WARP · Warsaw AstRo-Physics meeting

Cosmology with quasars in KiDS

Photometric-redshift uncertainties of quasars

Szymon J. Nakoneczny

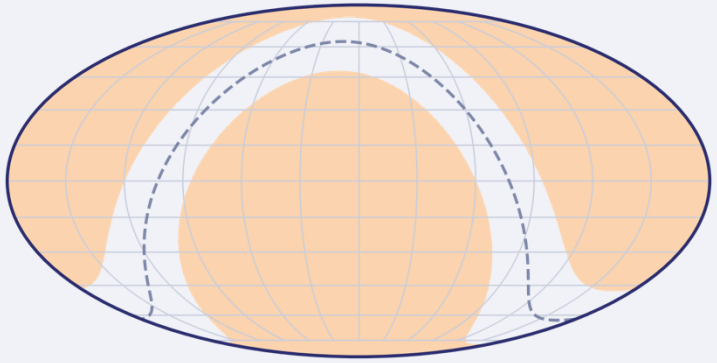
with Kacper Drabicki and Maciej Bilicki

Center for Theoretical Physics, Polish Academy of Sciences, Warsaw

Catalogs and LSST

Quaia

Gaia + unWISE



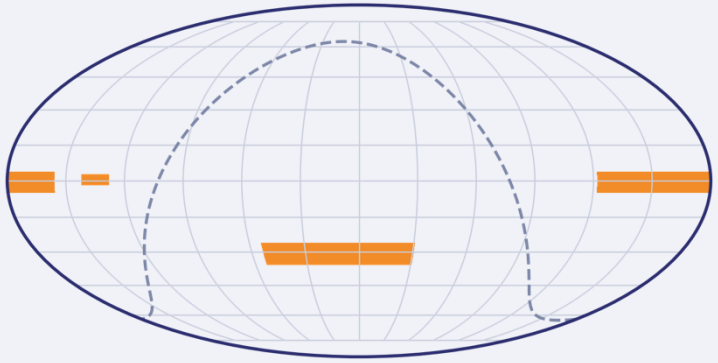
$G < 20.5 \cdot f_{sky} \approx 0.7$

$N_{QSO} \approx 1.3$ M

$\Sigma_{QSO} \approx 45$ deg^{-2}

KiDS

ugri + ZYJHKs



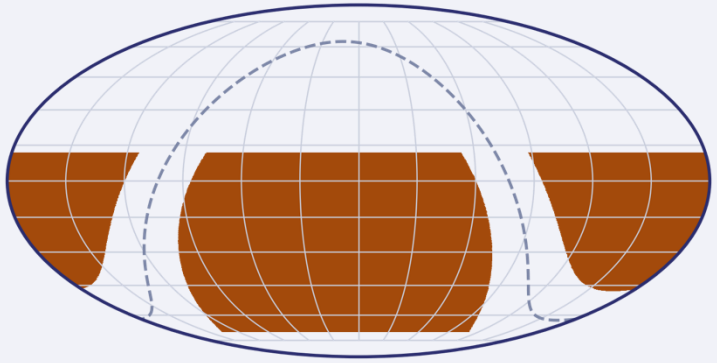
$r < 23.5 \cdot f_{sky} \approx 0.024$

$N_{QSO} \approx 0.34$ M

$\Sigma_{QSO} \approx 340$ deg^{-2}

LSST

ugrizy



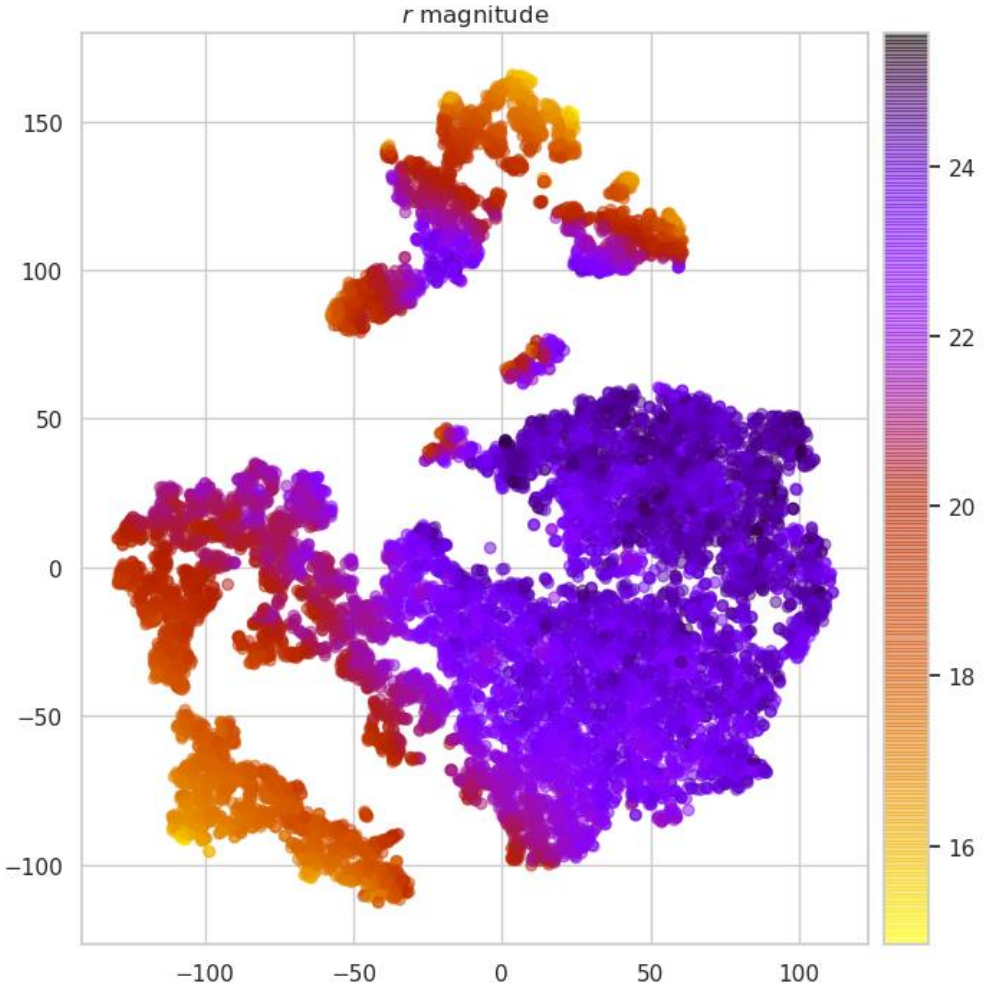
$r < 27.5 \cdot f_{sky} \approx 0.44$

$N_{QSO} \approx 6–12$ M

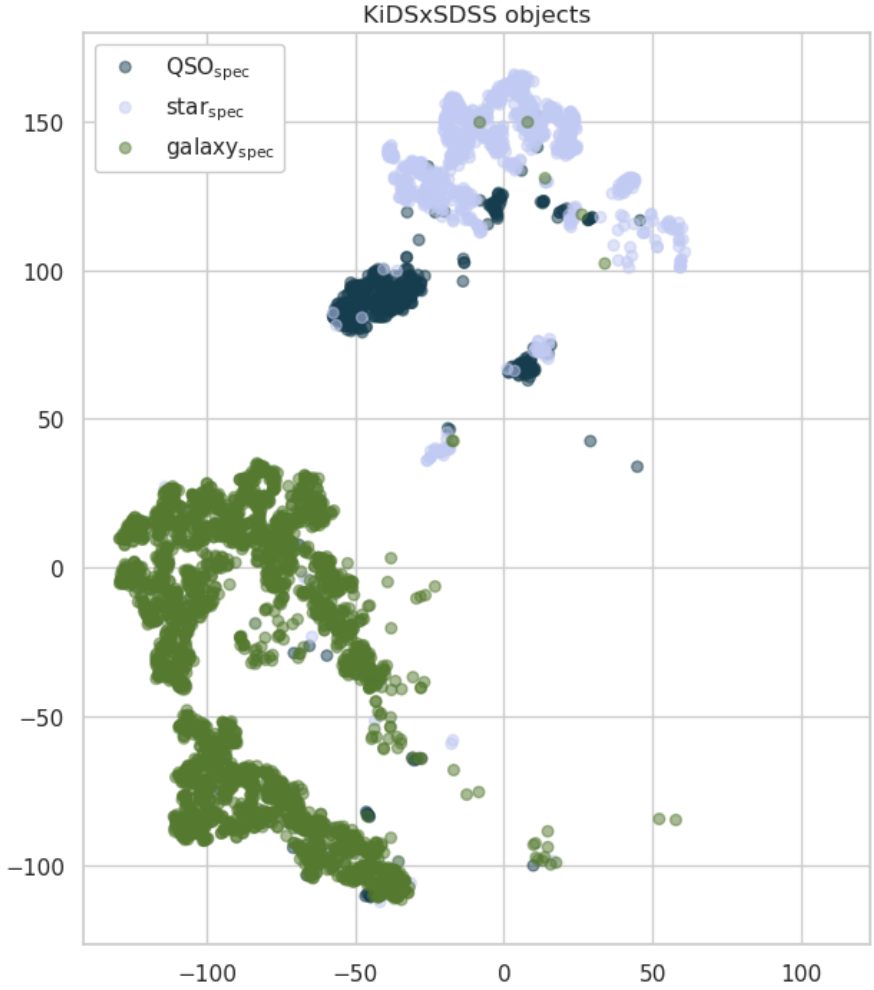
$\Sigma_{QSO} \approx 300–700$ deg^{-2}

Maps schematic; shade ∝ quasar density · Storey-Fisher+2024; Nakoneczny+2021; William+2025; Wright+2024 (KiDS DR5); Ivezić+2019; ApJ 1000, 165 (2026)

Spectroscopy covers only the bright quasars



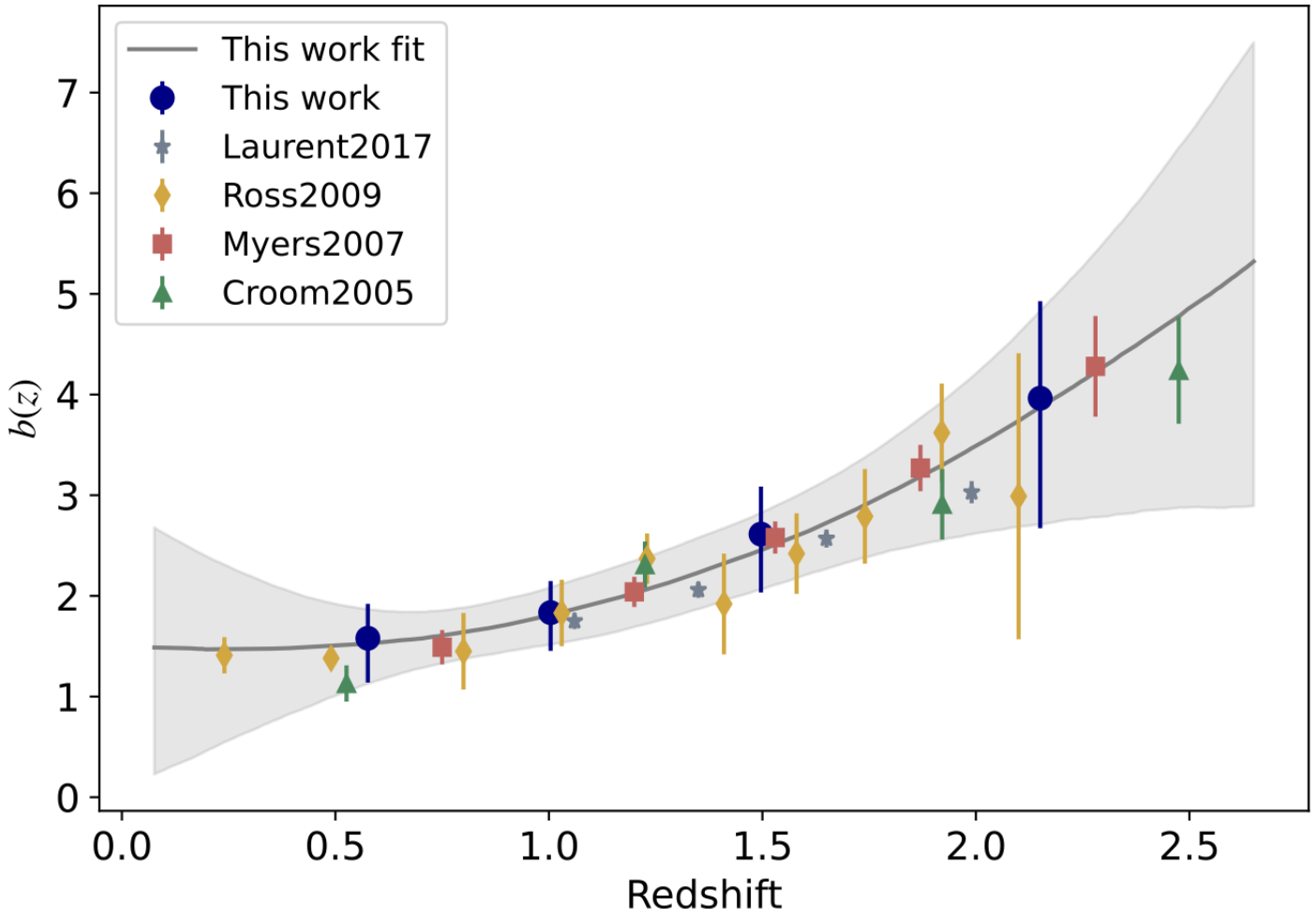
KiDS sources coloured by r magnitude



KiDS × SDSS spectroscopic classes

t-SNE of the KiDS feature space: Nakoneczny et al. 2021, A&A 649, A81

Quasar clustering in KiDS: where we start



- **Sample:** KiDS DR4 “safe” quasars, r < 22, ~157 000 objects
- **Bins:** 4 in z_{phot}: 0.1–0.8, 0.8–1.2, 1.2–1.8, 1.8–2.7
- **Result:** bias grows with redshift
  $b = \mathbf{1.58}^{+0.34}_{-0.44}$ at $0.1 < z_{phot} < 0.8$
  $b = \mathbf{3.96}^{+0.96}_{-1.29}$ at $1.8 < z_{phot} < 2.7$
- **Caveat:** b(z) depends on the assumed n(z)

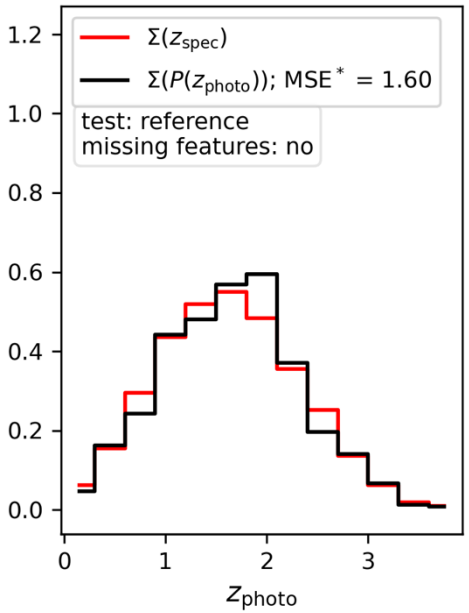
Next steps

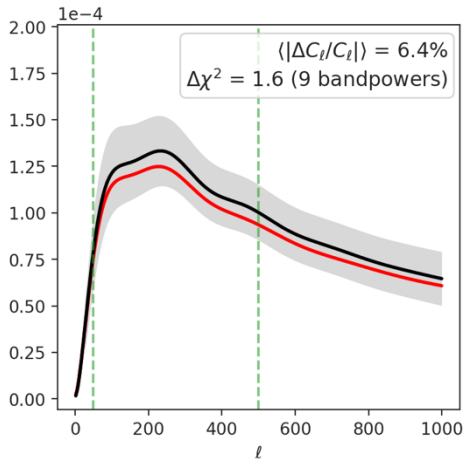
+ cross-correlation with CMB lensing κ
+ photo-z uncertainty modelling
+ n(z) calibration

Figure: William et al. 2025, arXiv:2511.17311 (Fig. 6) · sample: Nakoneczny et al. 2021

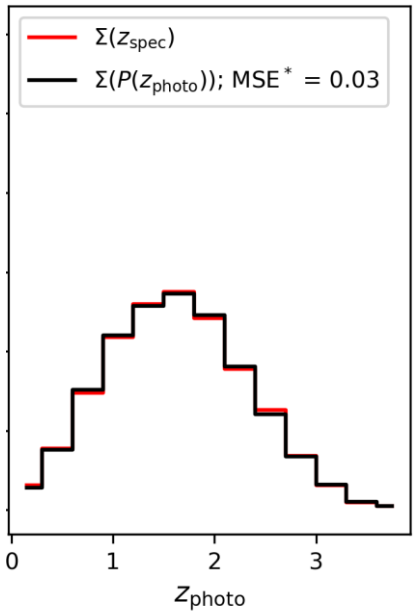
Reference

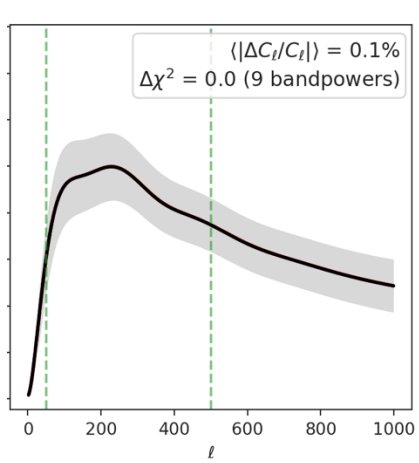
ANN





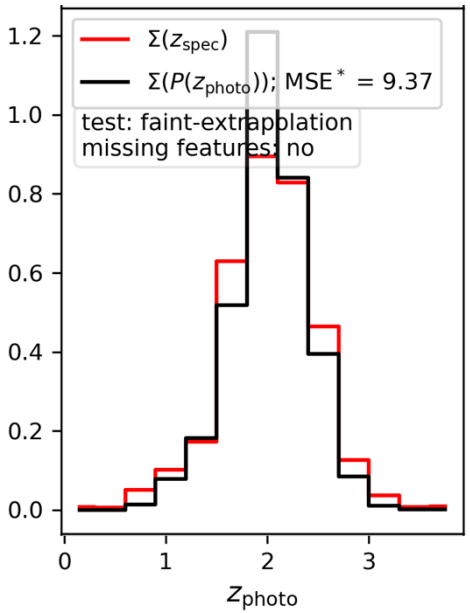
BNN

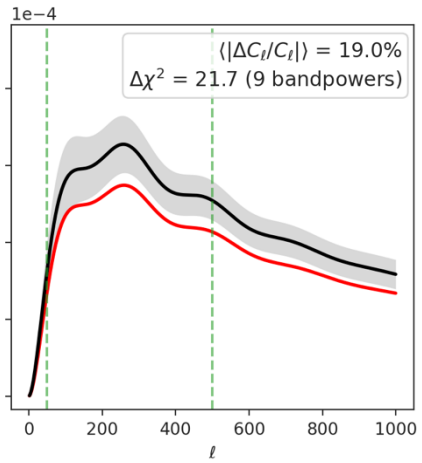




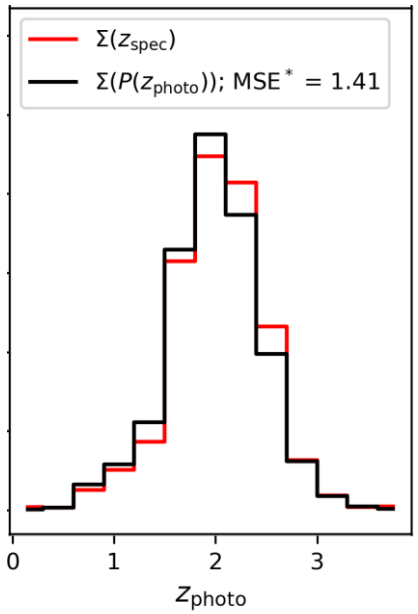
Faint

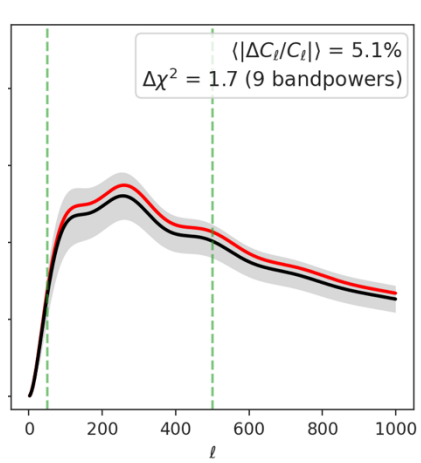
ANN

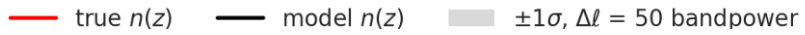




BNN

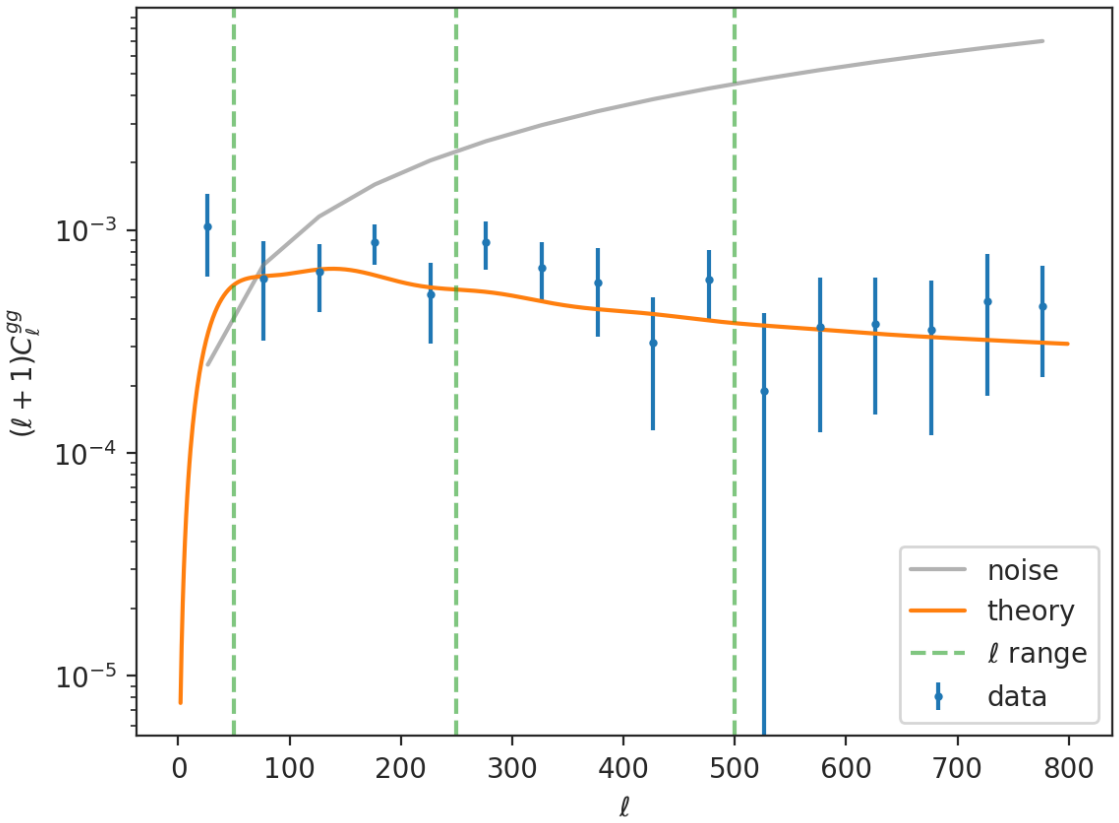




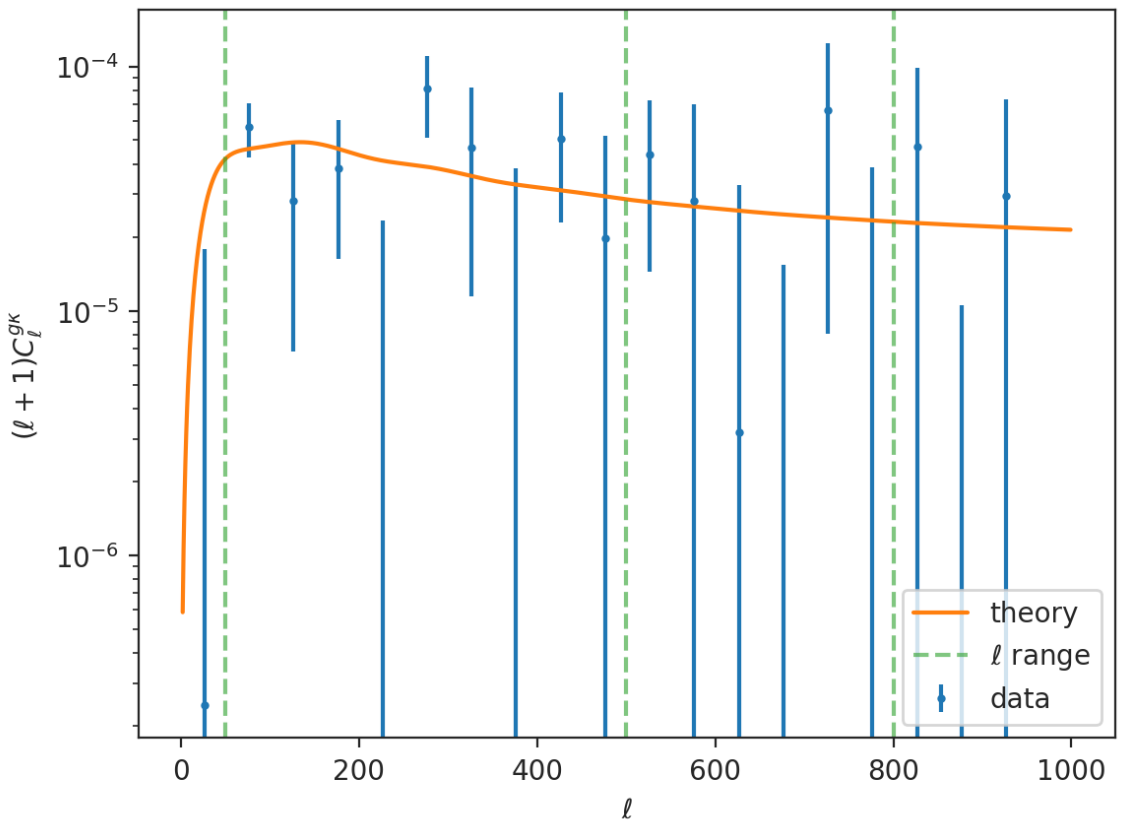


Angular power spectra of KiDS quasars

Quasar auto-spectrum C_ℓ^{gg}



Quasar × CMB lensing $C_\ell^{g\kappa}$



$0.5 < z_{photo} < 1.1$

Summary and next steps

Summary

- **Scope:** KiDS ×DESI, extrapolation tested up to ~1 mag
- **≥ 2 Gaussian components are essential** for quasar photo-z
- **Uncertainty-aware n(z) matters:** for faint quasars the C_ℓ error drops from ~20% to 1–10%

Next steps

- **Calibrate n(z)** of the KiDS quasar sample
- **Clustering + CMB lensing** → quasar bias and σ_8

Publication: Drabicki et al. 2026, arXiv:2603.19882

Contact: nakoneczny@cft.edu.pl