X-SHOOTER OBSERVATIONS OF QSO PAIRS

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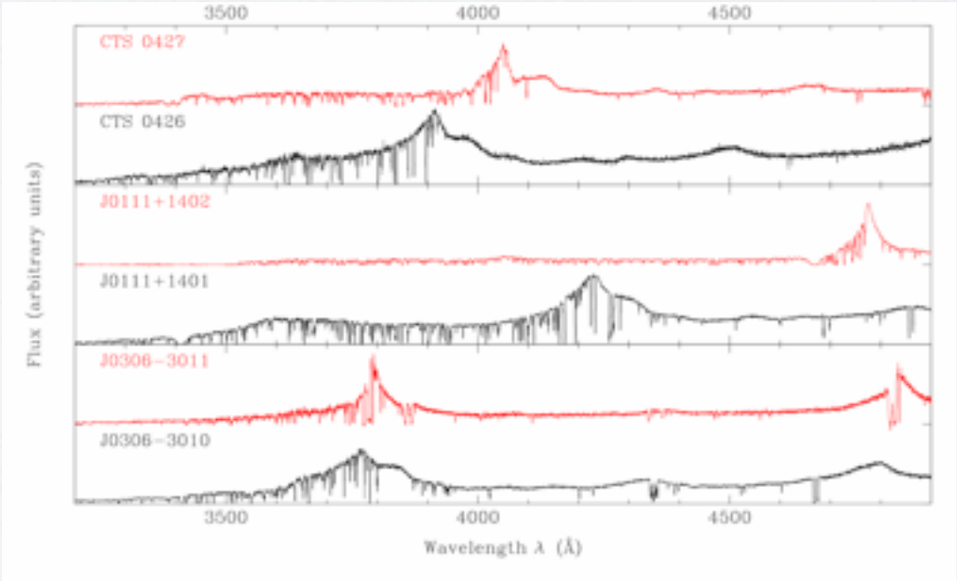
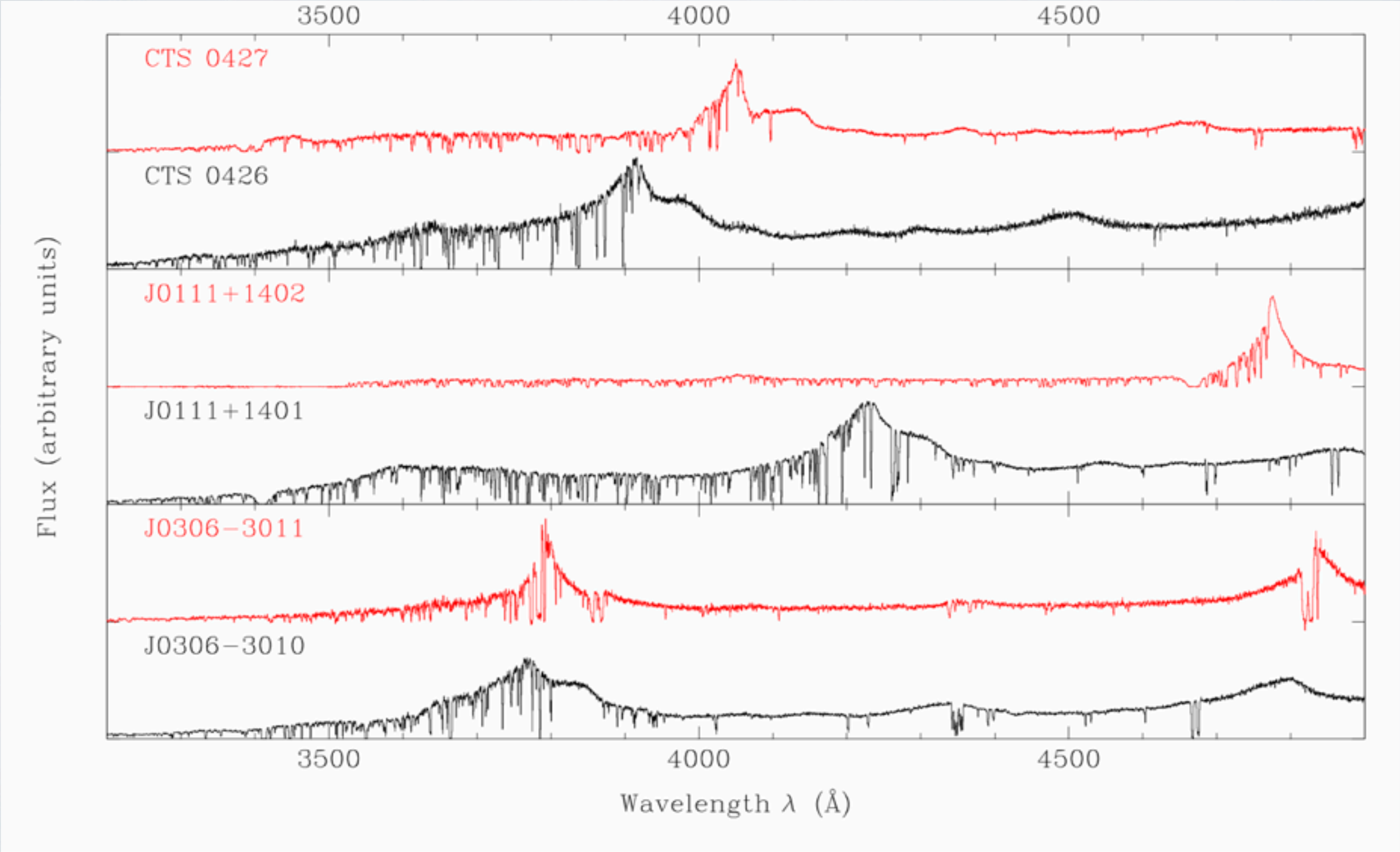
Como – October 22, 2010

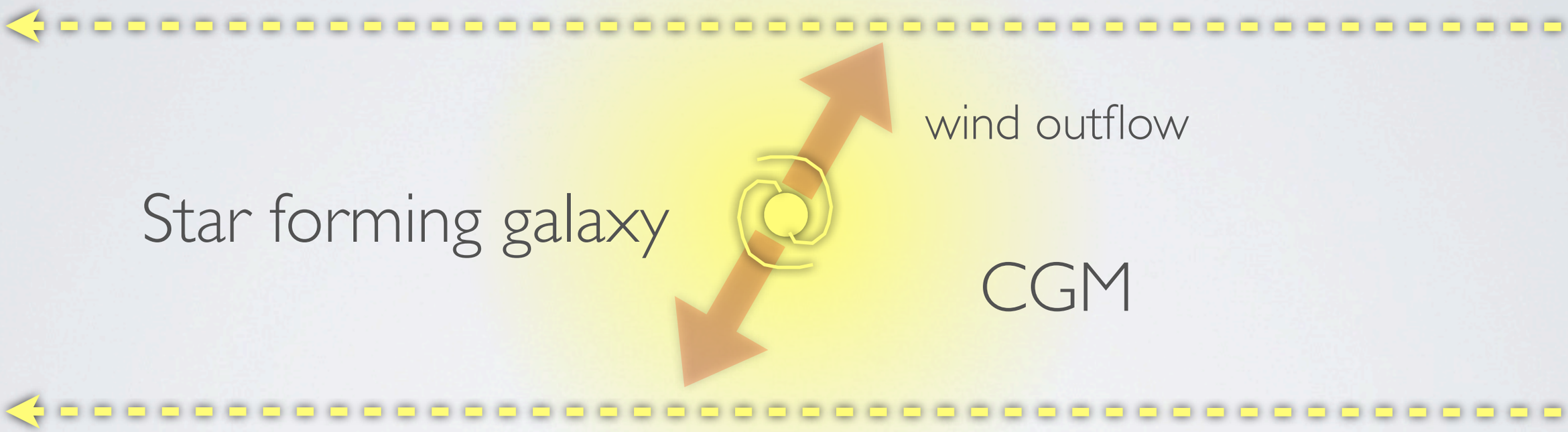


WHY QSO PAIRS?



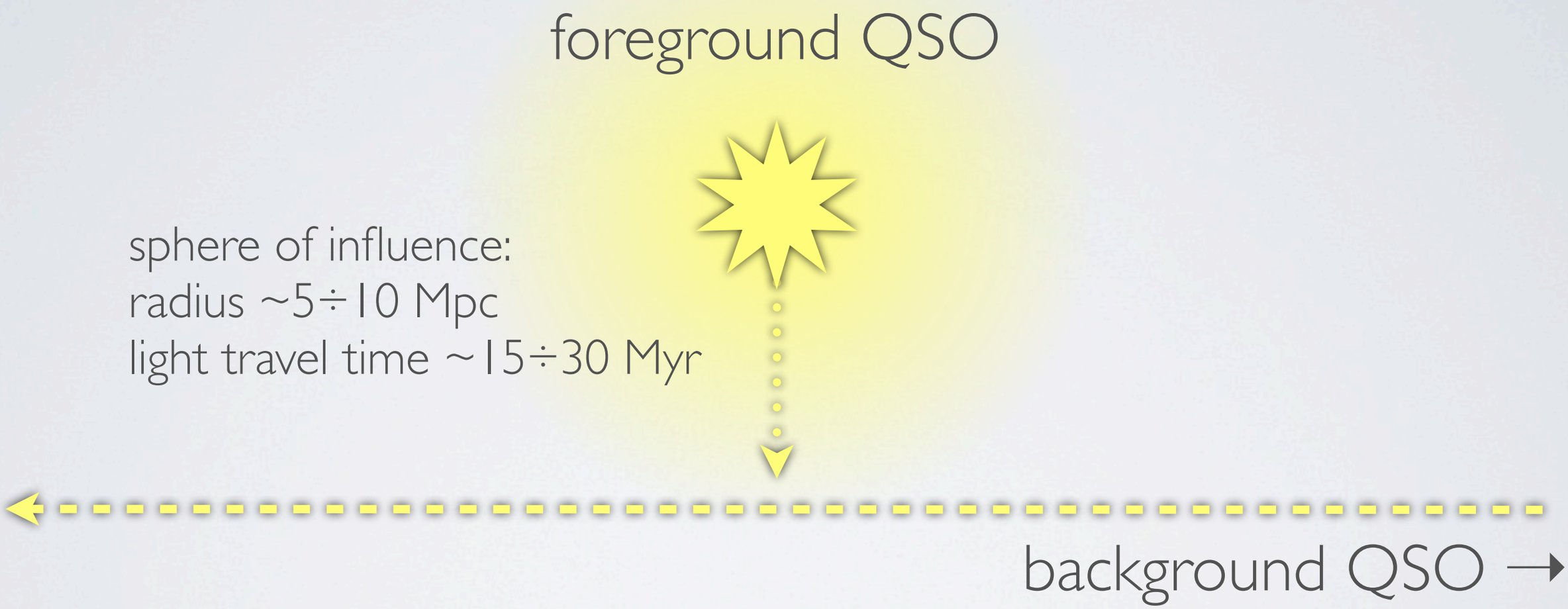
COINCIDENCE OF METAL-LINE SYSTEMS

Connection LBG-C IV absorption (Adelberger et al. 2005)



Transverse correlation → size of the absorbers, velocity of the outflow (Cappetta et al. 2010, Martin et al. 2010)

TRANSVERSE PROXIMITY EFFECT



- **Statistics of Lyman-α forest** (Fernández-Soto et al. 1989, Croft 2004)
- **Ionization of metal-line systems** (Gonçalves et al. 2008)

ALCOCK-PACZYŃSKI TEST

Ratio between LOS size and **transverse size depend on Ω_Λ** (Alcock & Paczyński 1979)

Auto-correla– –tion function

Cross-correlation function

(Hui et al. 1999)

~13($\Delta\theta$/arcmin)^2 pairs needed (McDonald 2003) → **not yet achieved** (Coppolani et al. 2006, D'Odorico et al. 2006, Cappetta et al. 2010)

ALCOCK-PACZYŃSKI TEST

Ratio between LOS size and transverse size depend on Ω_Λ (Alcock & Paczyński 1979)

ENTER X-SHOOTER...

~13($\Delta\theta$/arcmin)^2 pairs needed (McDonald 2003) → **result not yet achieved** (Coppolani et al. 2006, D'Odorico et al. 2006)

QSO SAMPLE

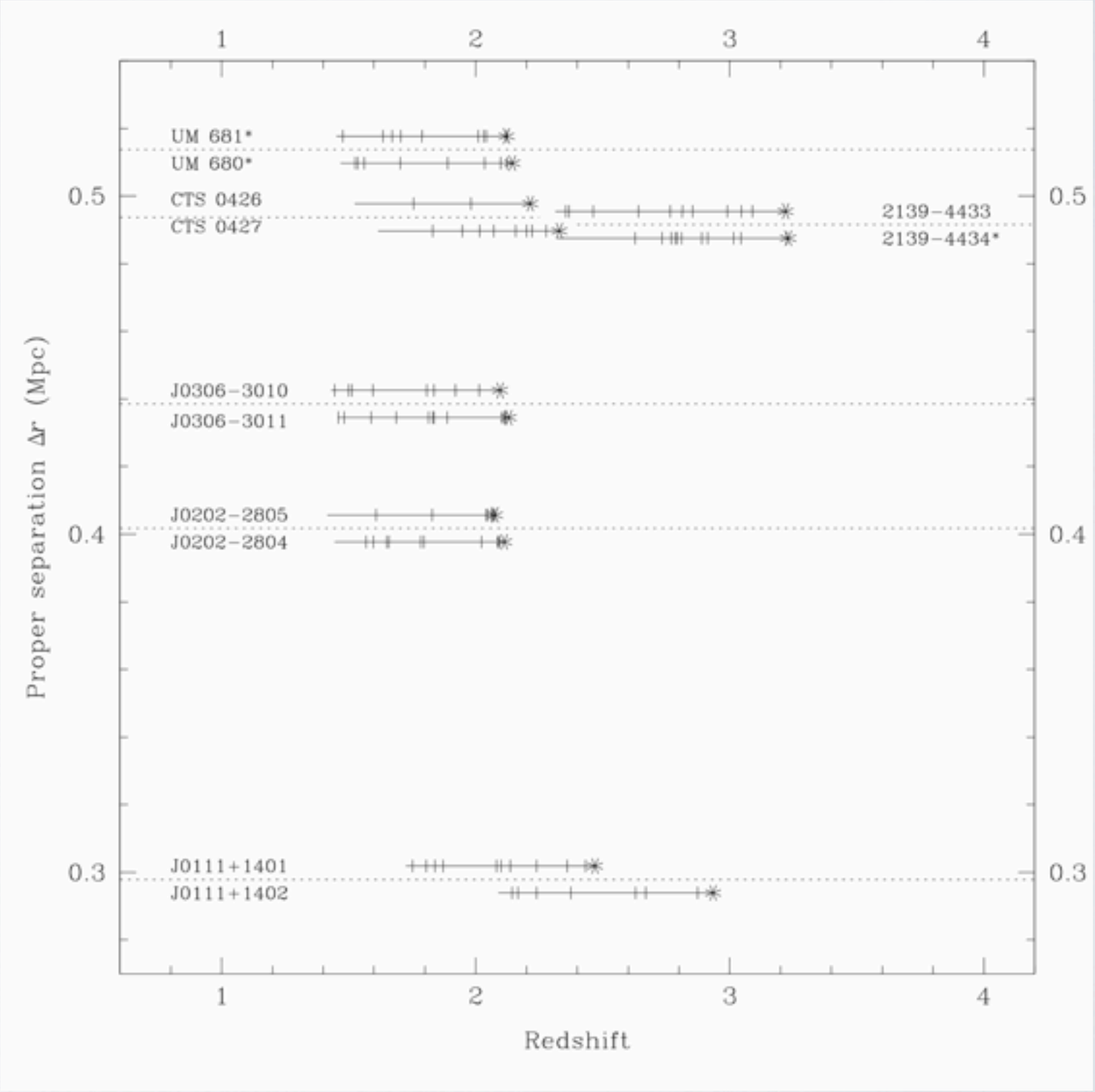
4.5 (…) pairs

2 QSOs (COMM-1)
+ 6 QSOs (P84)
+ 1 QSO (P85)

+

5 more pairs

+ 4 QSOs (P86, accepted)
+ 6 QSO (P87, pending)



QSO SAMPLE

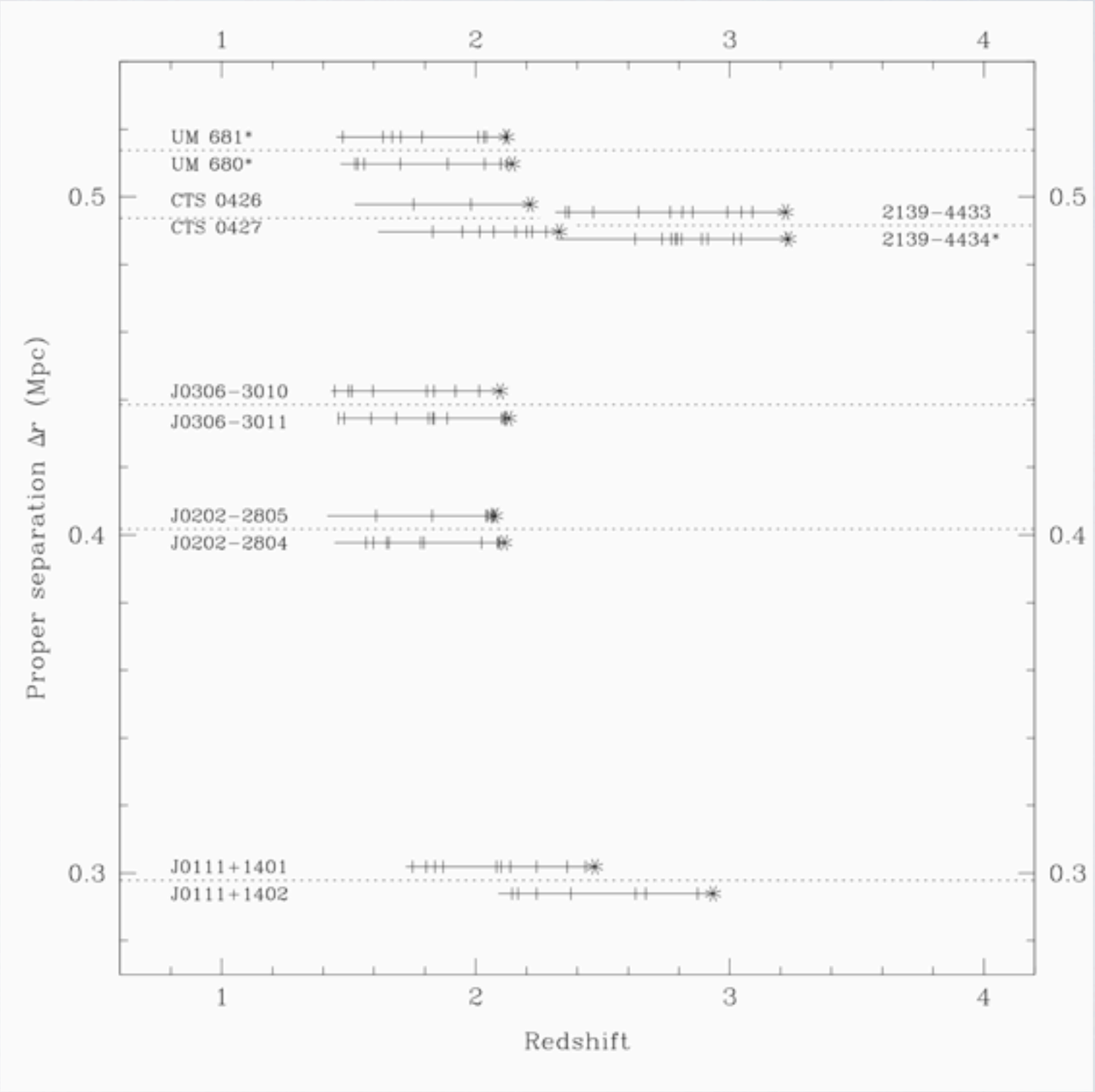
4.5 (…) pairs

2 QSOs (COMM-1)
+ 6 QSOs (P84)
+ 1 QSO (P85)

+

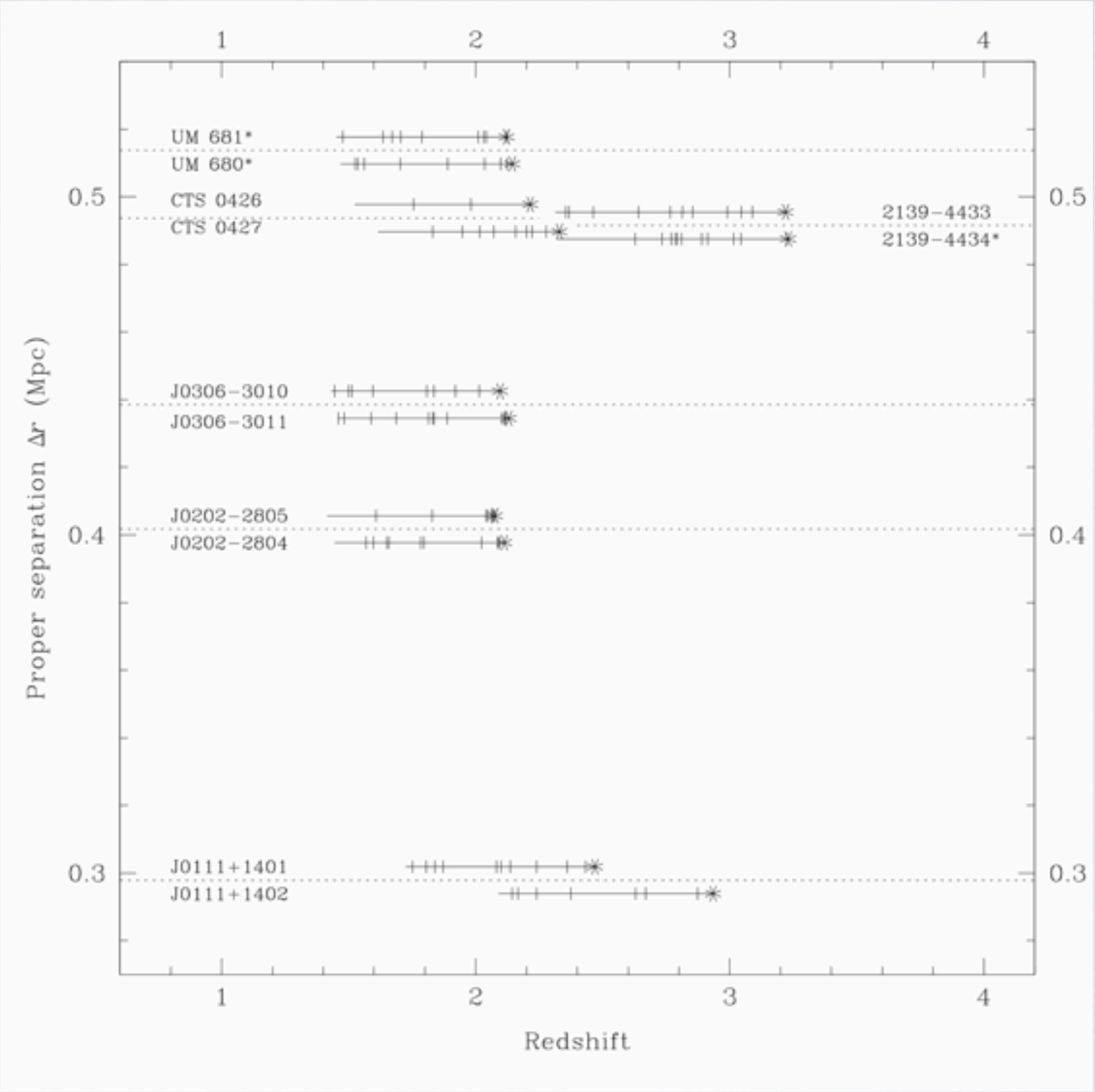
1.5 pairs

observed with UVES

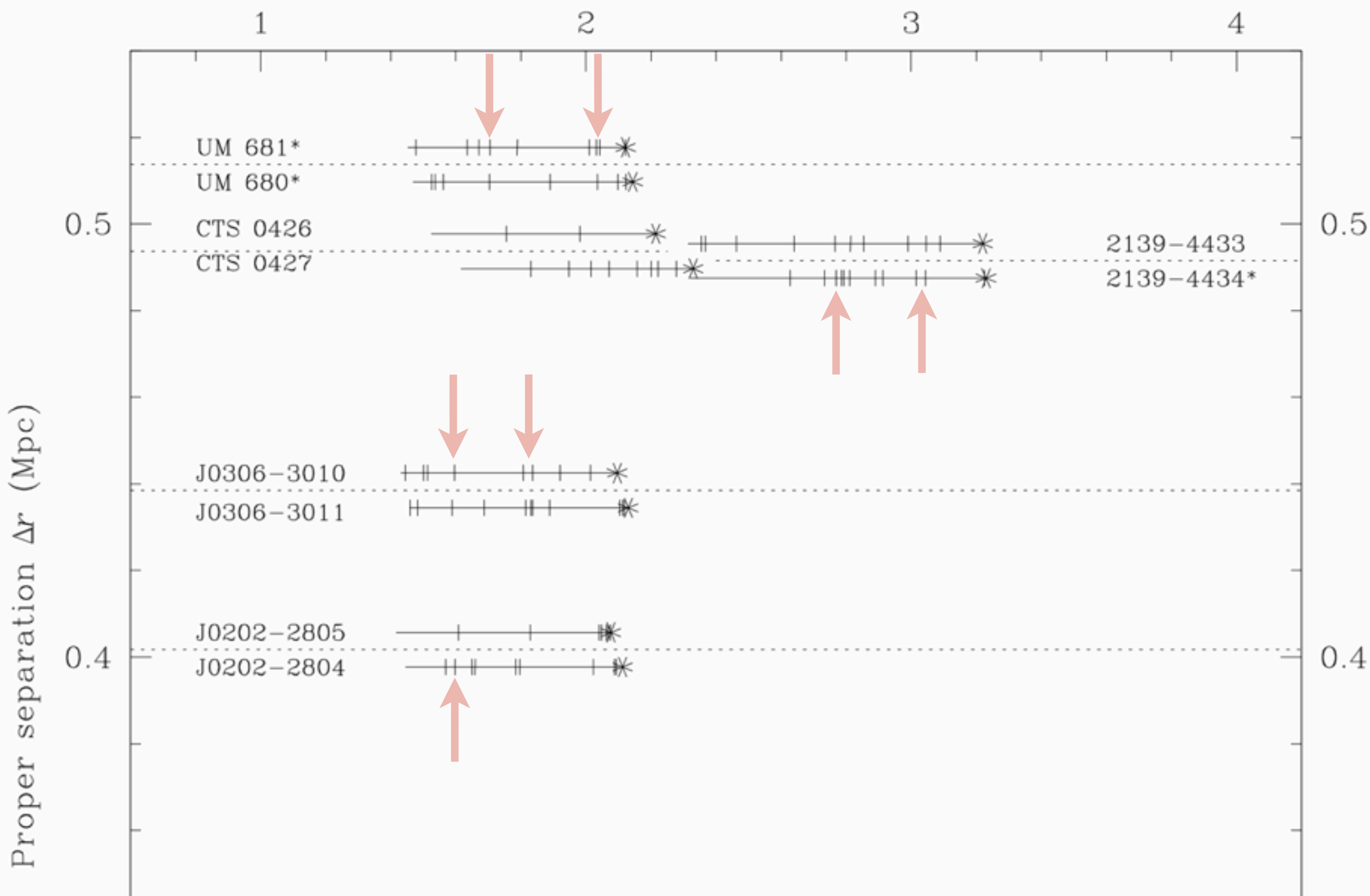


QSO SAMPLE

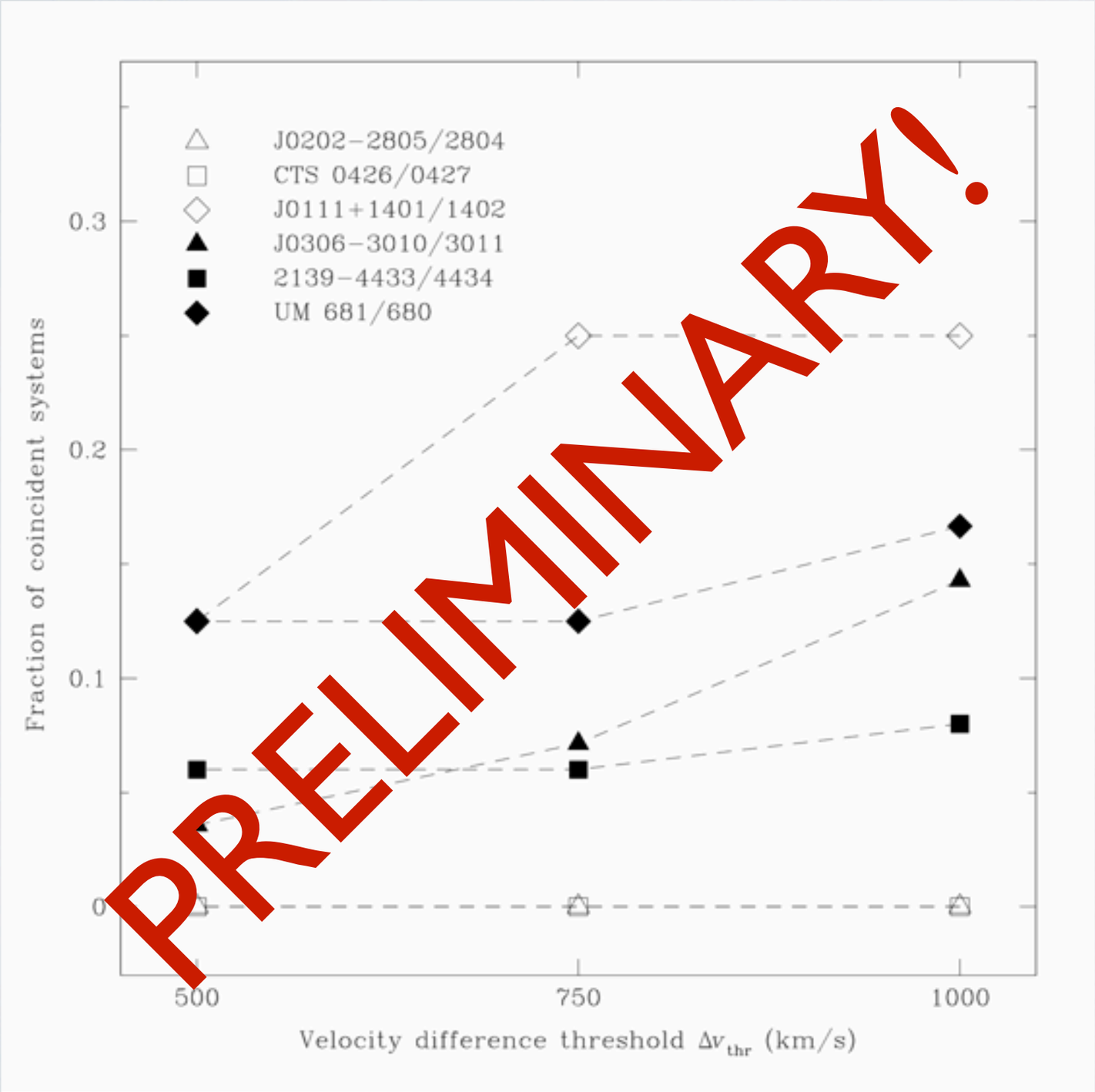
- Both **physical pairs and projected pairs**
- Redshifts **2÷3**
- Angular sep. ≲ **1 arcmin** → proper sep. ≲ **500 kpc**
- S/N **10÷50** in the **Lyman-α** and **C IV** forest



COINCIDENCES OF C IV ABSORPTION



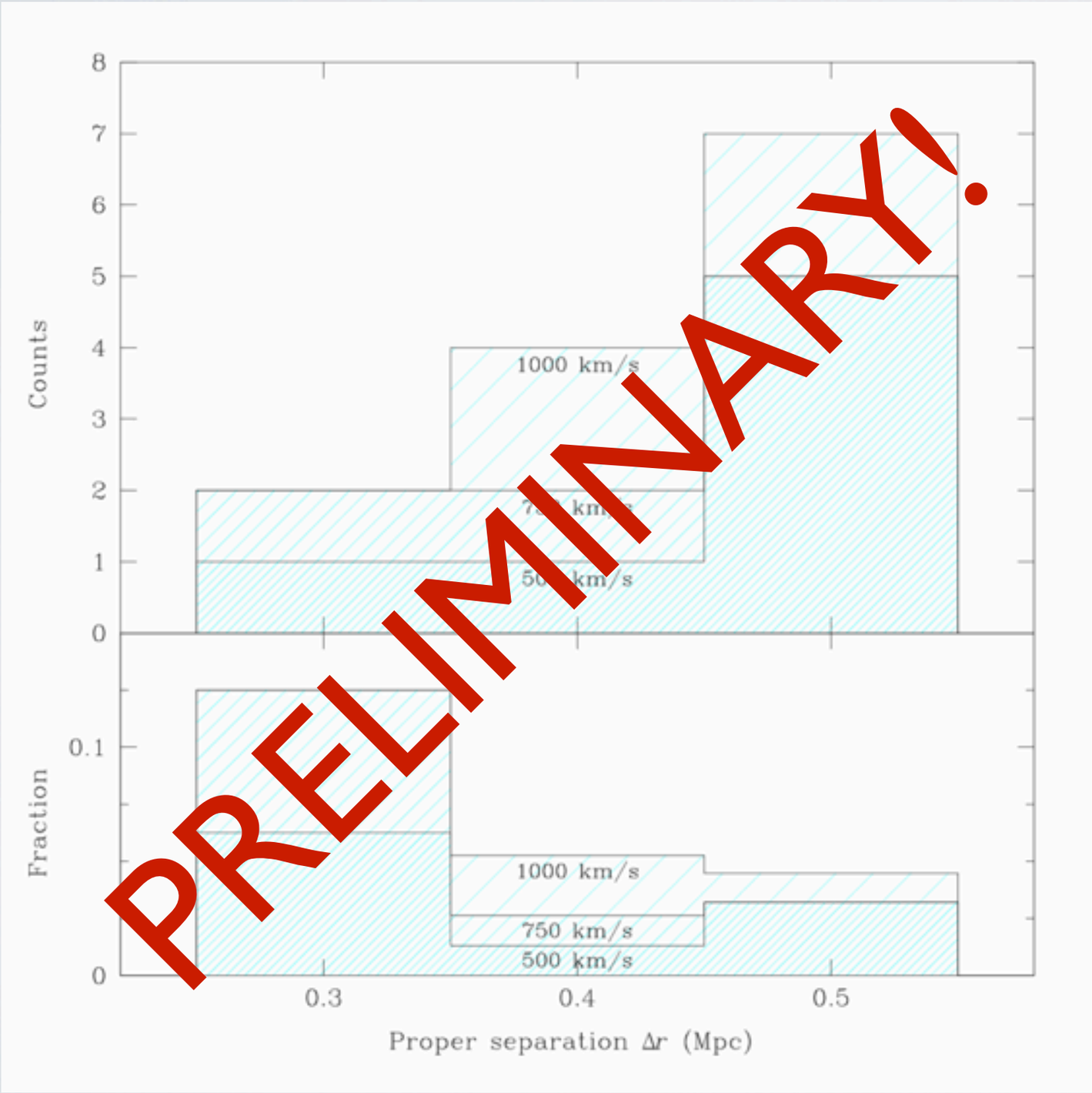
COINCIDENCES OF C IV ABSORPTION



WORK IN PROGRESS!

- Significant addition to UVES results (Cappetta et al. 2010)
- Marginal overabundance of coincident systems within 500 km/s (cf. Martin et al. 2010)
- Need to improve statistics…

COINCIDENCES OF C IV ABSORPTION



WORK IN PROGRESS!

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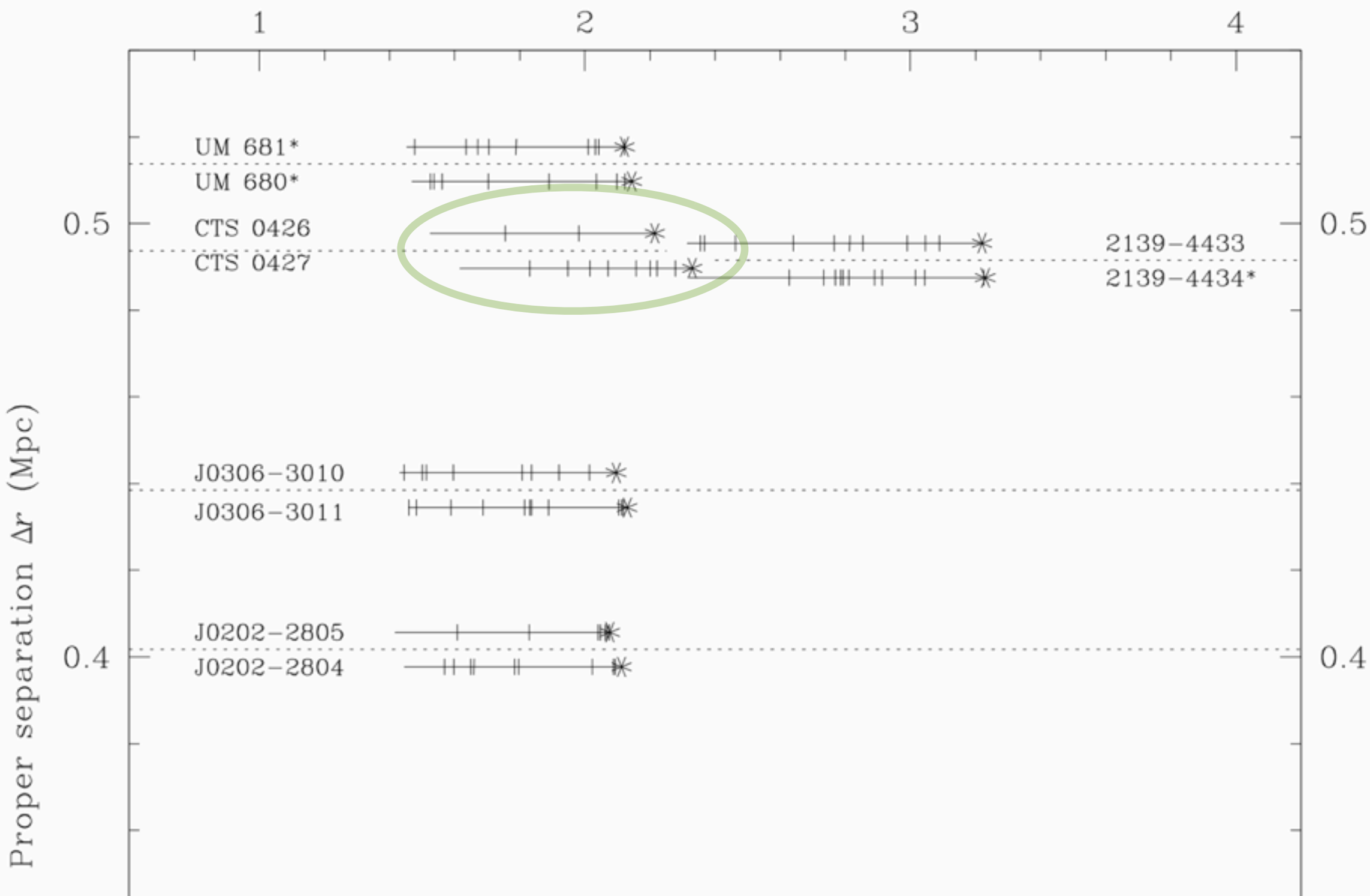
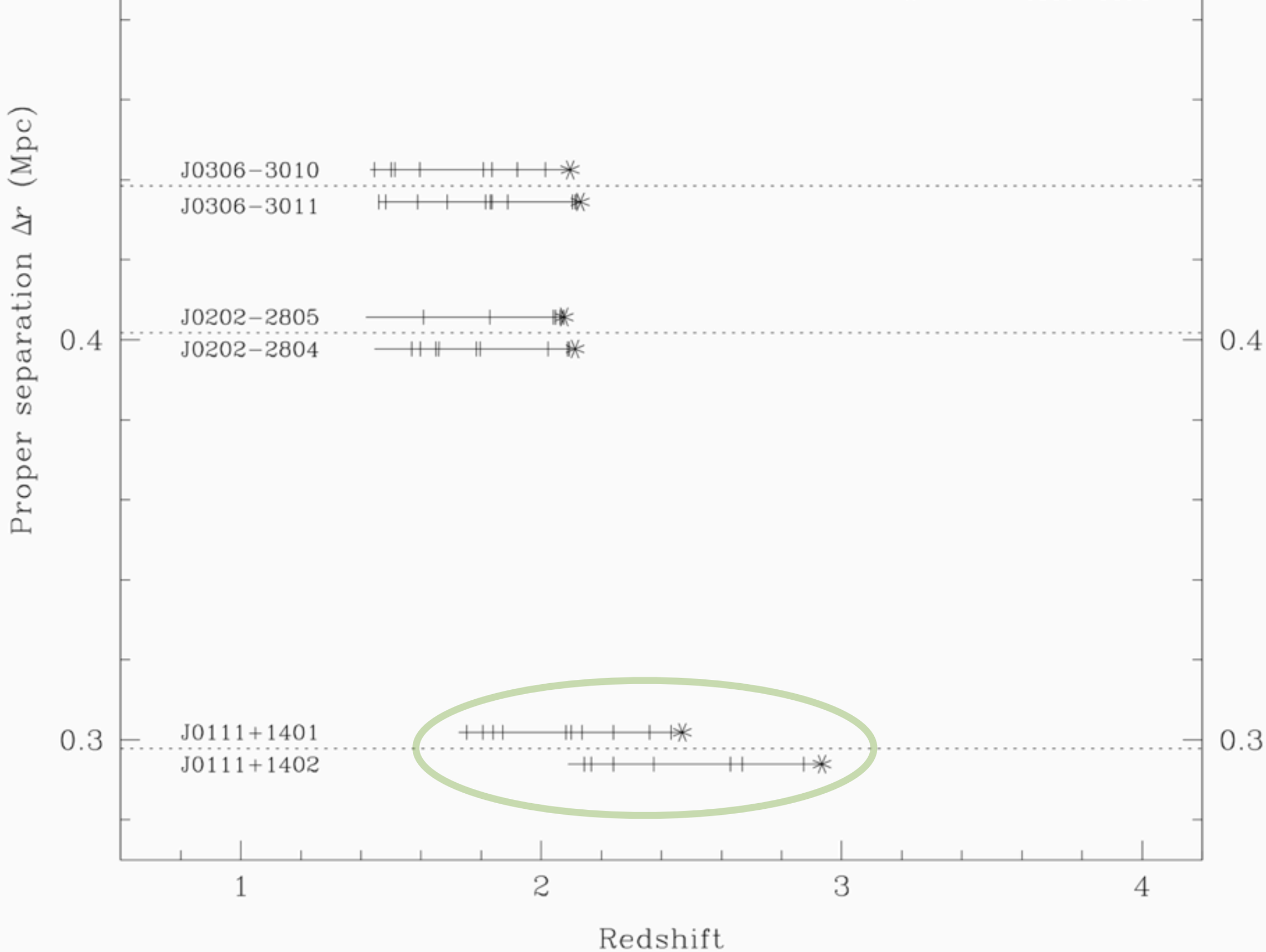
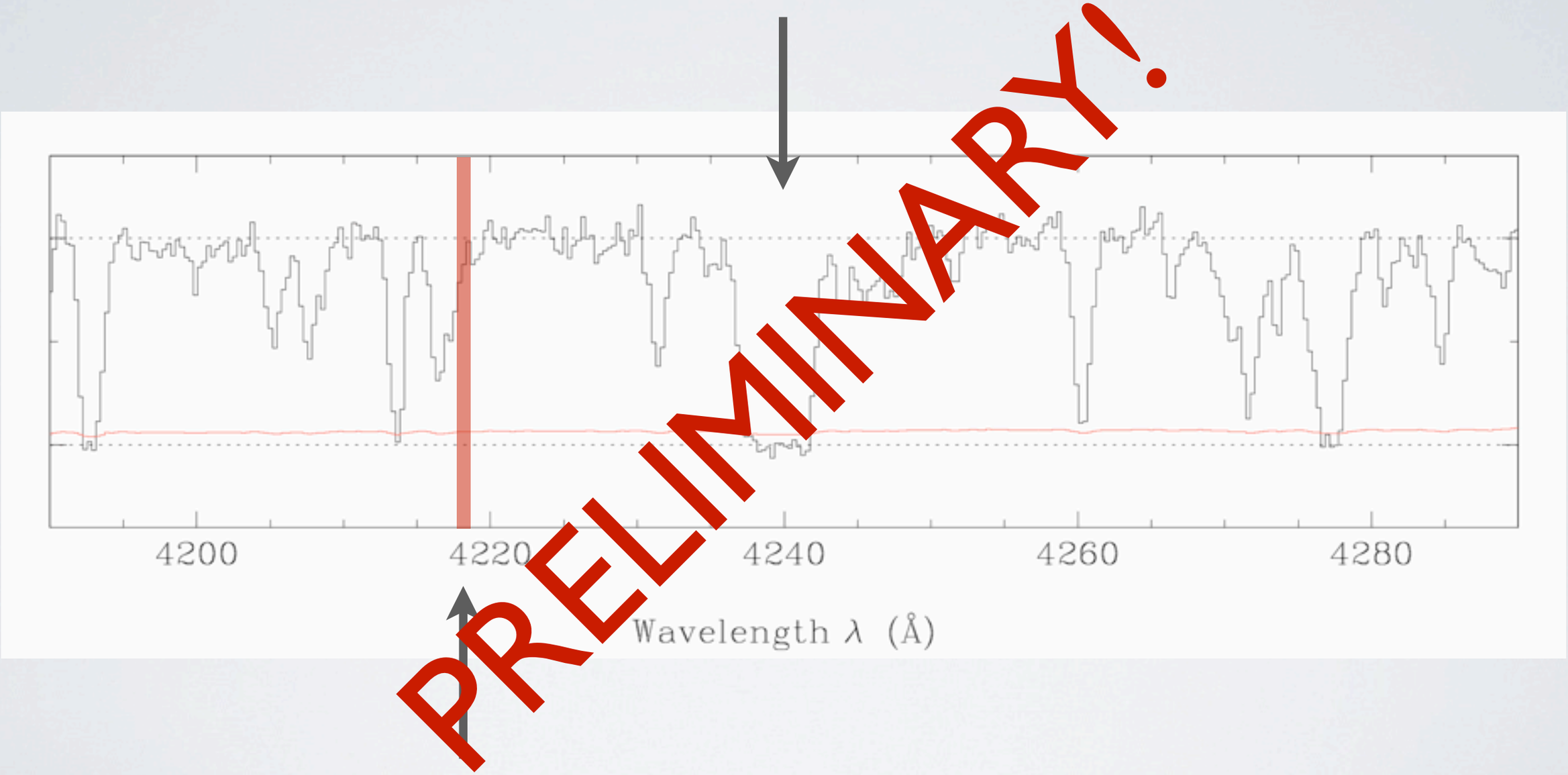
SUITABLE CANDIDATES FOR TPE




Proper separation Δr (Mpc)
0.4
0.3
J0306−3010
J0306−3011
J0202−2805
J0202−2804
J0111+1401
J0111+1402
1
2
3
4
Redshift

QSO J0111+1401/1402

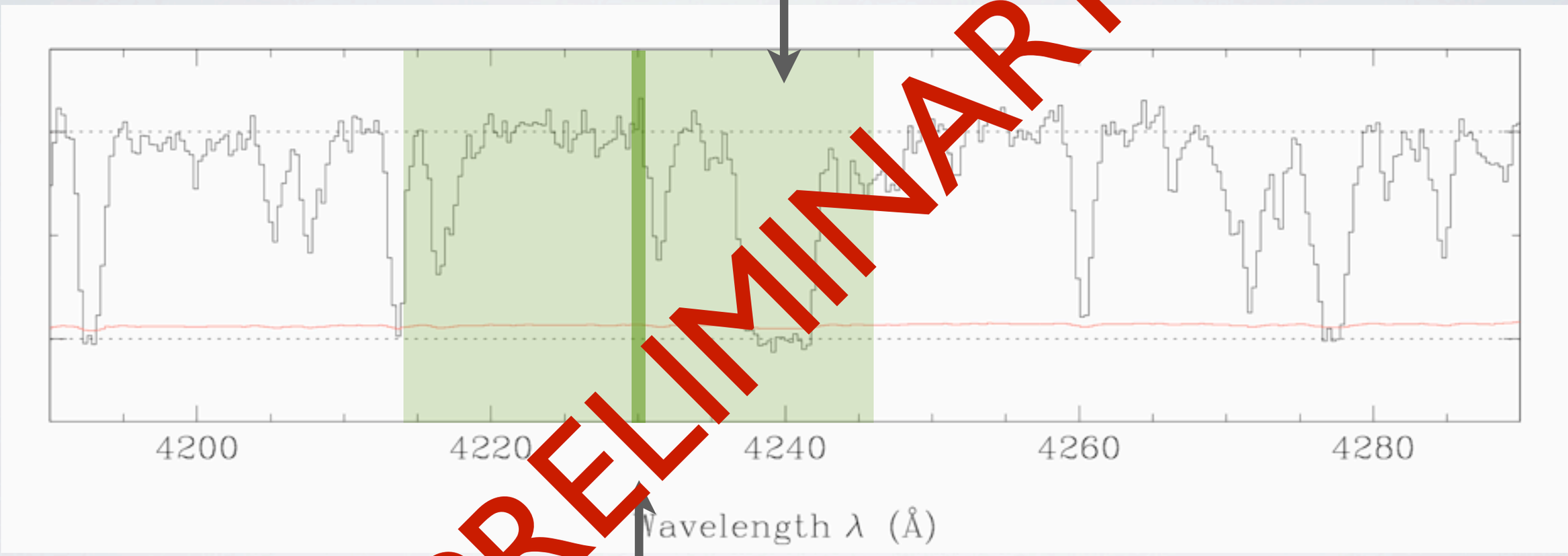
Strong **Lyman-α** signature



$z = 2.47$ (Hennawi et al. 2006)

QSO J0111+1401/1402

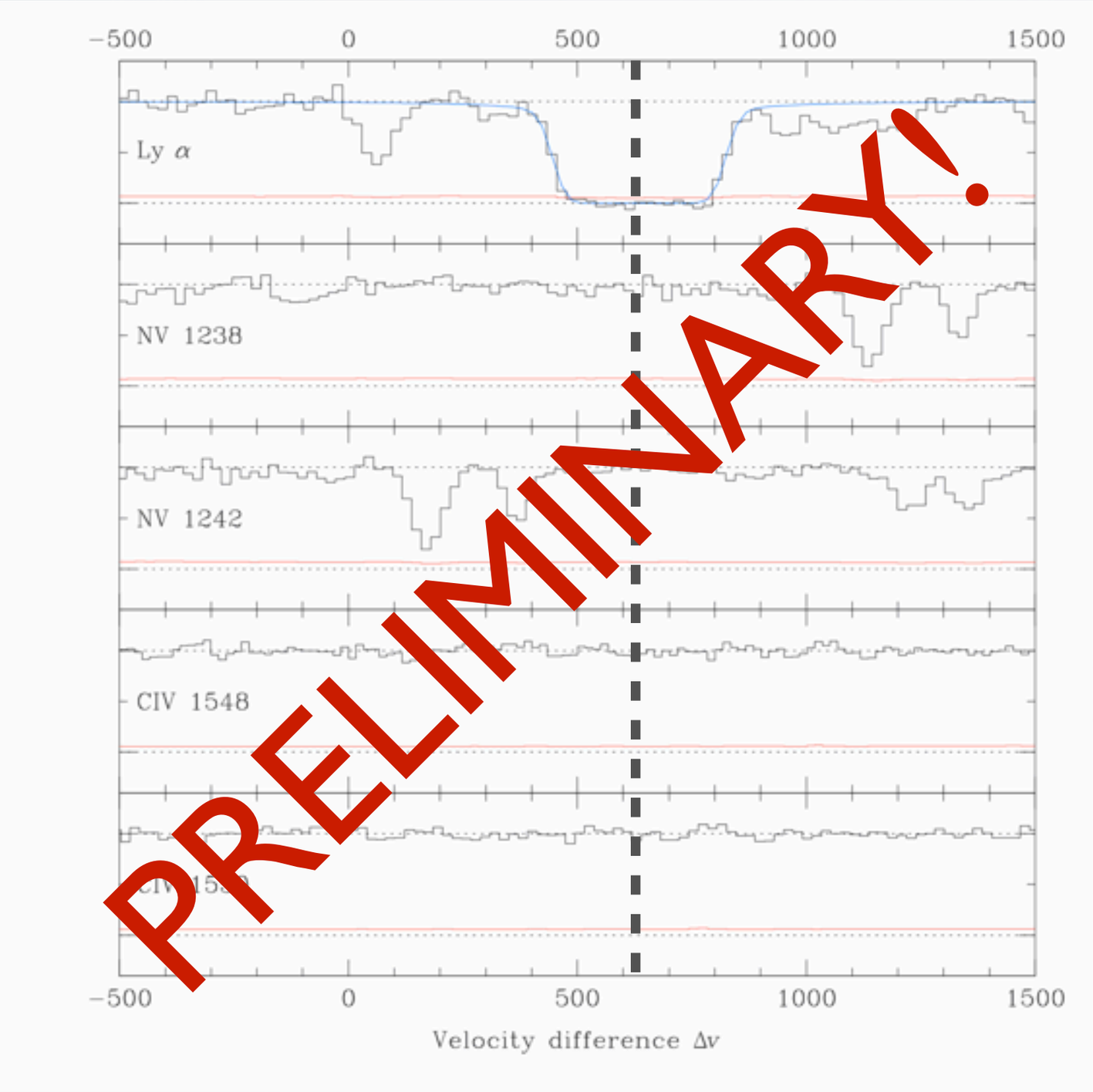
strong **Lyman-α** signature



PRELIMINARY!

corrected redshift from O I emission: $z = 2.480 \pm 0.017$

QSO J0111+1401/1402



Lyman-α @ z = 2.48736:

+

Absence of **N v** and **C IV** absorption

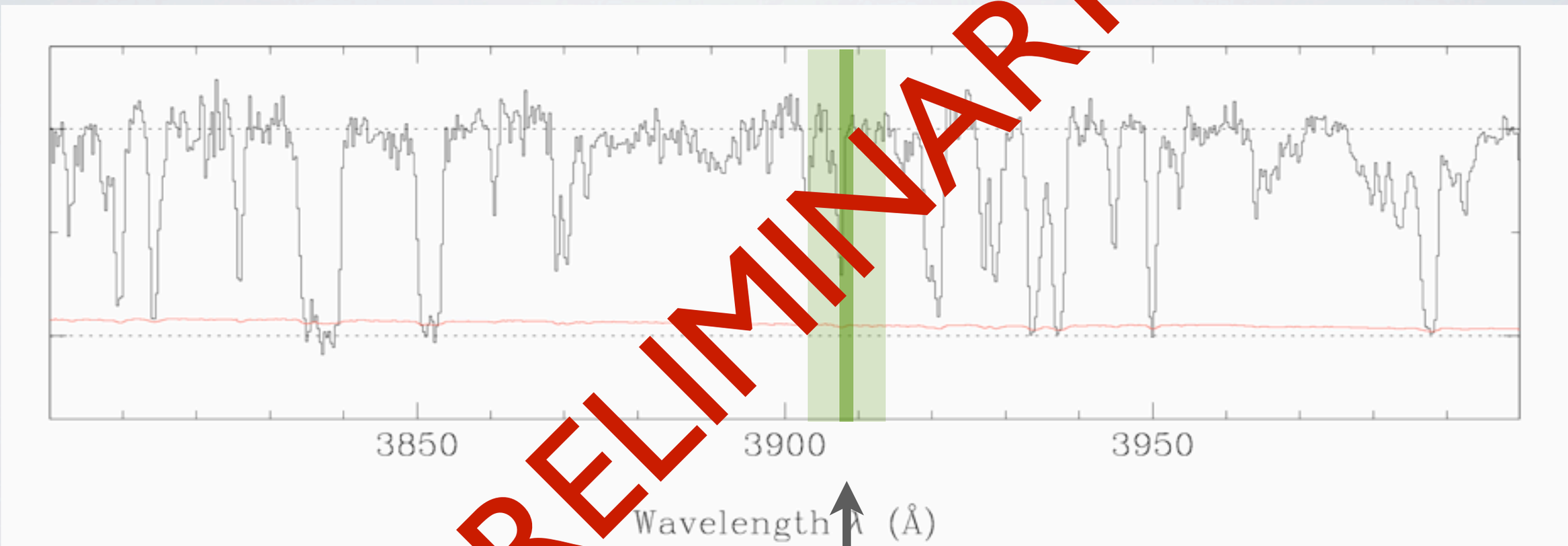
↓

TPE obscured by dense environment

(Fernández-Soto 1995, Hennawi et al. 2006)

CTS 0426-0427

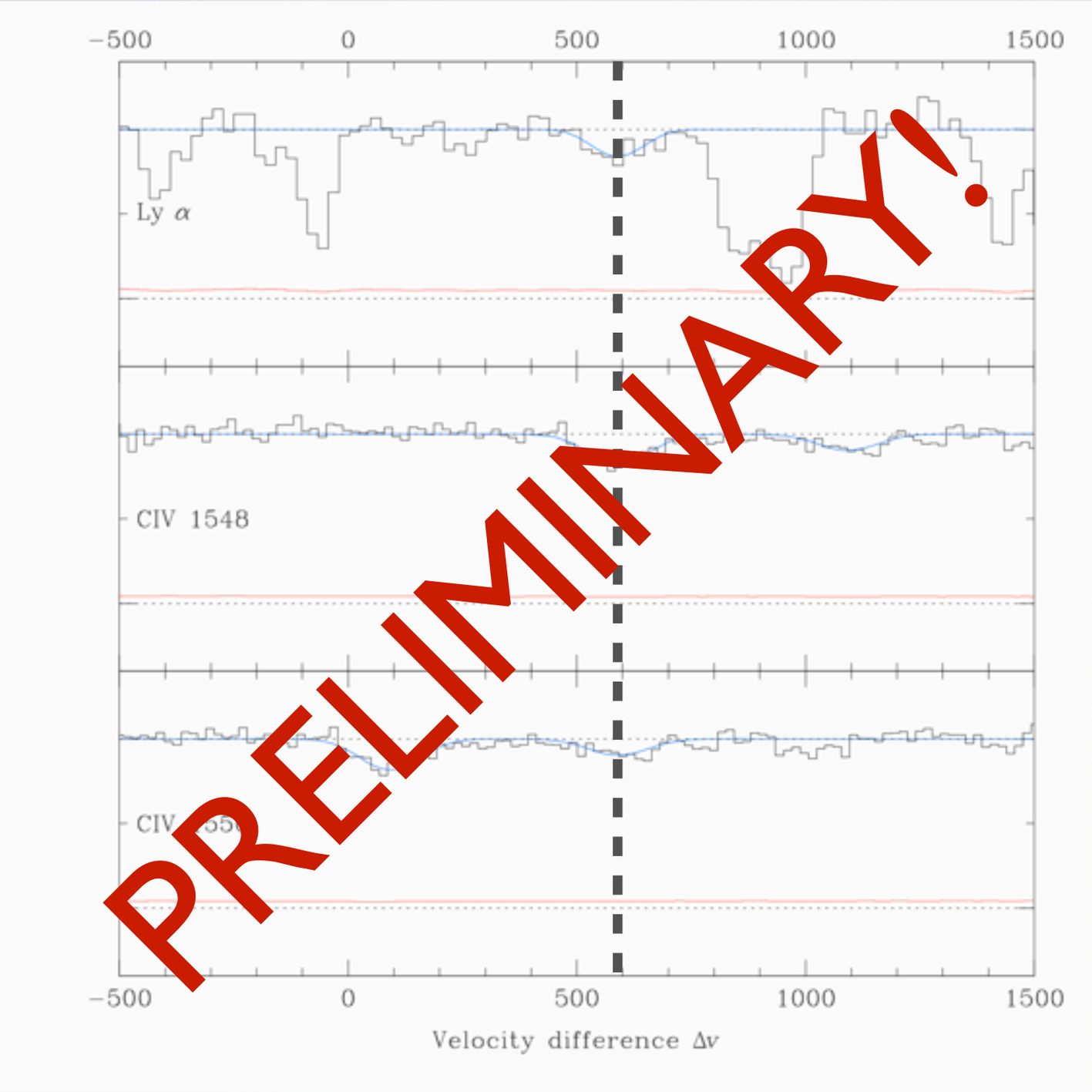
Dearth of **Lyman-α** absorption (cf. Dobrzycki & Bechtold 1991)



PRELIMINARY!

$z = 2.215 \pm 0.0044$ (Marble et al. 2008)

CTS 0426-0427



faint Lyman-α:

$\log N = 13.26 \pm 0.08$

+

C IV @ $z = 2.22134$:

$\log N = 13.62 \pm 0.04$

+

possible N V (blended)

High ionization

PRESENT AND FUTURE

- **X-Shooter** provides a unique opportunity to study QSO pairs
- Preliminary results are extremely promising for studying **coincidences of C IV systems** and the **TPE**
- Next steps: detailed **Lyman-α forest** analysis; complete identification of **all metal-line systems**; **auto-correlation and cross-correlation** measure
- Need for **more observation** to improve statistics and perform the AP test

THANKS!