

Fundamental constants: a complementary probe of cosmology

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“fine structure constant”

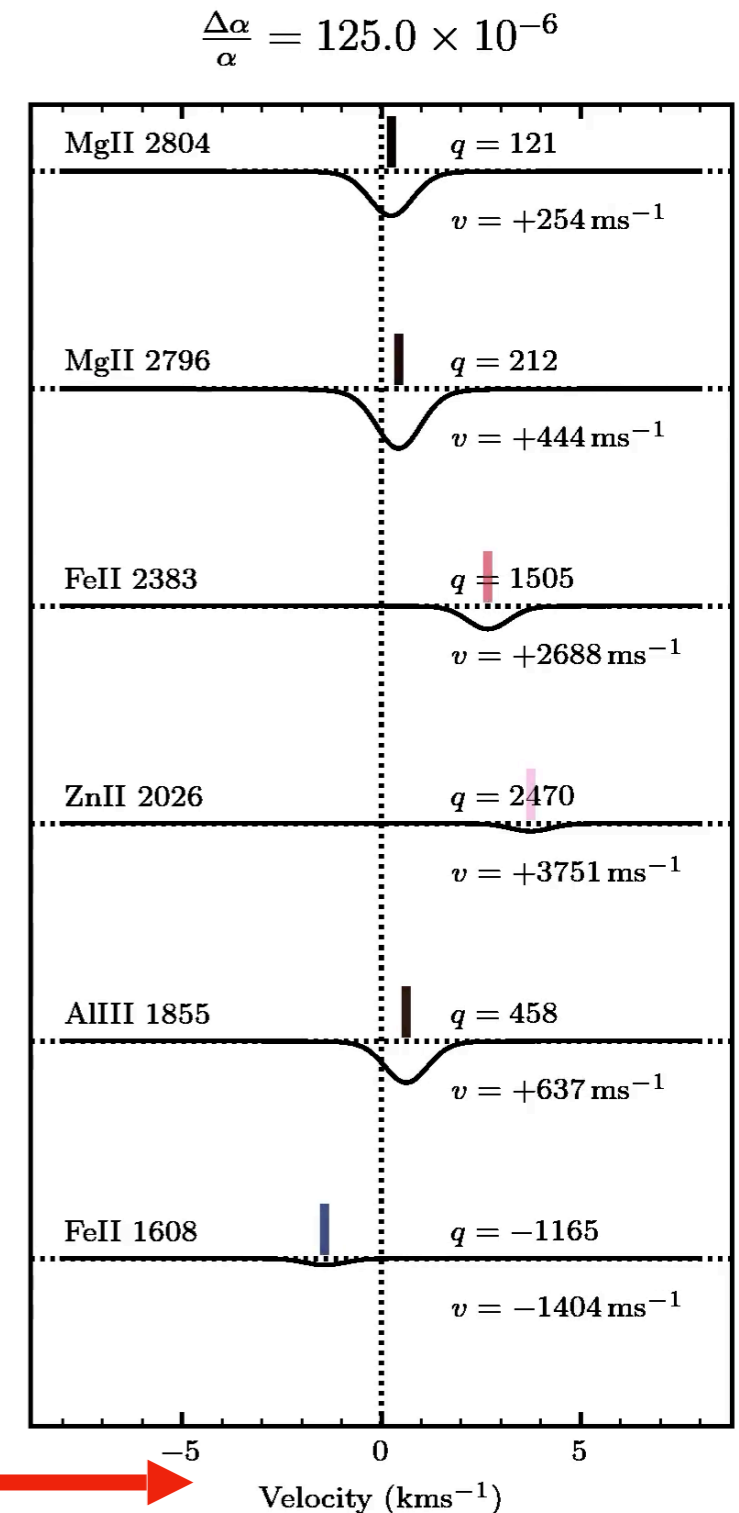
$$\alpha \equiv \frac{1}{4\pi\epsilon_0} \frac{e^2}{\hbar c} \approx \frac{1}{137}$$

← electromagnetism
← quantum mechanics ← general relativity

$$E \propto \alpha^2$$

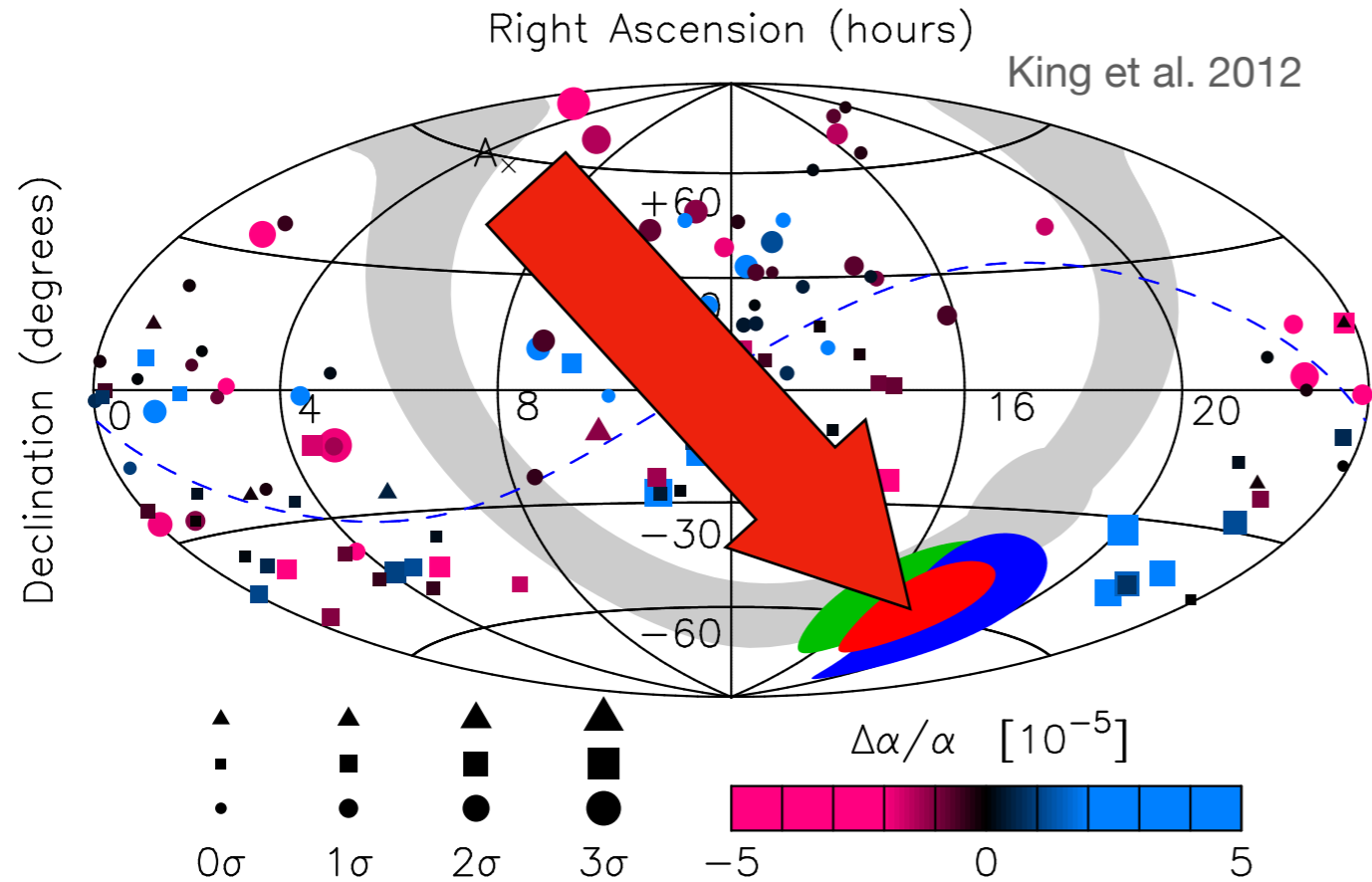
IF $\Delta\alpha \rightarrow \Delta E \rightarrow \Delta\lambda$

$$\frac{\Delta v}{c} = \frac{\Delta\lambda}{\lambda}$$

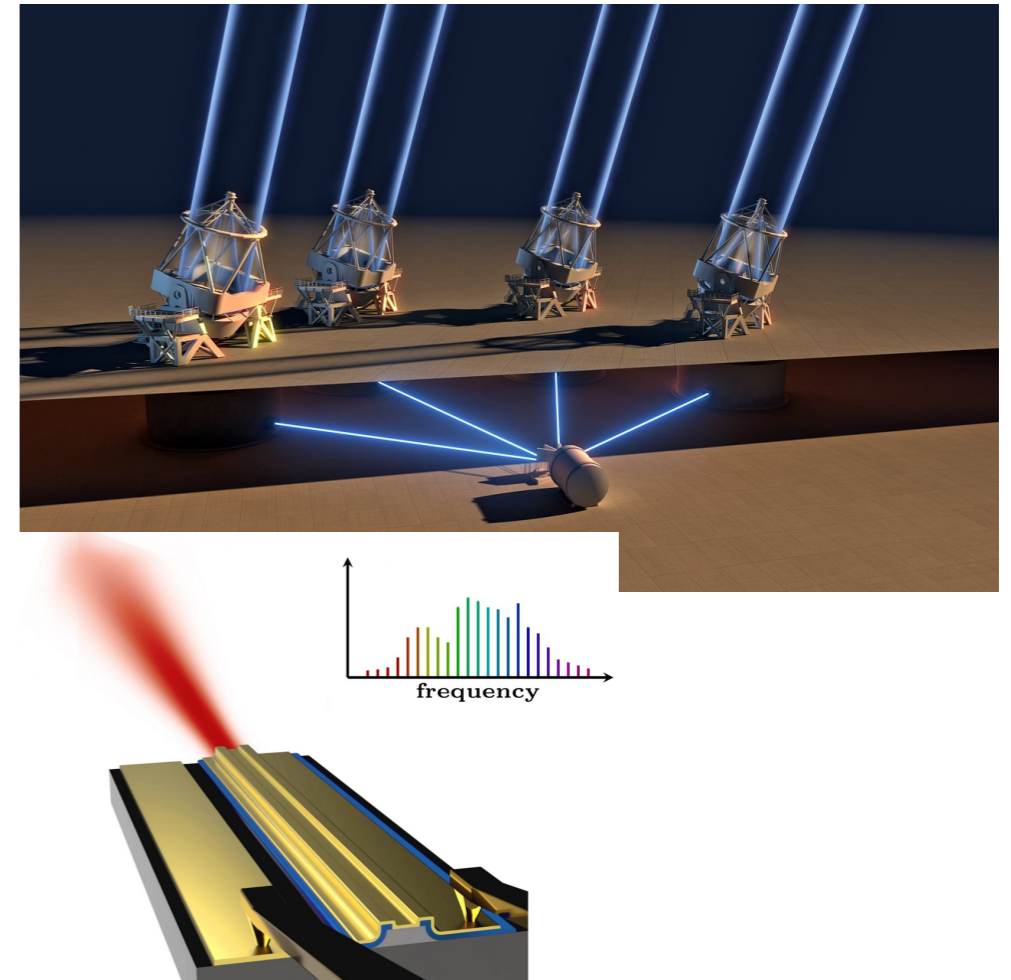


State of the field

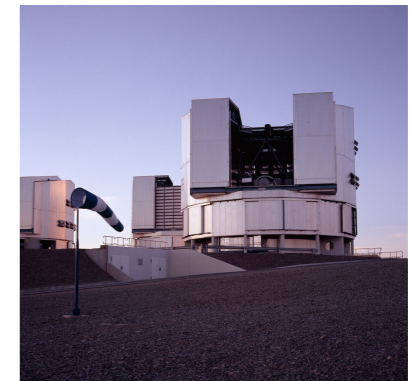
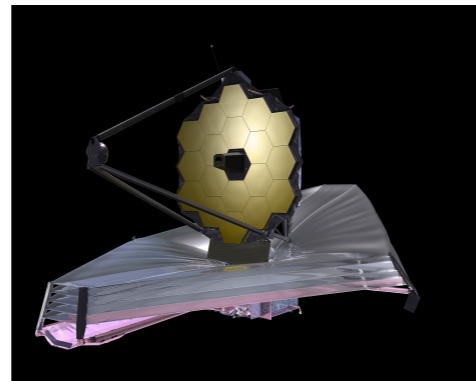
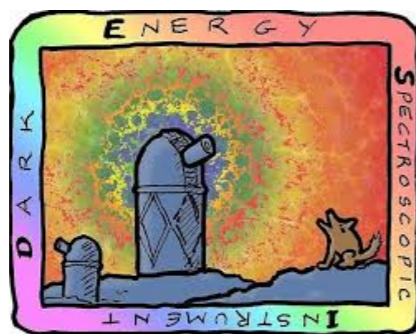
2012: VLT/UVES and Keck/HIRES
evidence for dipole variation at 4.1sigma



2018 — ongoing: VLT/ESPRESSO
Large Programme for fundamental physics



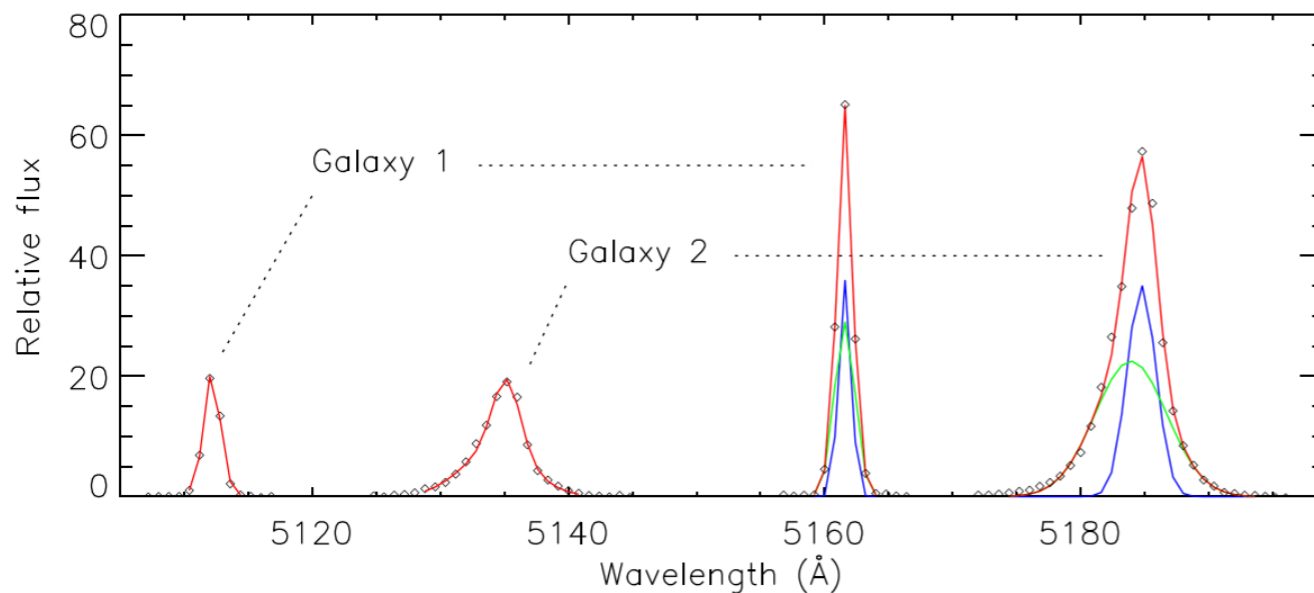
In the last year: New constraints from DESI, JWST, LAMOST, X-SHOOTER



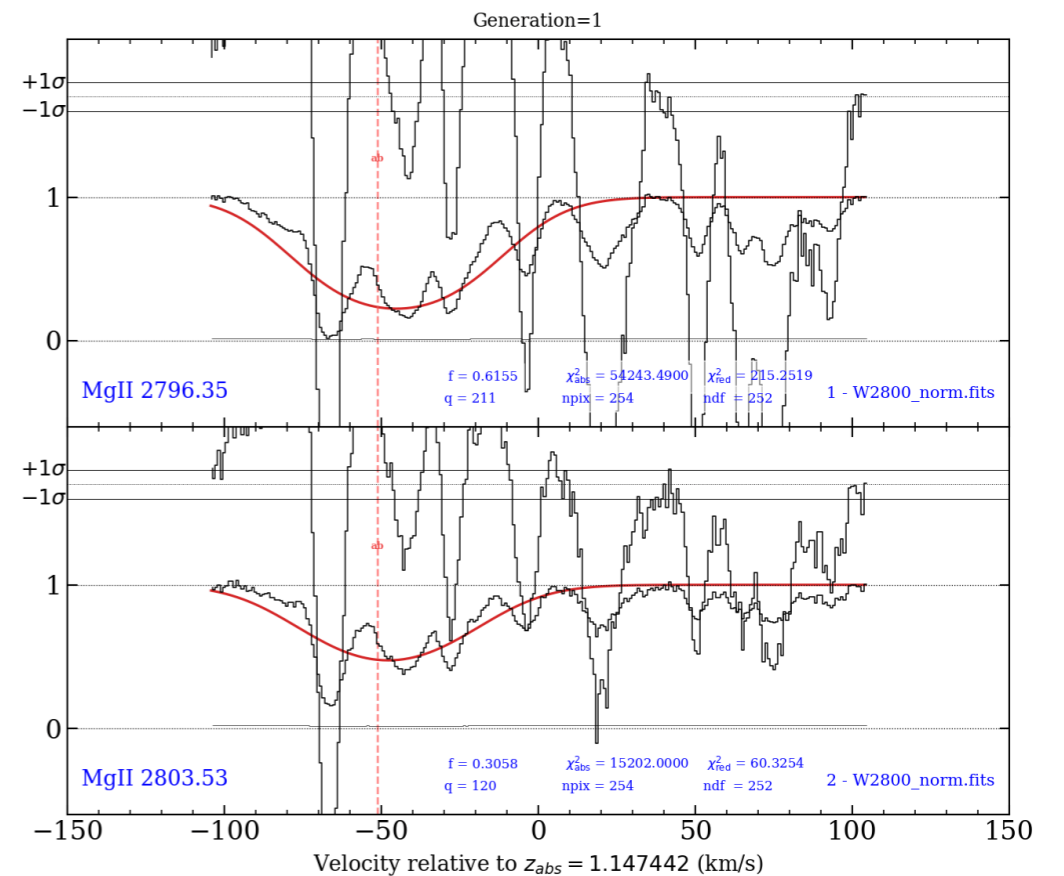
WST survey of fundamental constant variations

Two probes: ELGs ($z < 1$) and QSOs ($z > 1$)

Alkali-doublet method (Bahcall & Schmidt 1967)
using [O III] or [Ne III]
 $R = 4'000$
 $S/N \sim 20$ / resolution element



Many multiplet method (Dzuba & Webb 1999)
 $R = 40'000$
 $S/N \sim 50$ / resolution element

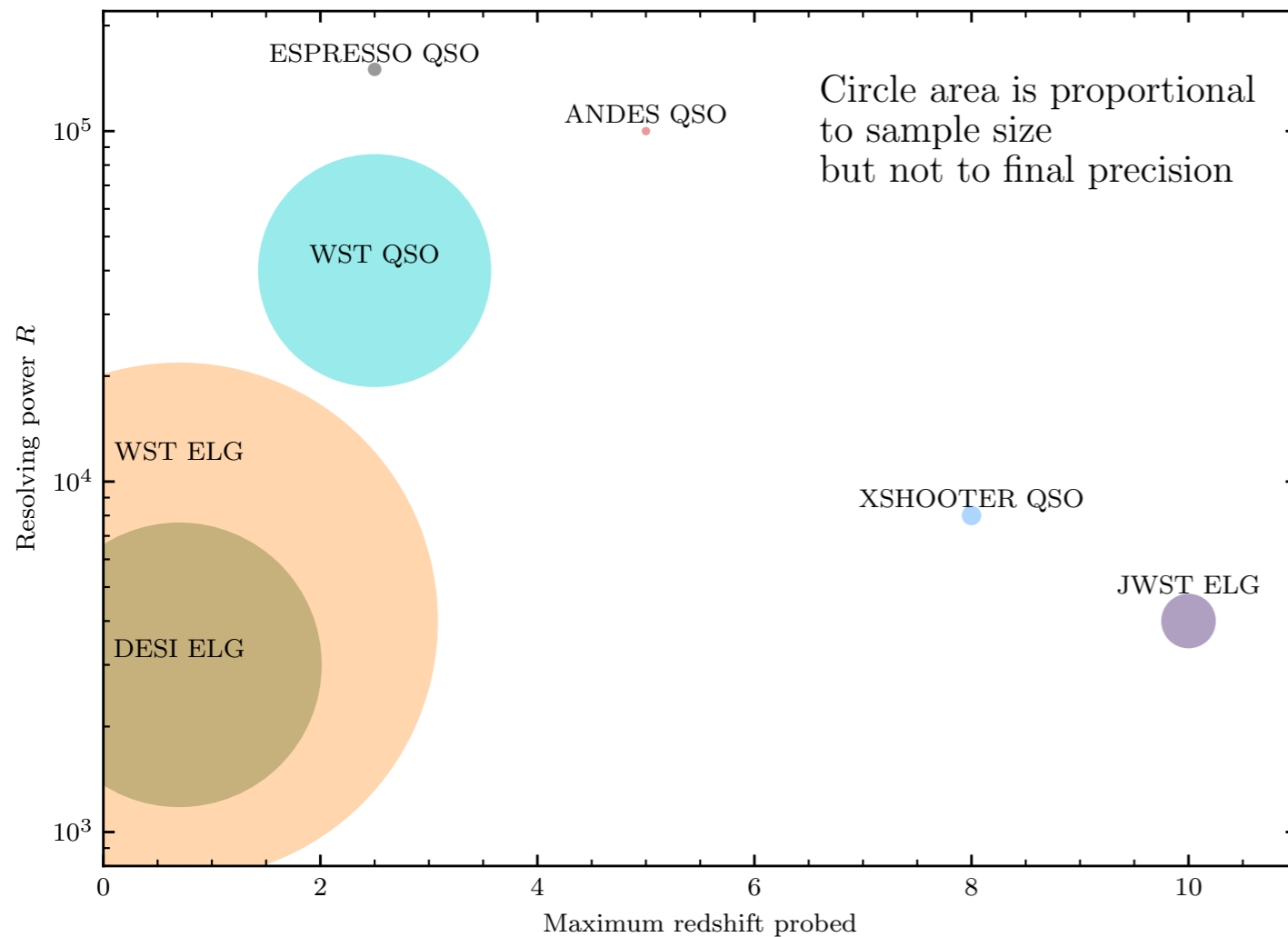


Implications for WST

1. Wavelength calibration: using laser freq. comb or Fabry-Pérot etalon
2. Survey design: multi-h exposures to reach S/N in faint targets

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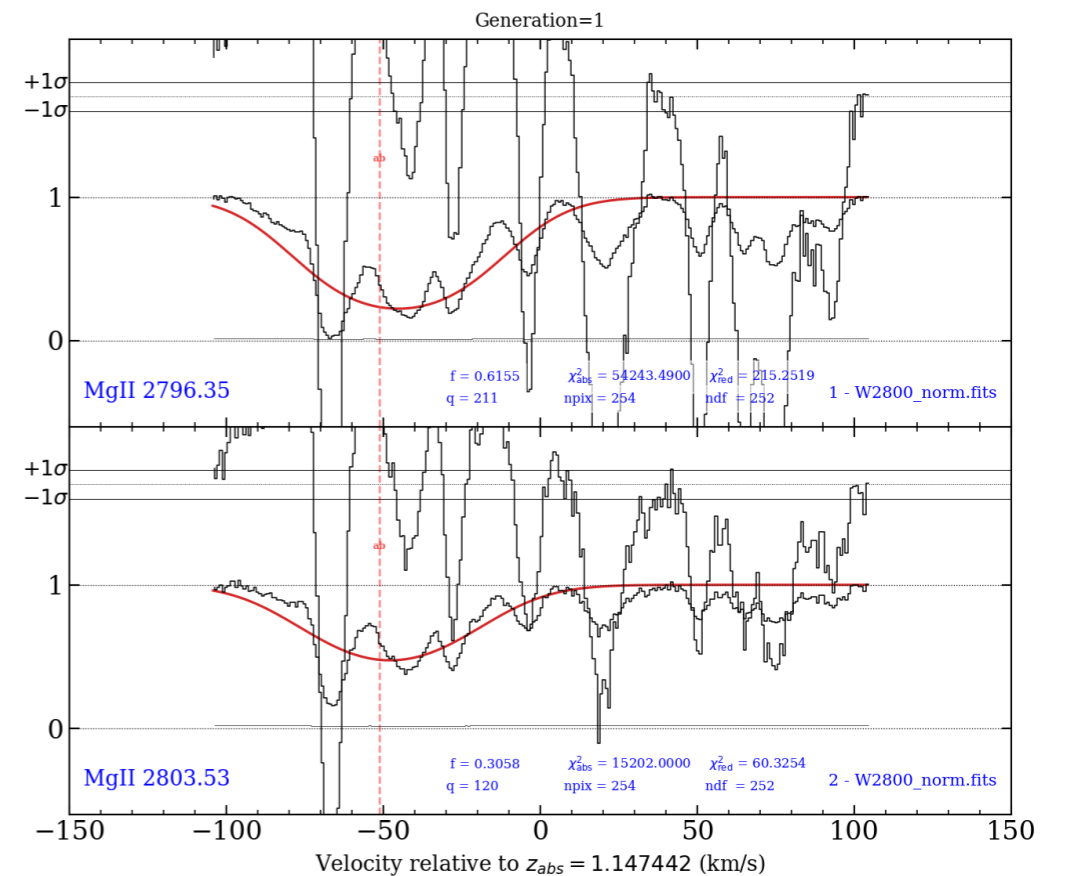
Two probes: ELGs ($z < 1$) and QSOs ($z > 1$)



Many multiplet method (Dzuba & Webb 1999)

$R = 40'000$

$S/N \sim 50$ / resolution element

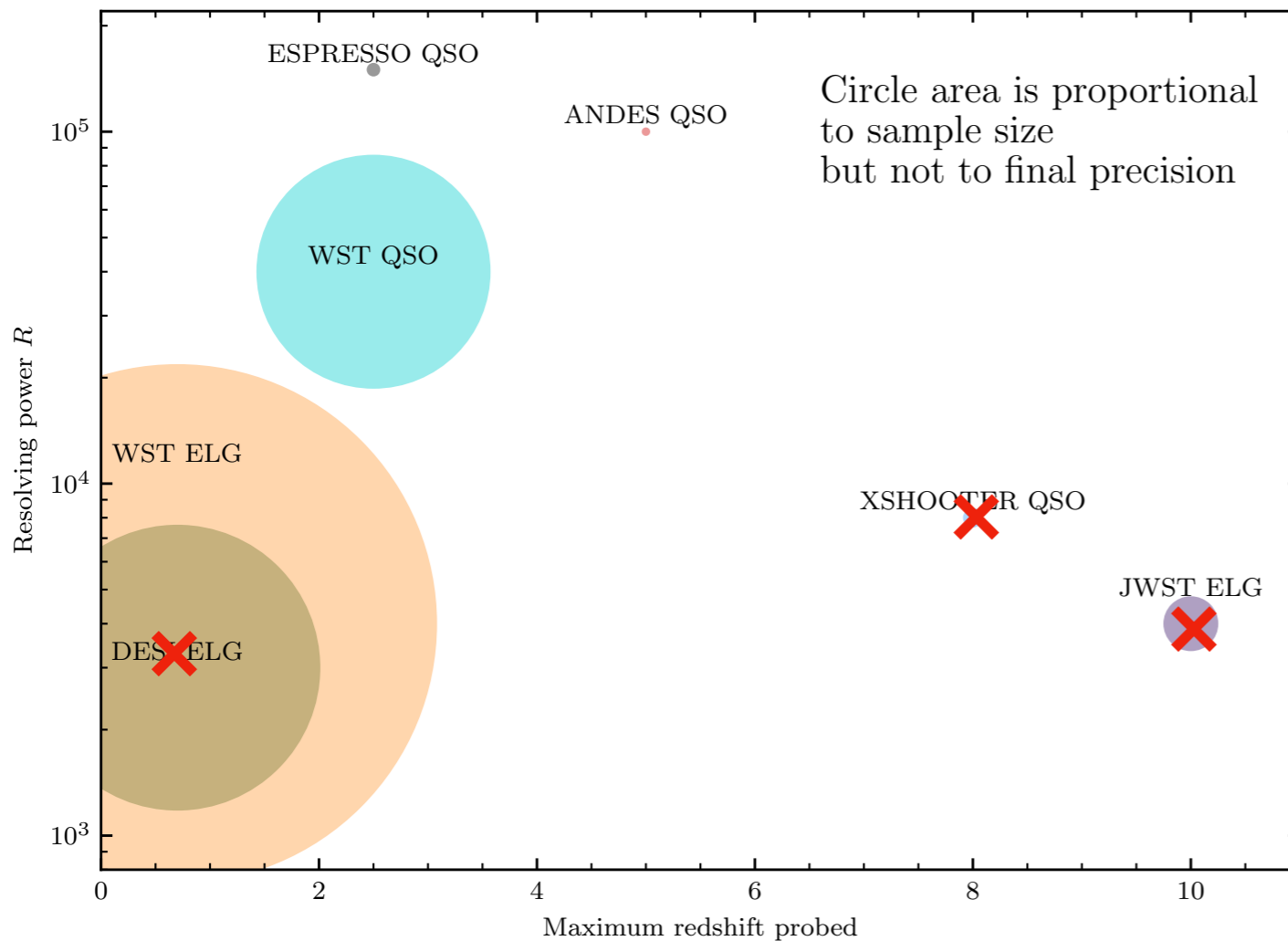


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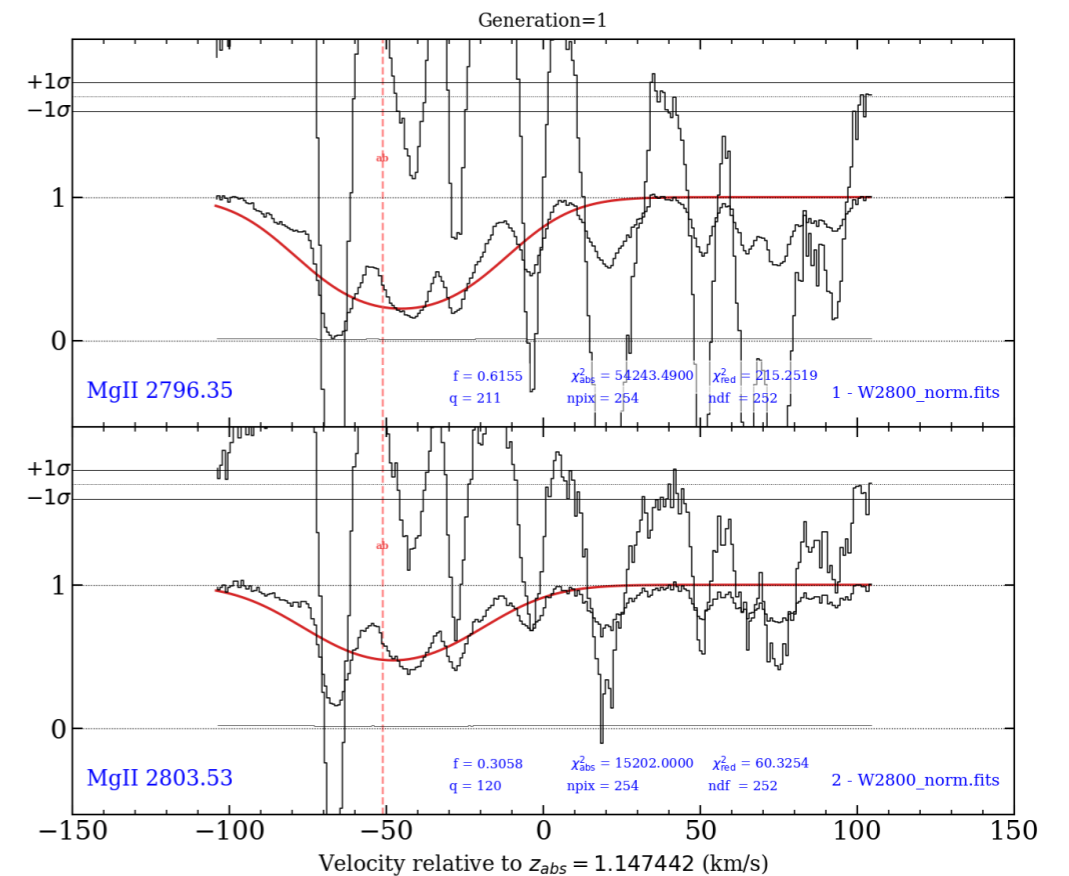
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