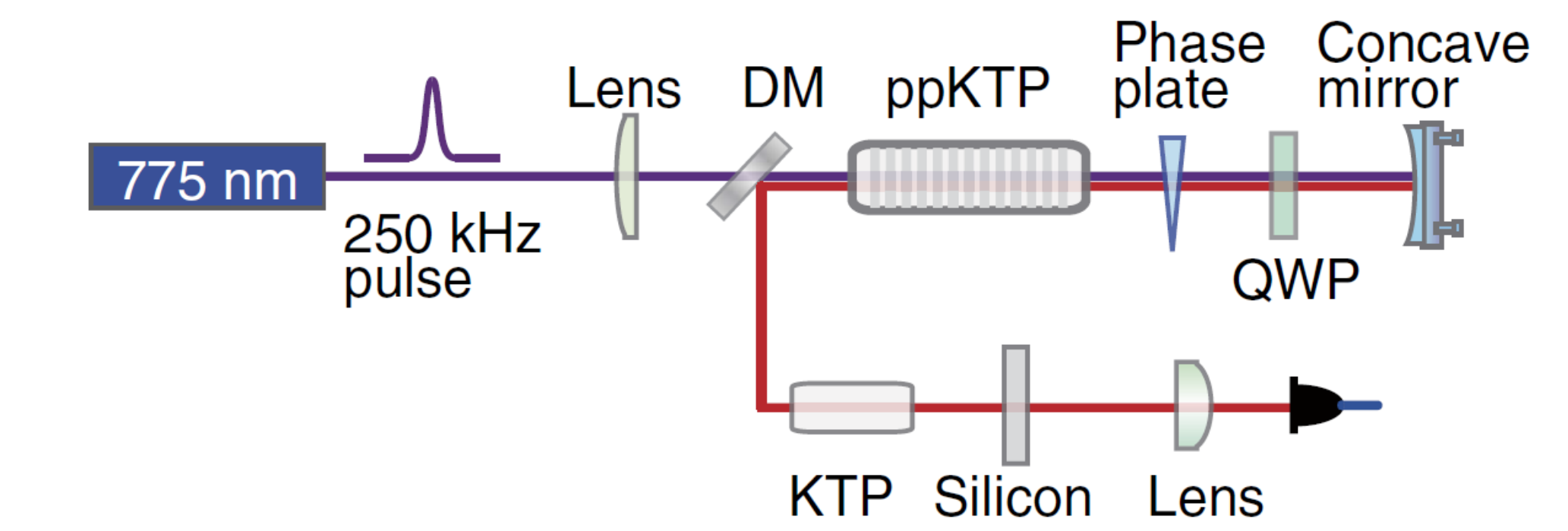
- Identical χ^2 nonlinear crystals.
- Identical pump profiles.
- Varying pump intensities.

MODEL: TWIN BEAM GENERATION IN WAVEGUIDES



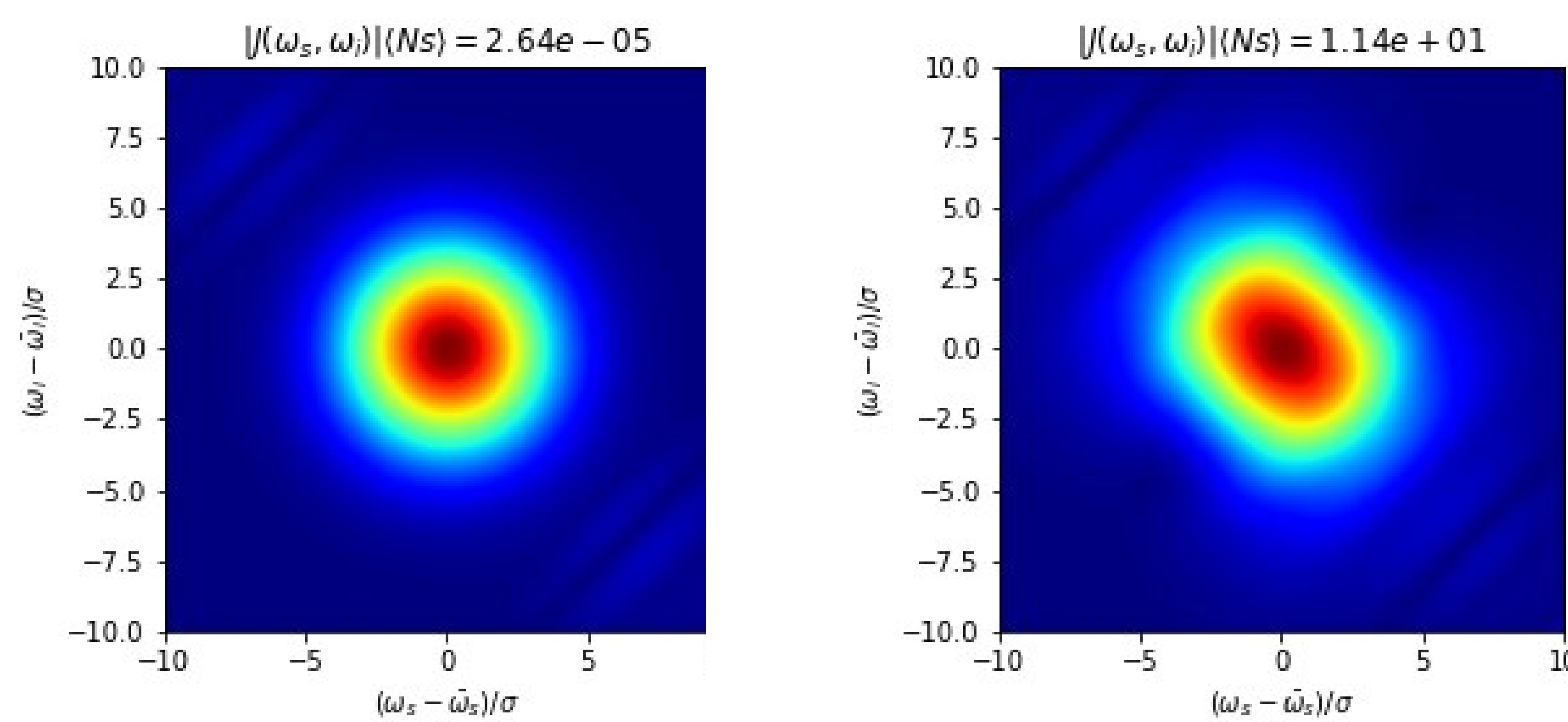
EXPERIMENTAL REALIZATION

- PPKTP Crystals
- Gaussian Boson Sampling Experiments

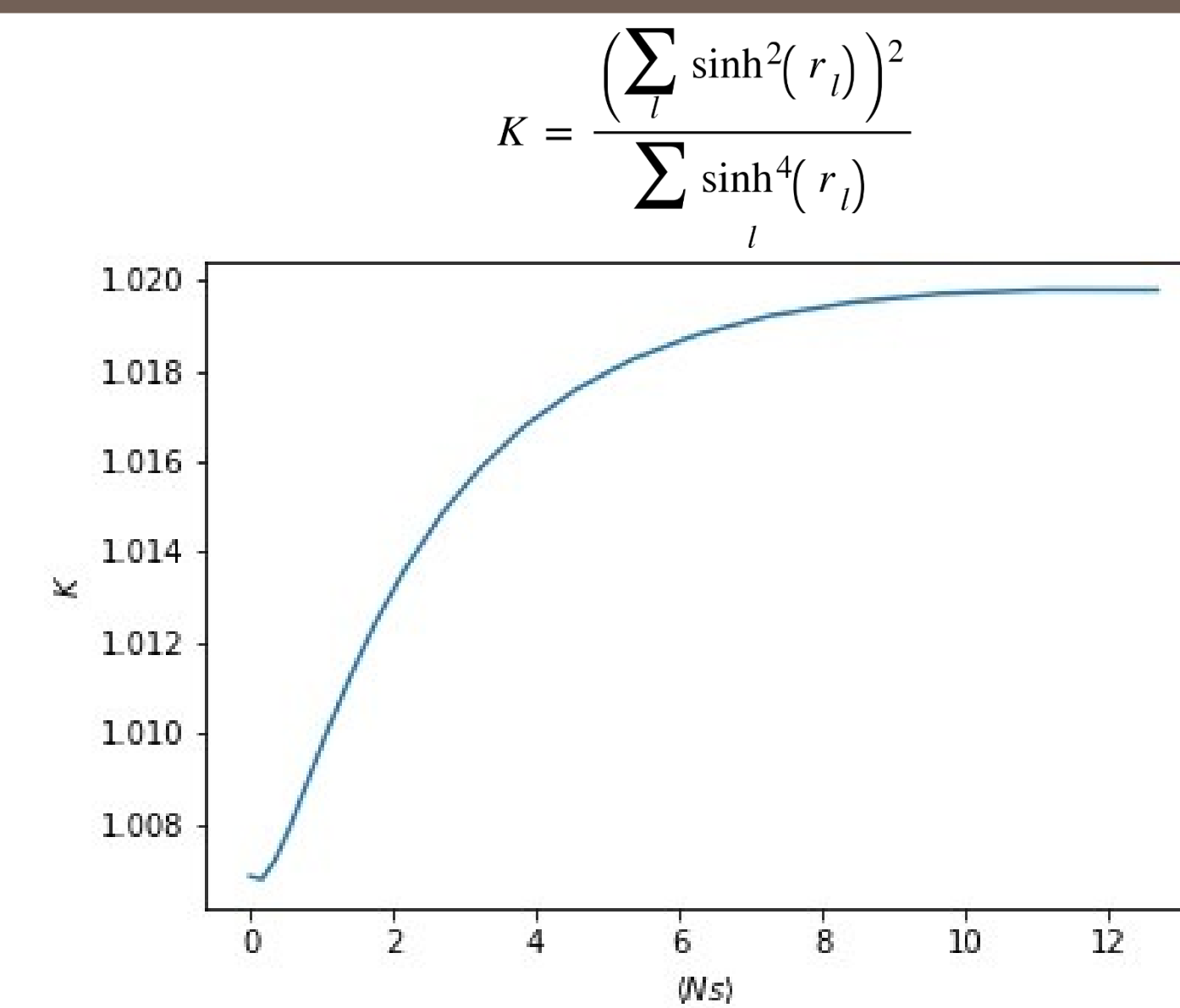


Han-Sen Zhong et al., Phys.Rev.Lett. 127. 180502 (2021)

JOINT SPECTRAL AMPLITUDE AND SPECTRAL PURITY



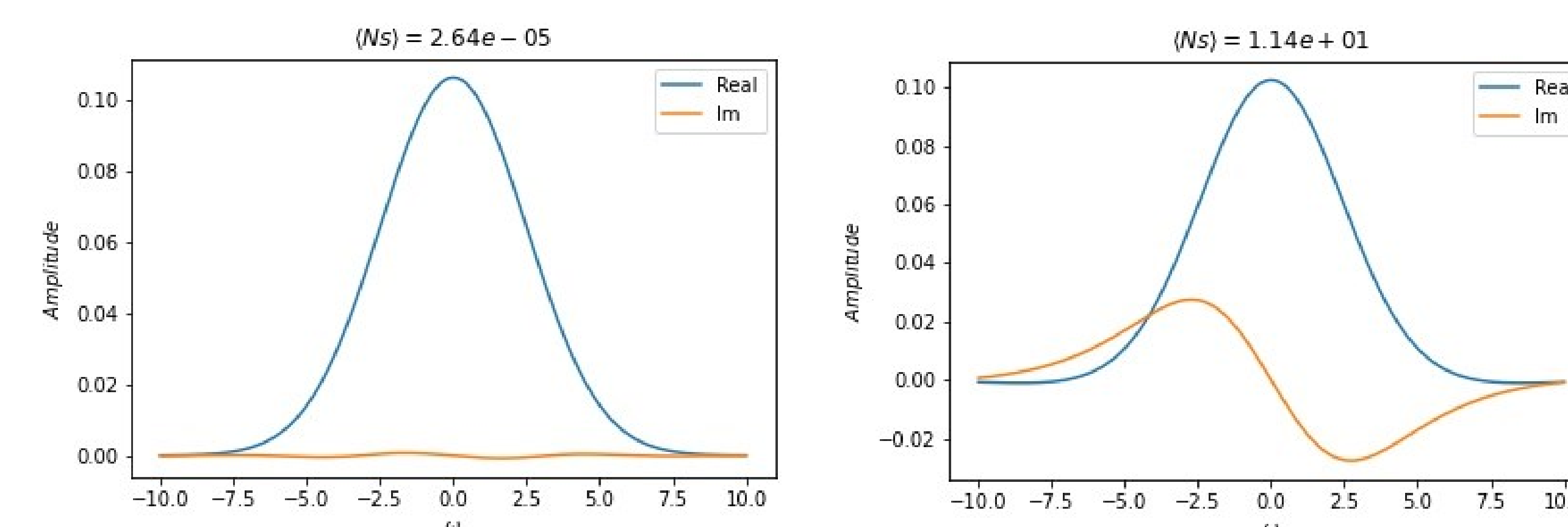
- Gain increases frequency correlations.
- Decrease in Spectral Purity



- Schmidt number increases with gain.
- Decrease in spectral purity.
- Still very close to unity.

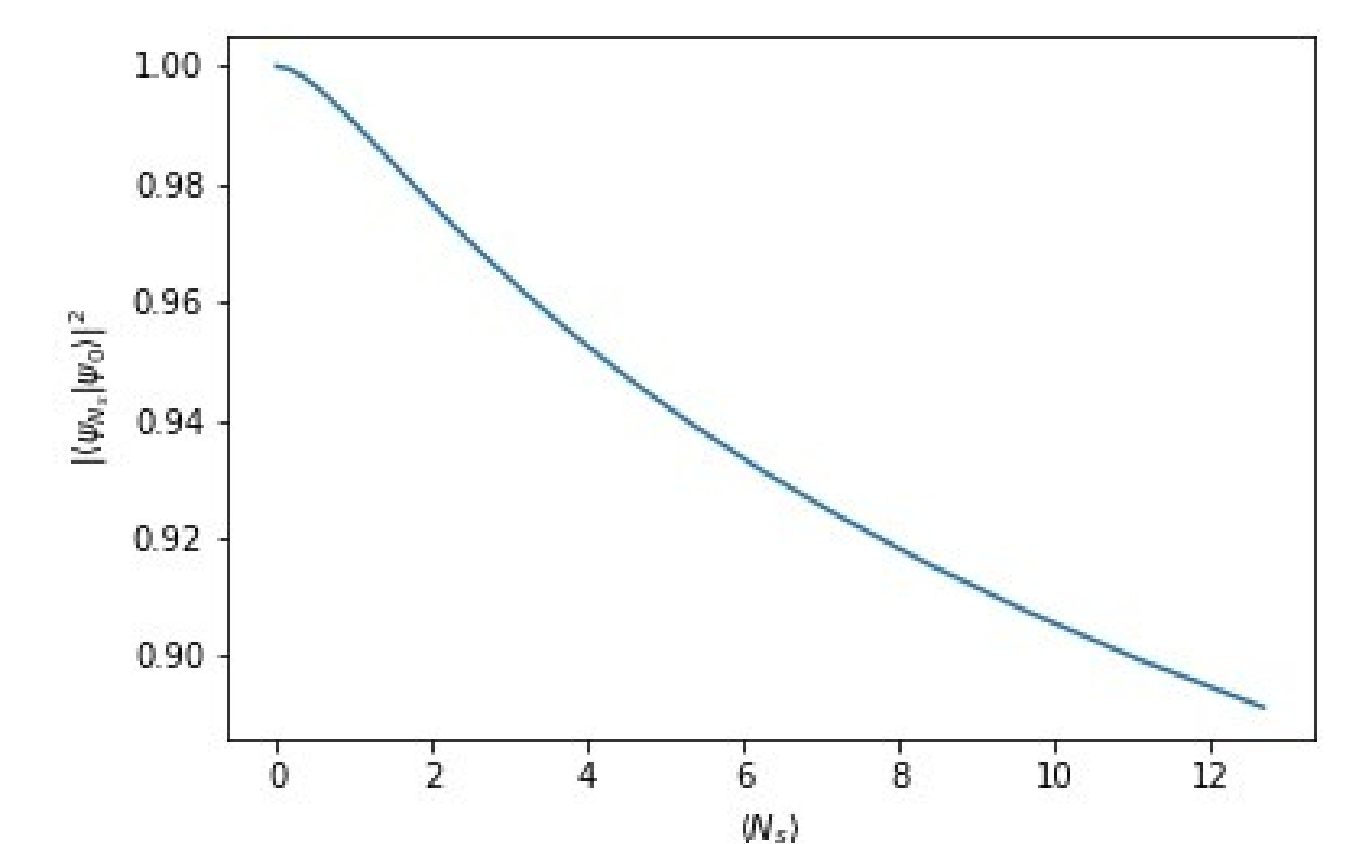
TEMPORAL MODE STRUCTURE AND FIDELITY

Temporal modes at different brightnesses



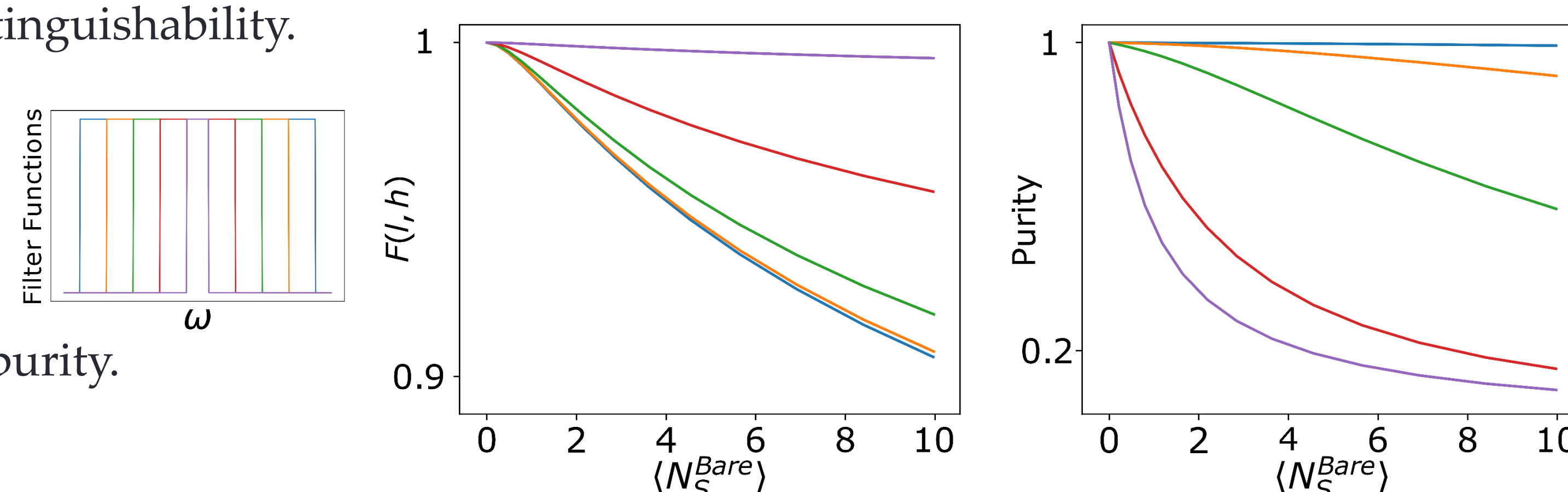
- Temporal modes at different brightnesses can differ greatly.
- Fidelity between temporal modes of different brightness < 1 .
- States are distinguishable.

Fidelity between low gain and successively higher gain modes



FILTERING AND PURITY

- Commonly used to decrease distinguishability.
- Increases Fidelity.
- Adds mixedness and decreases purity.
- Brighter modes incur greater purity loss.



CONCLUSIONS AND OUTLOOKS

- Varying pump intensities lead to temporal phase mismatch and partial distinguishability
- Filtering decreases distinguishability at the cost of decreasing purity.
- Considered only a single pass through crystal.
- How are the outcomes modified with double or multiple passes?