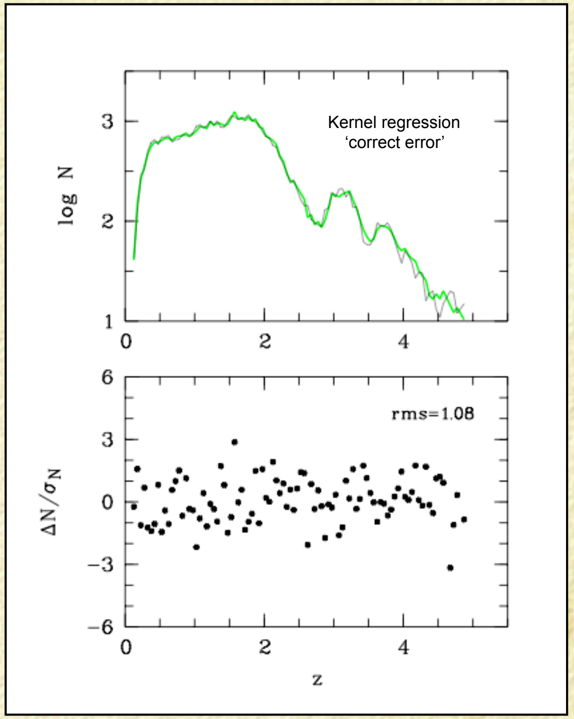
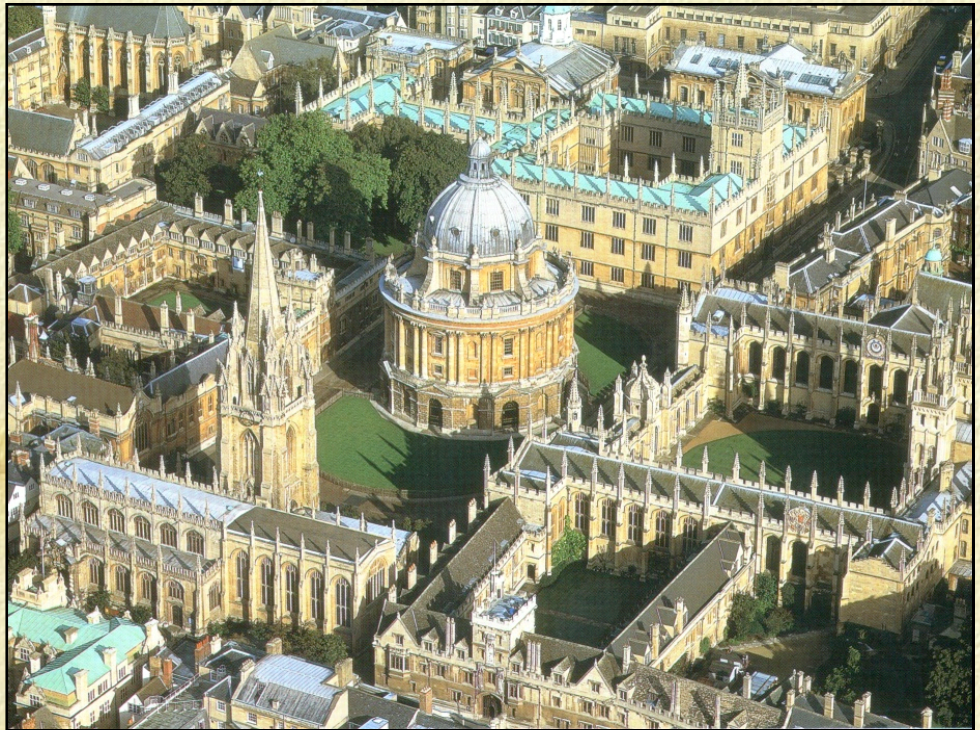
Photometric Redshift Training Sets



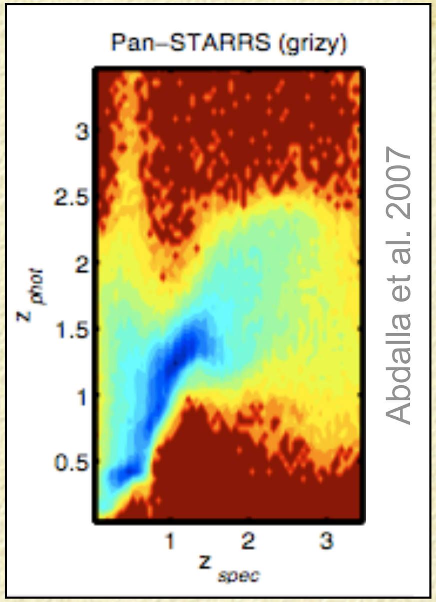


Christian Wolf
Oxford Physics

Use of Photometric Redshifts

- Applications
  - Extremely large stand-alone photo-z surveys
  - Search for interesting spectroscopic targets
- To learn about
  - Cosmology & dark energy via BAO and gravitational lensing
  - Galaxy growth embedded in dark matter haloes
  - Galaxy evolution over time and with environment
  - New phenomena

- Strong drive towards huge / all-sky surveys:
  - Dark Energy Survey, PanStarrs
  - VST, VISTA, LSST, IDEM …
- Beat Poisson noise…
- But: impact of systematics?!



Abdalla et al. 2007

The Two Ways of Photo-"Z"eeing

- Model input:
  - Educated guesses
  - I.e. template SEDs and for priors evolving luminosity functions etc.
- Photo-z output:
  - Educated guesses*
  - "What could be there? What is it probably not?"
- Needed for
  - Pioneering new frontier: depth in magnitude or z beyond spectroscopic reach

- Model input:
  - Statistical Distributions
  - I.e. empirically measured n(z) distributions for all locations in flux space
- Photo-z output:
  - Statistical Distributions
  - "What is there? And in which proportions?"
- Needed for
  - Extrapolating to wide area: known mag/z territory with spectroscopic description

*You will never obtain a reliable estimate of an n(z) distribution from a technique that involves more than zero pieces of information which do not represent a true distribution but a best-guess approximation instead…

The Two Ways of Photo-"Z"eeing

- Model input:
  - <u>Educated guesses</u>
  - I.e. template SEDs and for priors evolving luminosity functions etc.
- Photo-z output:
  - <u>Educated guesses*</u>
  - "What could be there? What <u>is</u>

- Work continues on
  - Best templates
  - Best luminosity functions
  - Best code debugging
  - An <u>engineering problem</u> taken care of by PHAT

- Model input:
  - <u>Statistical Distributions</u>
  - I.e. empirically measured n(z) distributions for all locations in flux space
- Photo-z output:
  - <u>Statistical Distributions</u>
  - "What <u>is</u> there? And in which

- Work continues on
  - How to get n(z) correctly in presence of errors?
- Problem solved:
  - Wolf (2009), MN in press
  - n(z) with <u>Poisson-only errors</u>

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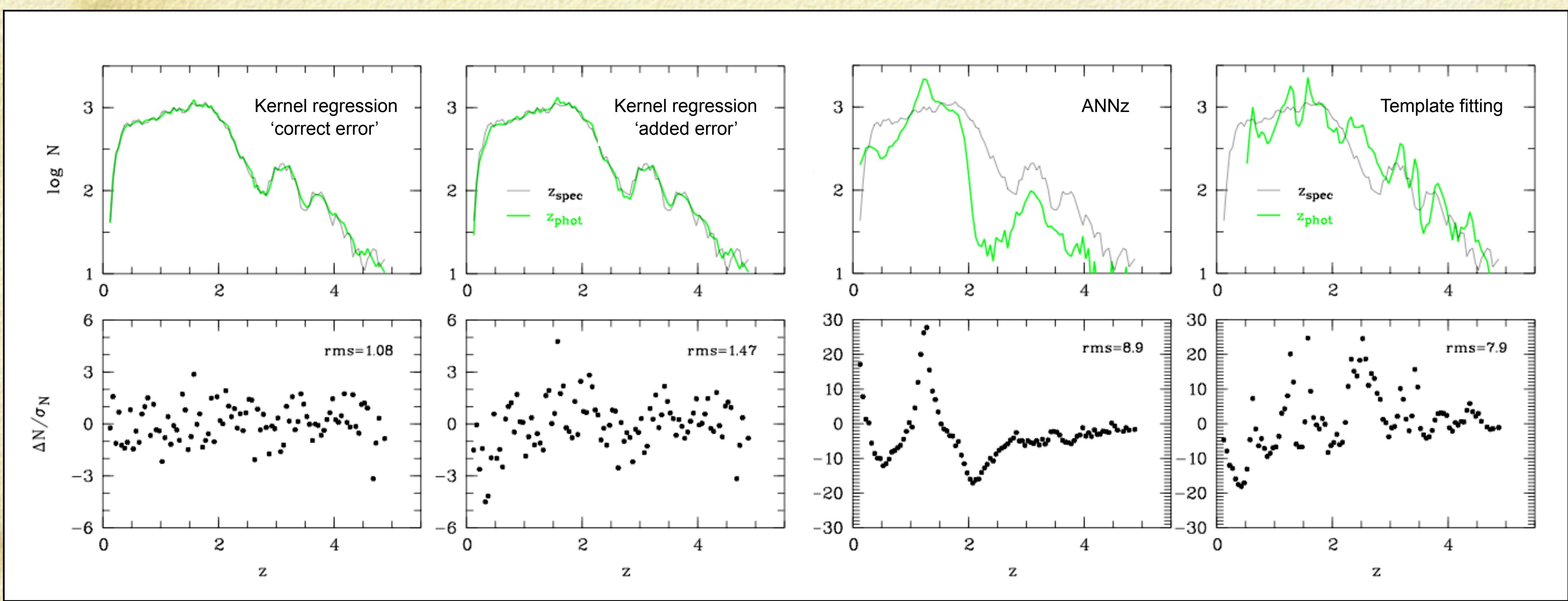
Reconstruction of Redshift Distributions from ugriz-Photometry of QSOs



Left panel: The n(z) of a QSO sample is reconstructed with errors of 1.08× Poisson noise (works with any subsample or individual objects as well) using "χ^2-testing with noisy models"

State of the Art vs. Opportunity

- Current methods
  - Precision sufficient for pre-2010 science
  - But insufficient and critical for the next decade
- Current surveys
  - VVDS and DEEP-2: 20%..50% incomplete at 22..24 mag
  - SDSS (bright survey) 3…4%?
- Propagates into bias
  - $\eta_{\text{non-recov}}$=0.2 (20% incomplete)

  $\Rightarrow$ $|\langle\delta z\rangle|$=0.2 ! and $\delta w \sim 1$!

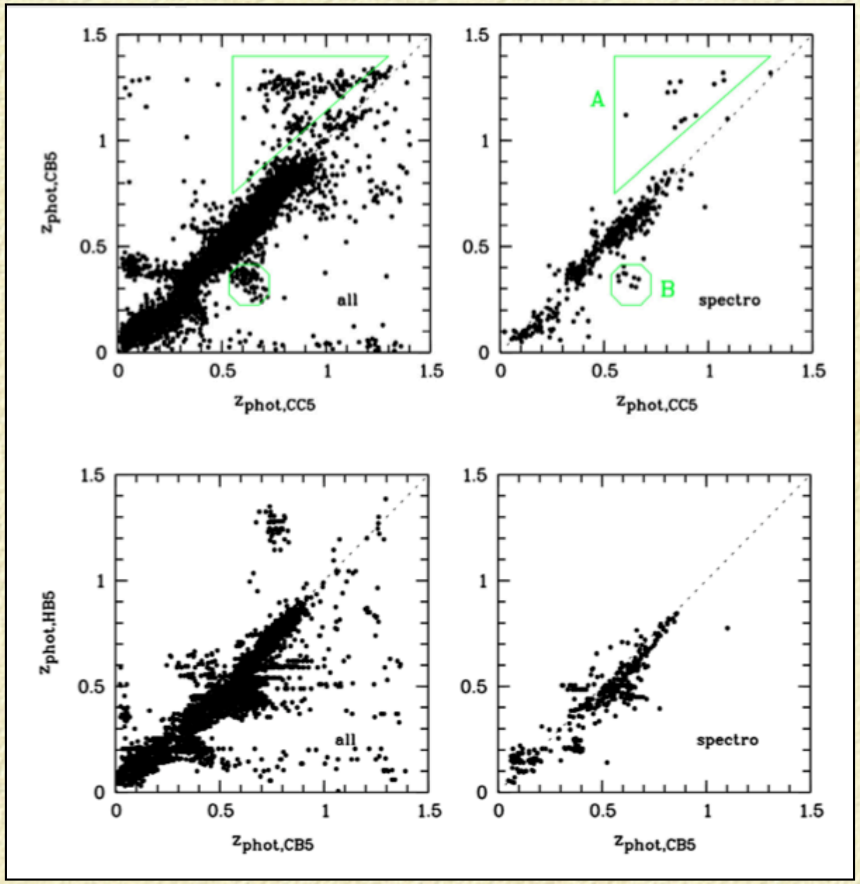
$$|\langle\delta z\rangle| = |\langle\delta z_{\text{out}}\rangle| \times \left(\eta_{\text{non-recov}} + \frac{1}{N_{\text{model,local}}}\right)$$

- Poisson-precision results need
  - + Adoption of W 2009 method to remove methodical limitations
  - + Complete "training set" to remove limitations of data
  - – Incompleteness = "systematics"
- Issues & goals
  - Lines in the NIR, weak lines at low metallicity, what else?
  - Goal 1..5% incompleteness
  - Provide sub-samples with <1% incompleteness
  - Fundamental limits? Blending?

Templates again…?

- Alternative:
  - Use template-based photo-z's for spectroscopically incomplete objects
- Pro:
  - Sounds easy…
- Con:
  - Trends: those difficult for z_{spec} are difficult for z_{phot} as well!
  - Trust: if you can't get a z_{spec}, why do you want to believe a z_{phot}?

Sample	$R = [17, 23]$			
Configuration	Compl. [%]	$f_{0.15}$ [%]	$f_{3\sigma}$ [%]	$\langle\delta_z\rangle \pm \sigma_z$
CC5 vs. CB5, all	99.4	6.3	9.7	−0.007 ± 0.035
CC5 vs. CB5, spectro	100.0	3.2	9.8	−0.006 ± 0.030
CB5 vs. HB5, all	92.6	9.0	8.7	−0.033 ± 0.053
CB5 vs. HB5, spectro	95.7	2.5	2.8	−0.057 ± 0.047



Recommendations

1. Investigate: why spectroscopic incompleteness, compare e.g. VVDS with VVDS-ultra-deep
2. Observe (pilot) with FMOS the unknown sources in VVDS / DEEP-2 / zCOSMOS / …
3. Confirm where FMOS makes a difference, also how many sources are still left & why
4. Assess merit of larger FMOS photo-z calibration survey
5. Also: VIMOS-red-upgrade, improved sky, resolution dependence, future instruments (XMS),...