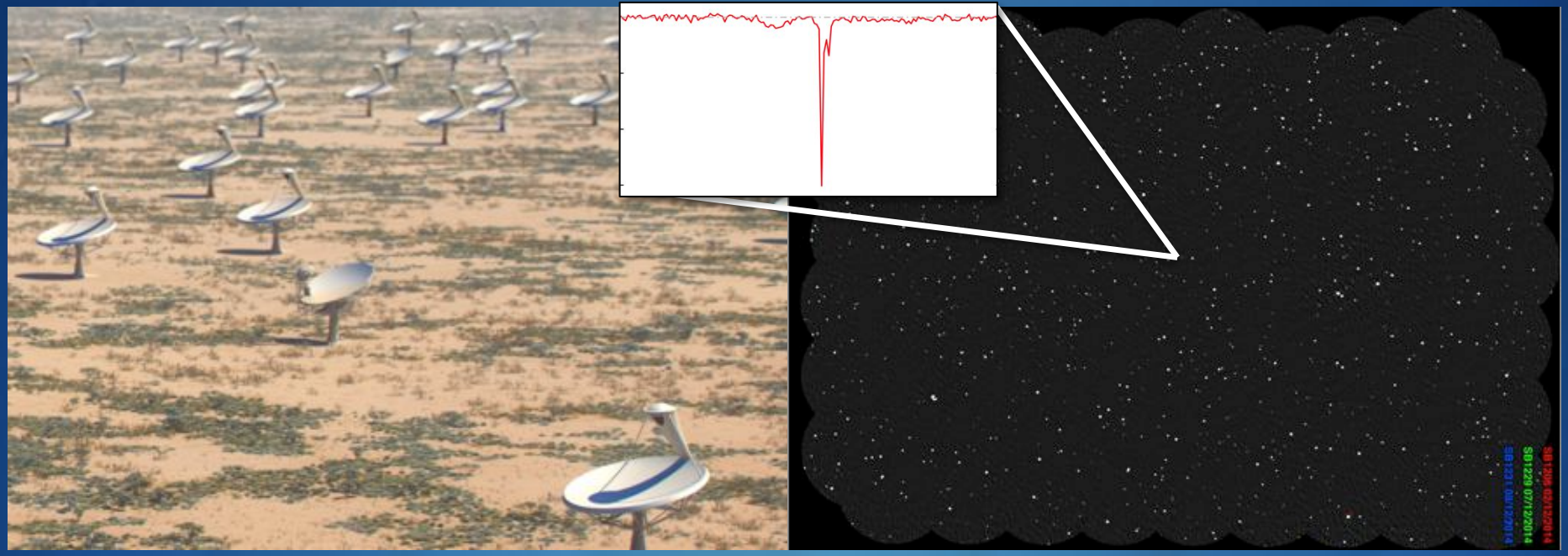
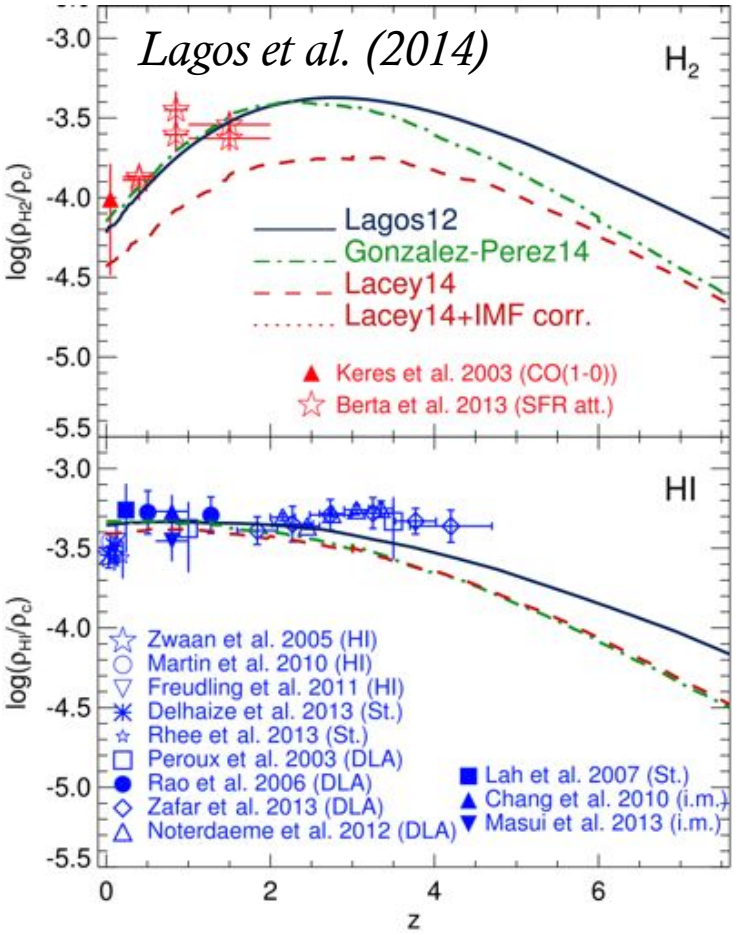
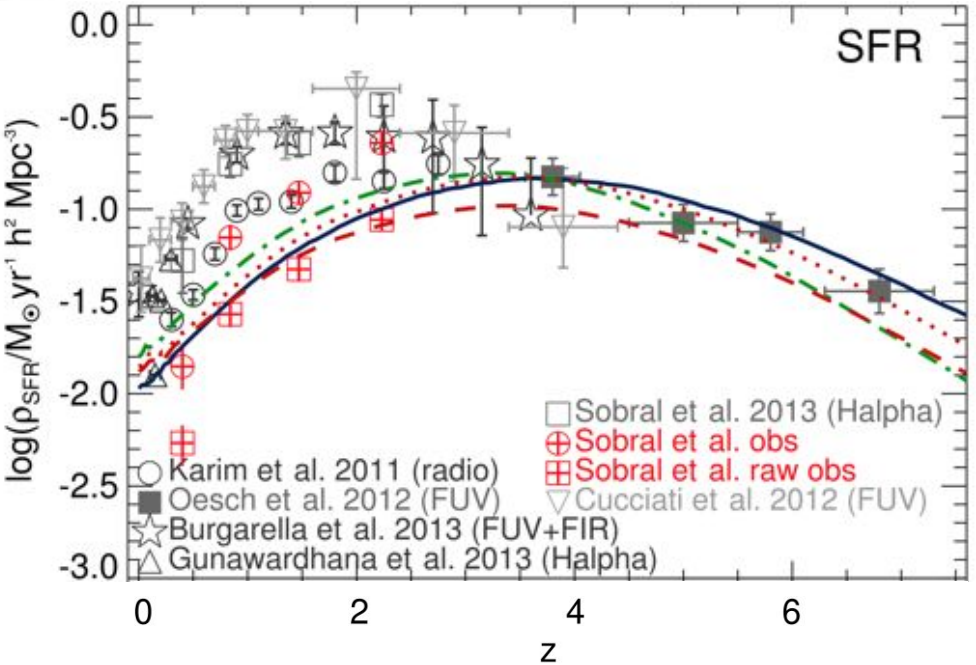


Illuminating neutral gas in the $z = 0$ - 1 Universe

James Allison (Bolton Fellow, CSIRO)

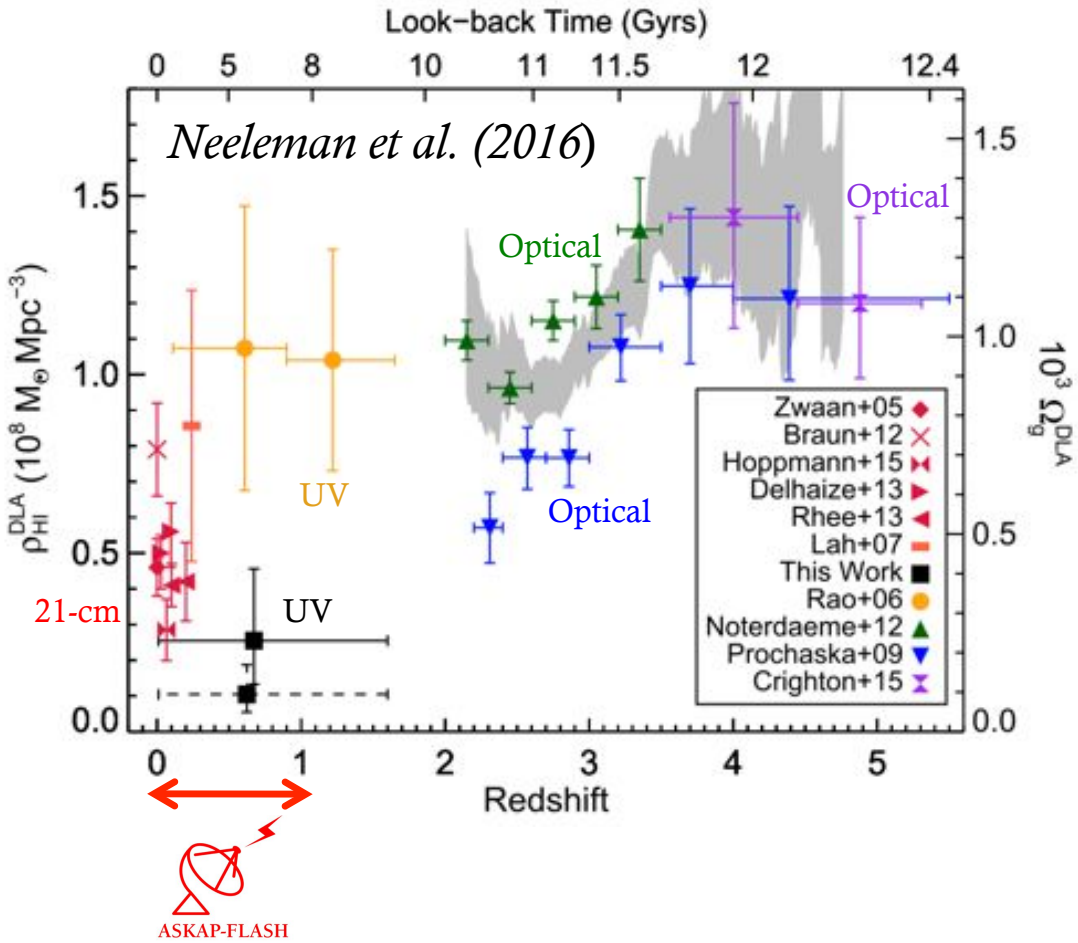
Why do we care? - Fuel for star formation

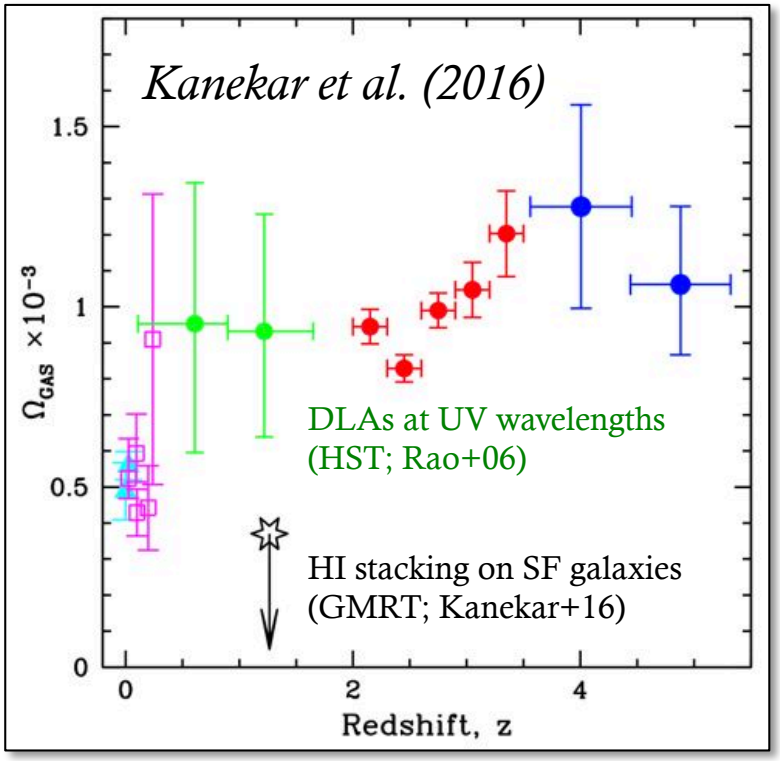




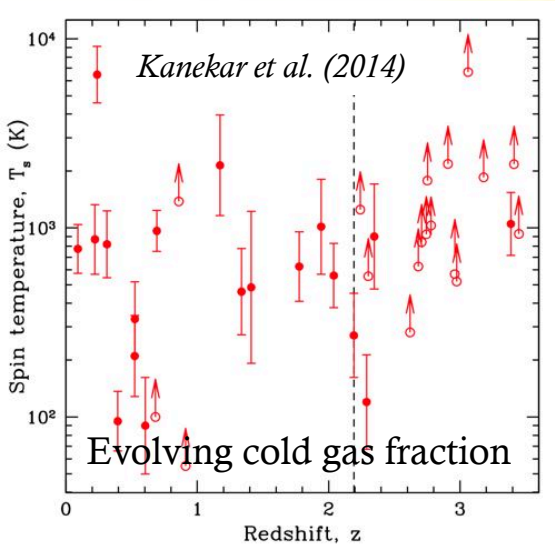
- Why is the cosmological evolution of the total HI apparently much less than that seen in H_2 and SFR?
- Does observational bias play a role (e.g. dust obscuration or sample selection)?

An incomplete picture of neutral gas at $0.2 < z < 1.7$



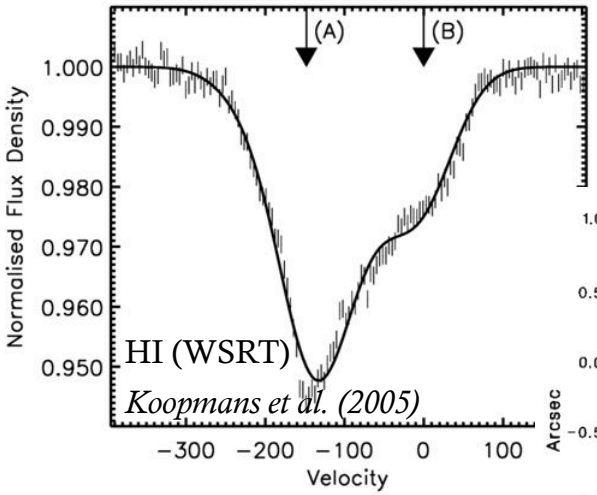


Why 21-cm HI absorption?

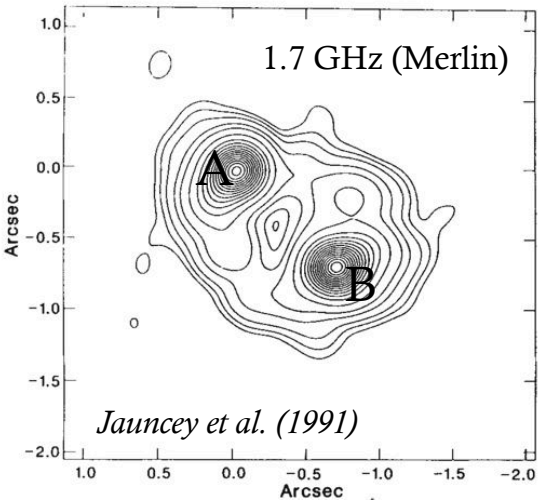


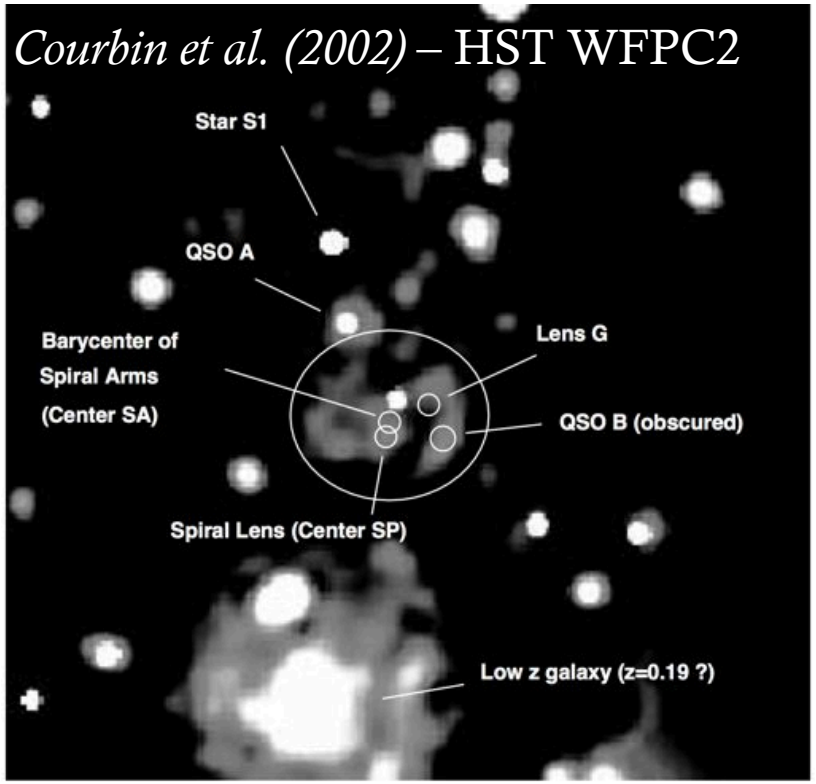
- For a flux limited survey of radio sources, detection of HI absorption is independent of redshift
- HI absorption is sensitive to the colder gas, thereby tracing the fraction of cold ($T \sim$ 100K) ISM and the fuel for star formation
- SKA pathfinders can be used to carry out a blind survey of HI absorption in an observationally-challenging epoch

Case Study 1: PKS B1830-211



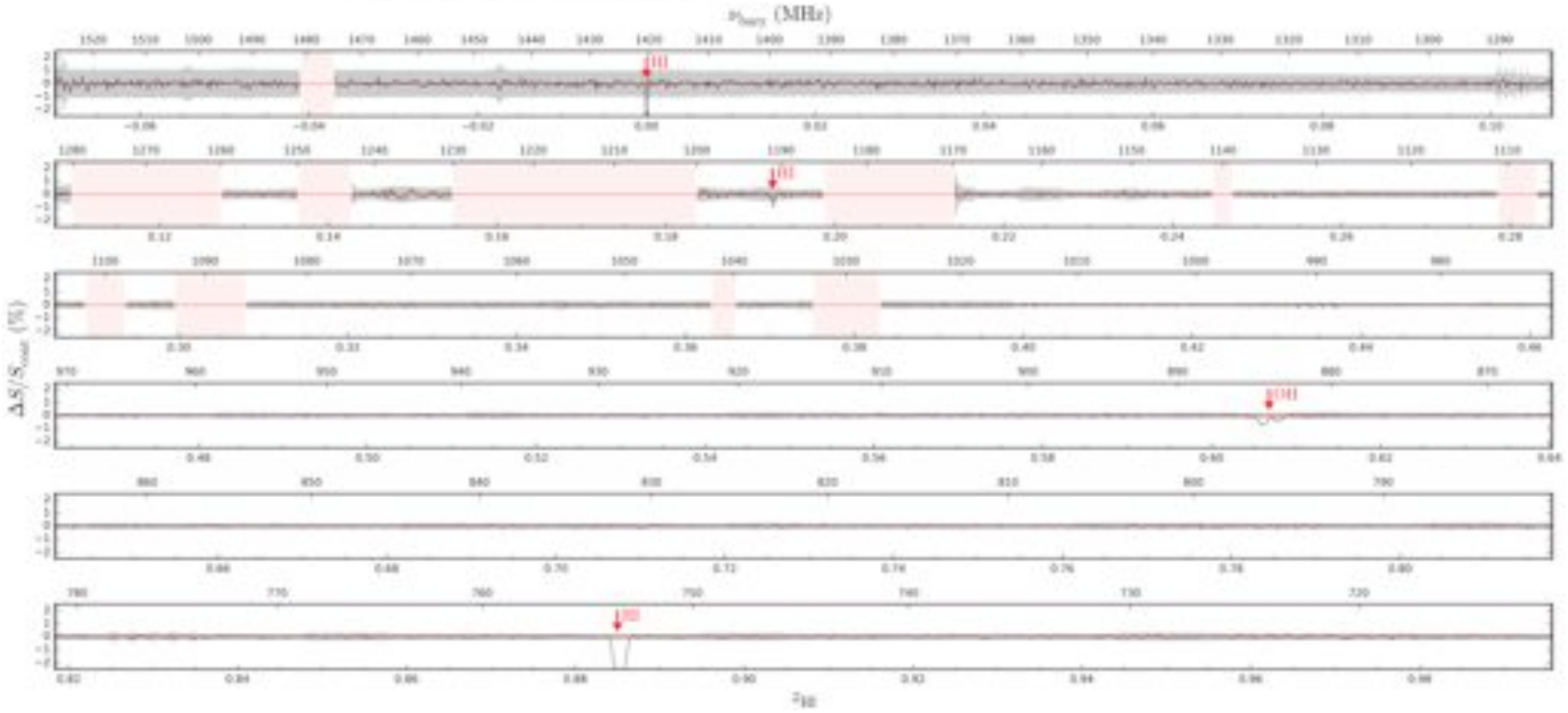
Einstein Ring





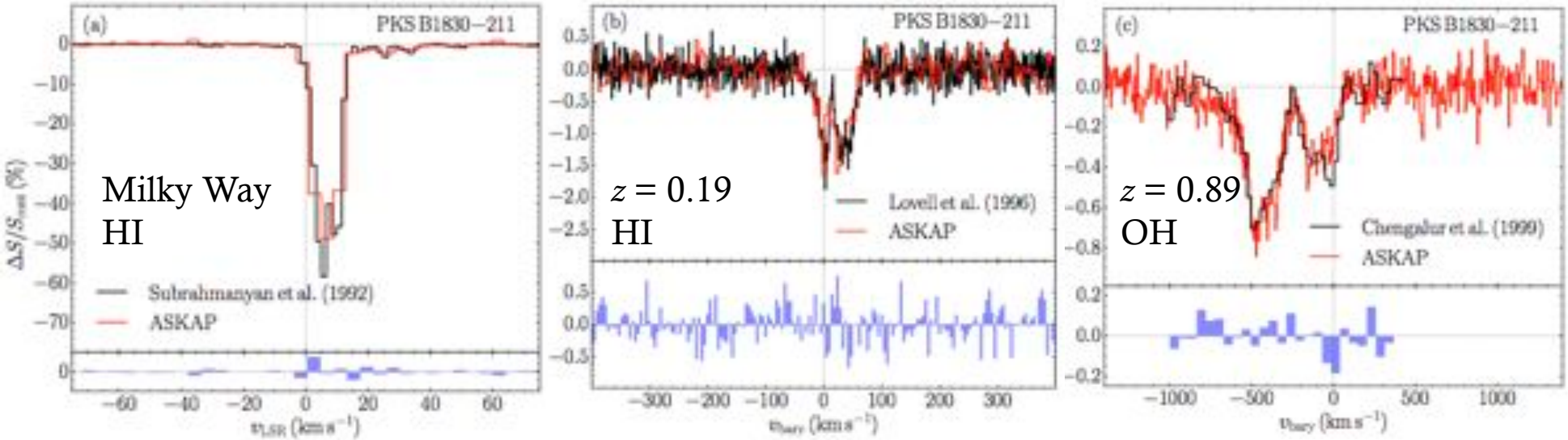
- 10 Jy blazar at $z = 2.507$ (Lidman et al. 1999)
- Spiral galaxy at $z = 0.886$ (Winn et al./Courbin et al. 2002)
- Second galaxy at $z = 0.192$ (Lovell et al. 1996)

ASKAP-BETA survey for intervening galaxies



(Allison et al. 2016a – in prep.)

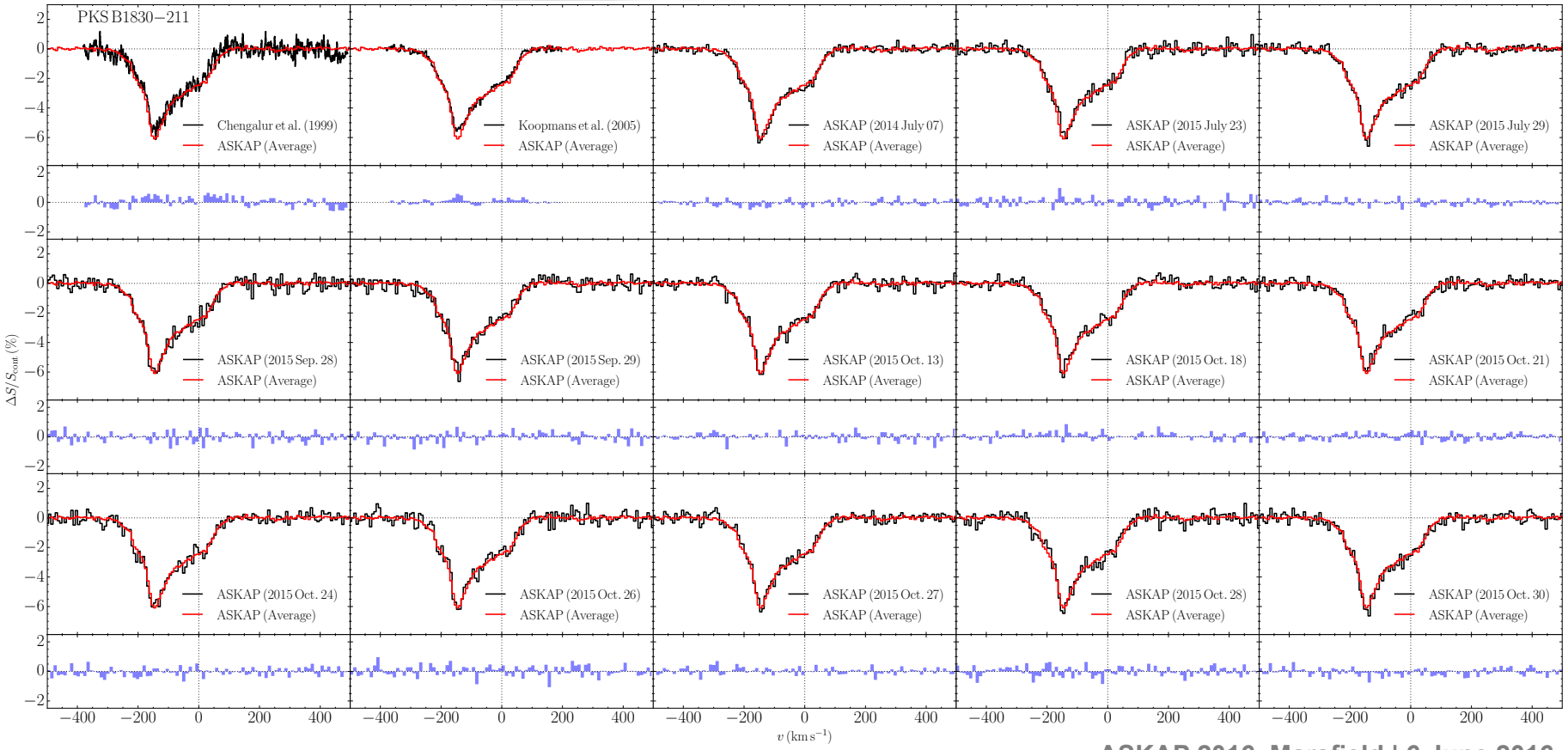
Comparison with the literature



- Good consistency between ASKAP-BETA optical depth spectra and literature
- See same velocity structures in the gas

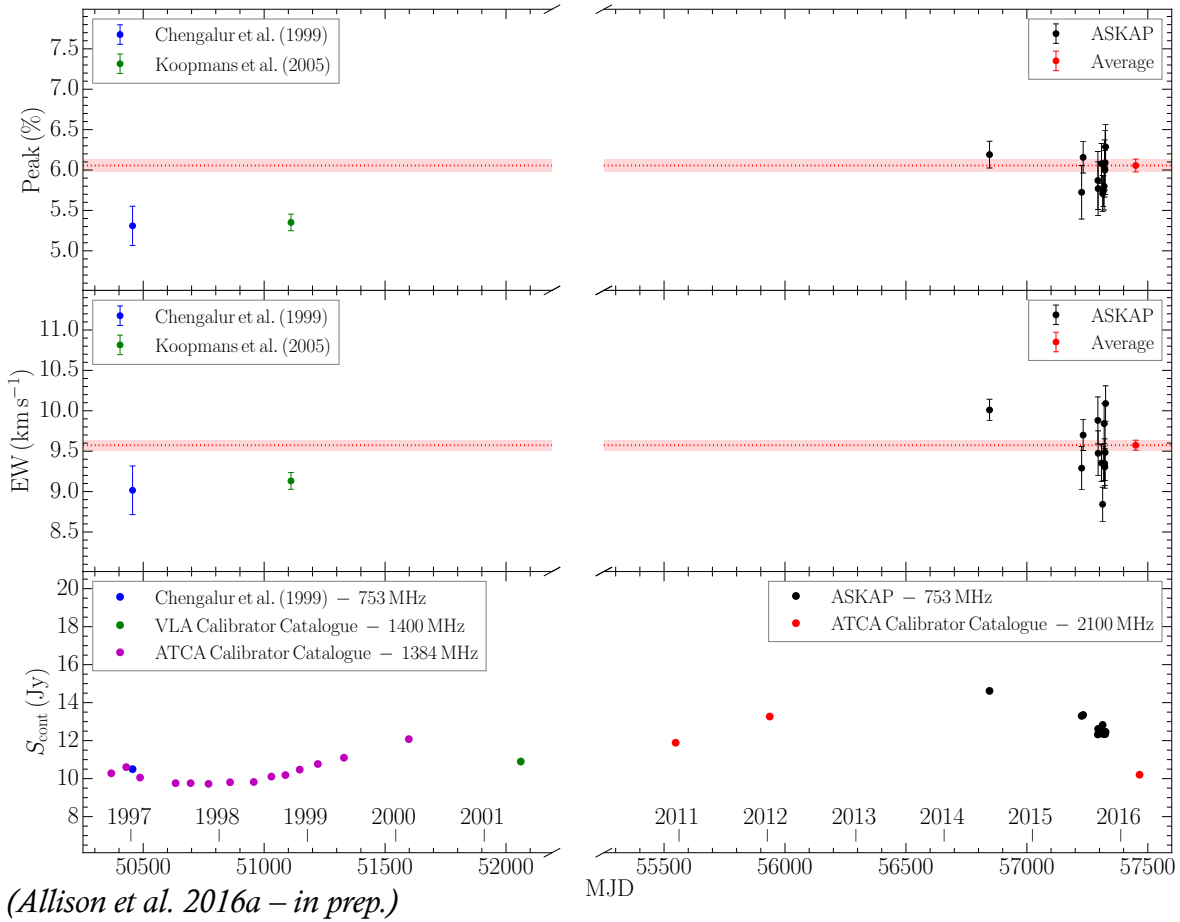
(Allison et al. 2016a – in prep.)

Monitoring HI absorption in the $z = 0.89$ gravitational lens



(Allison et al. 2016a – in prep.)

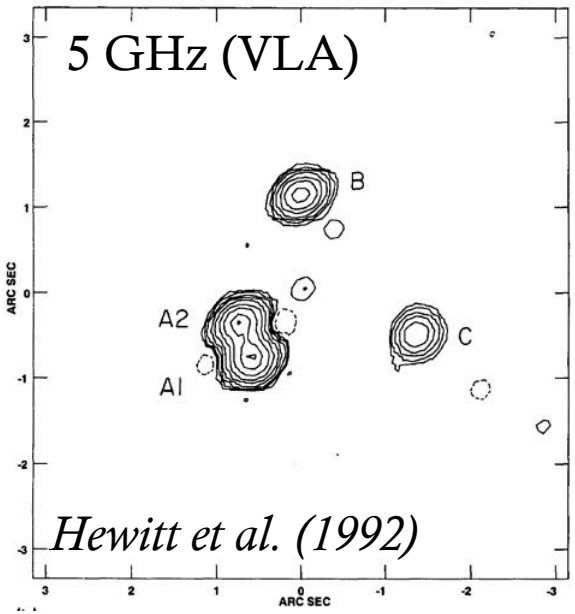
Probing changes in the jet structure via HI absorption

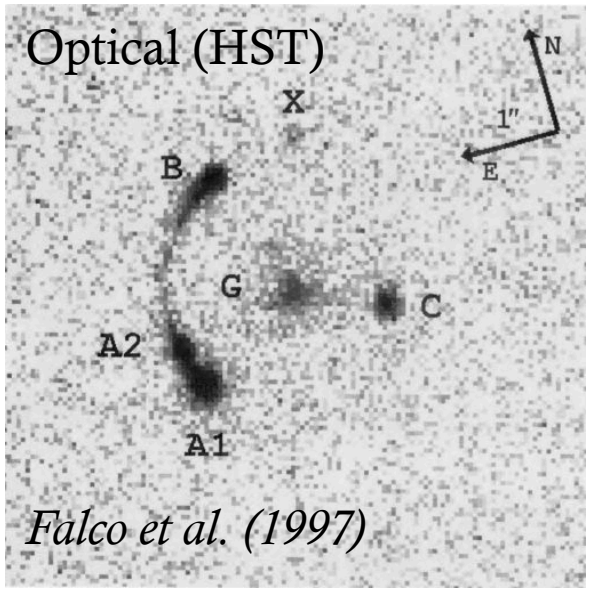


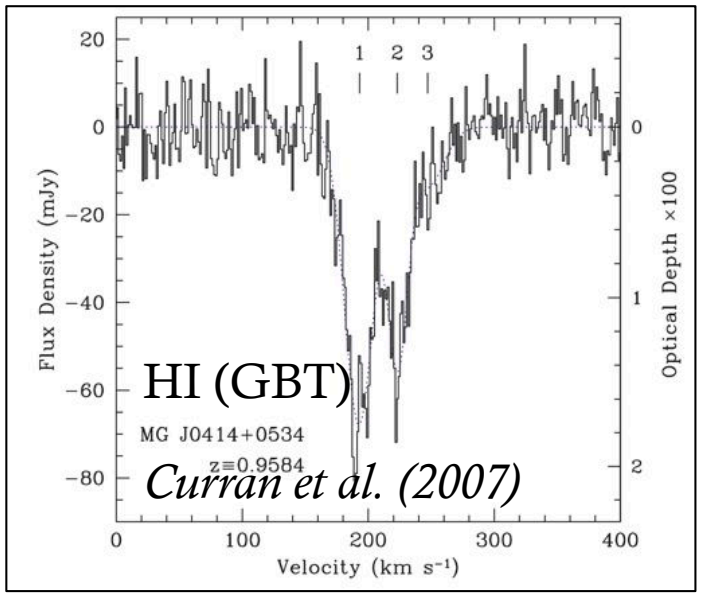
(Allison et al. 2016a – in prep.)

- Evidence for systematic increase in HI opacity in z = 0.89 gravitational lens over 20 years
- Changes in the background source structure are magnified at the lens (e.g. Jin et al. 2003)
- If matched to the HI cloud distribution will imprint on the absorption
- Similar changes seen in molecular gas (e.g. Mueller et al. 2008)

Case study 2: MGJ0414+0534



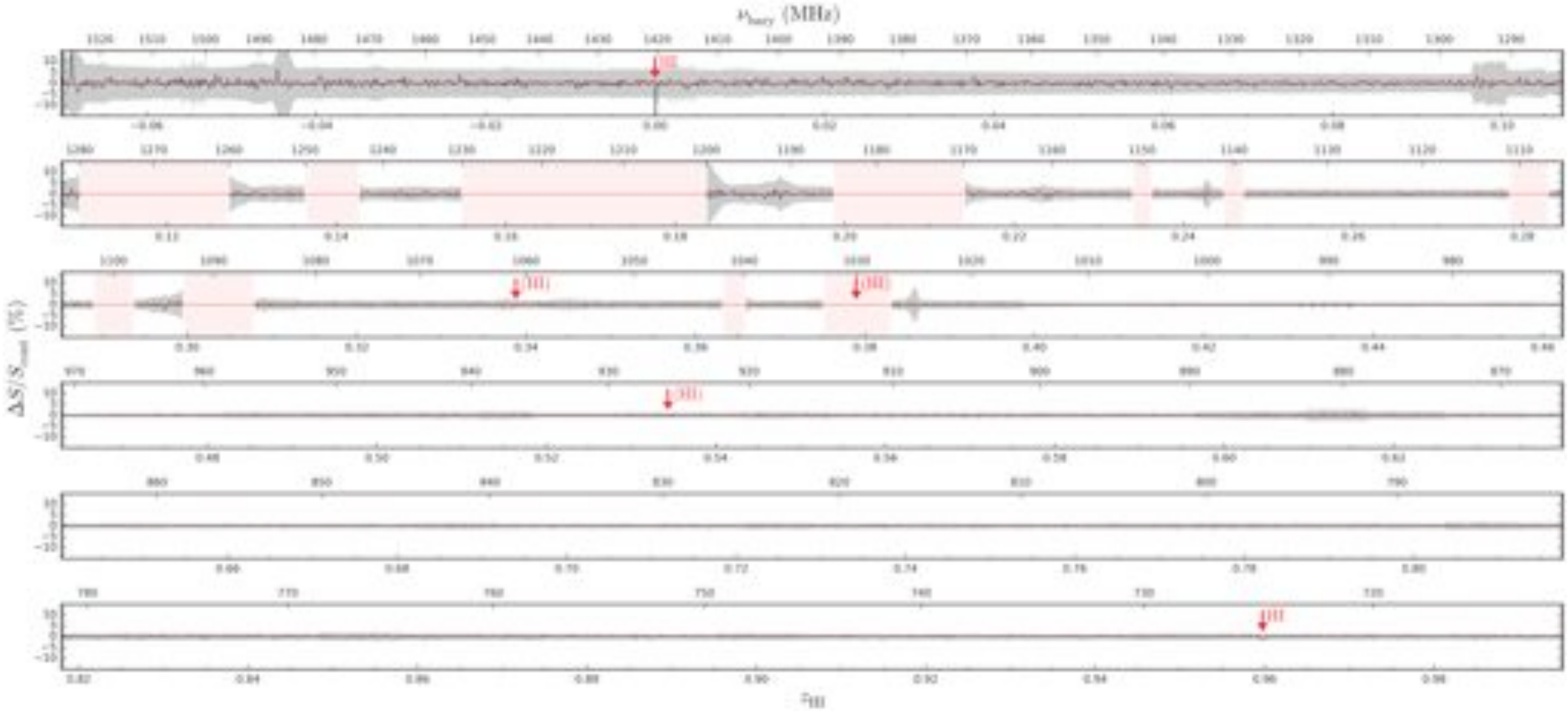




- 2 Jy "exceedingly" red quasar at $z = 2.639$ ($V - K = 10.26$; Lawrence et al. 1995)
- Early-type galaxy at $z = 0.958$ (Tonry & Kochanek 1999)
- Evidence of other lens components ("Object X"; Schechter & Moore 1993)

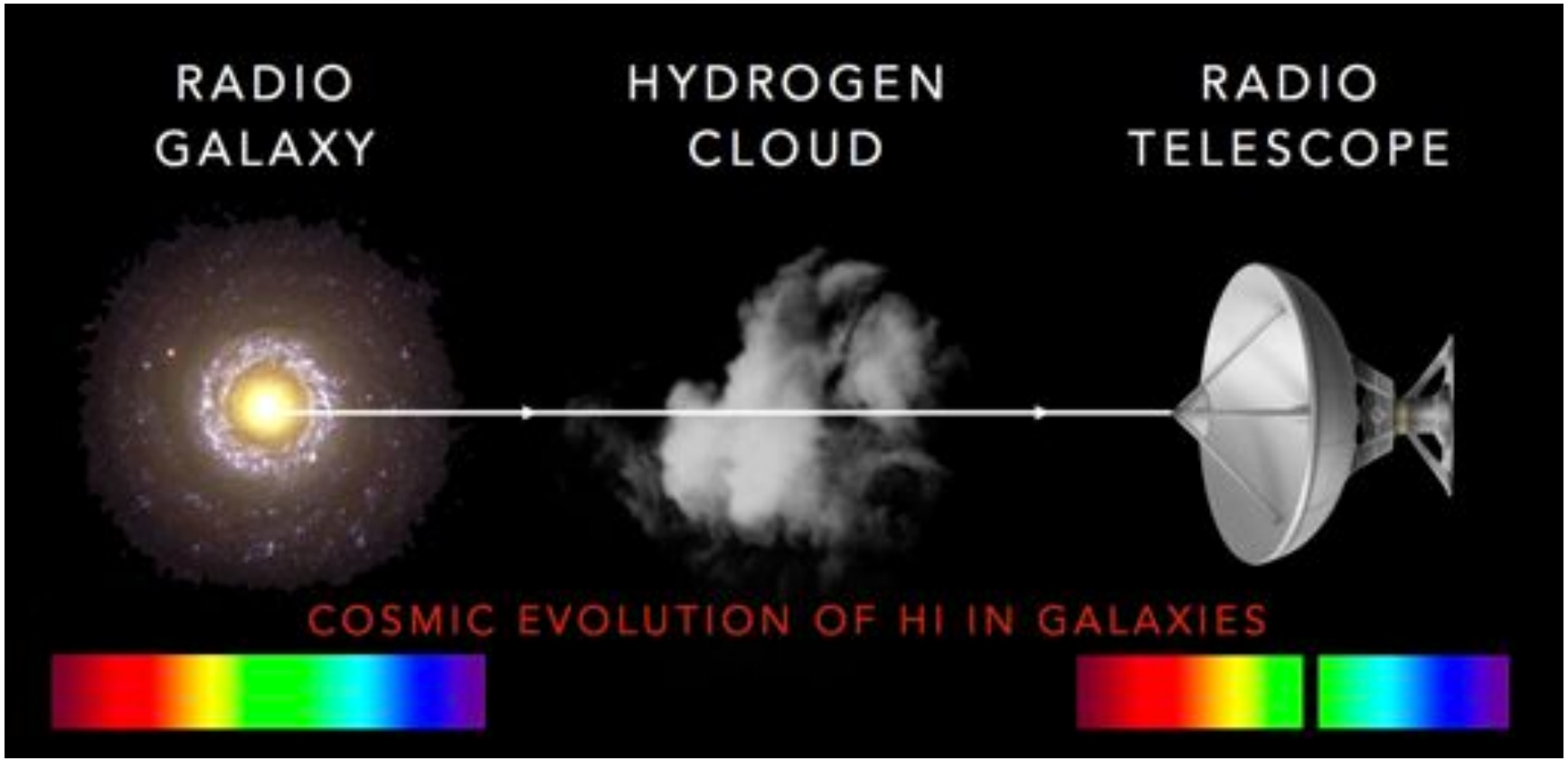
(Allison et al. 2016a – in prep.)

No evidence for several line-of-sight lens components

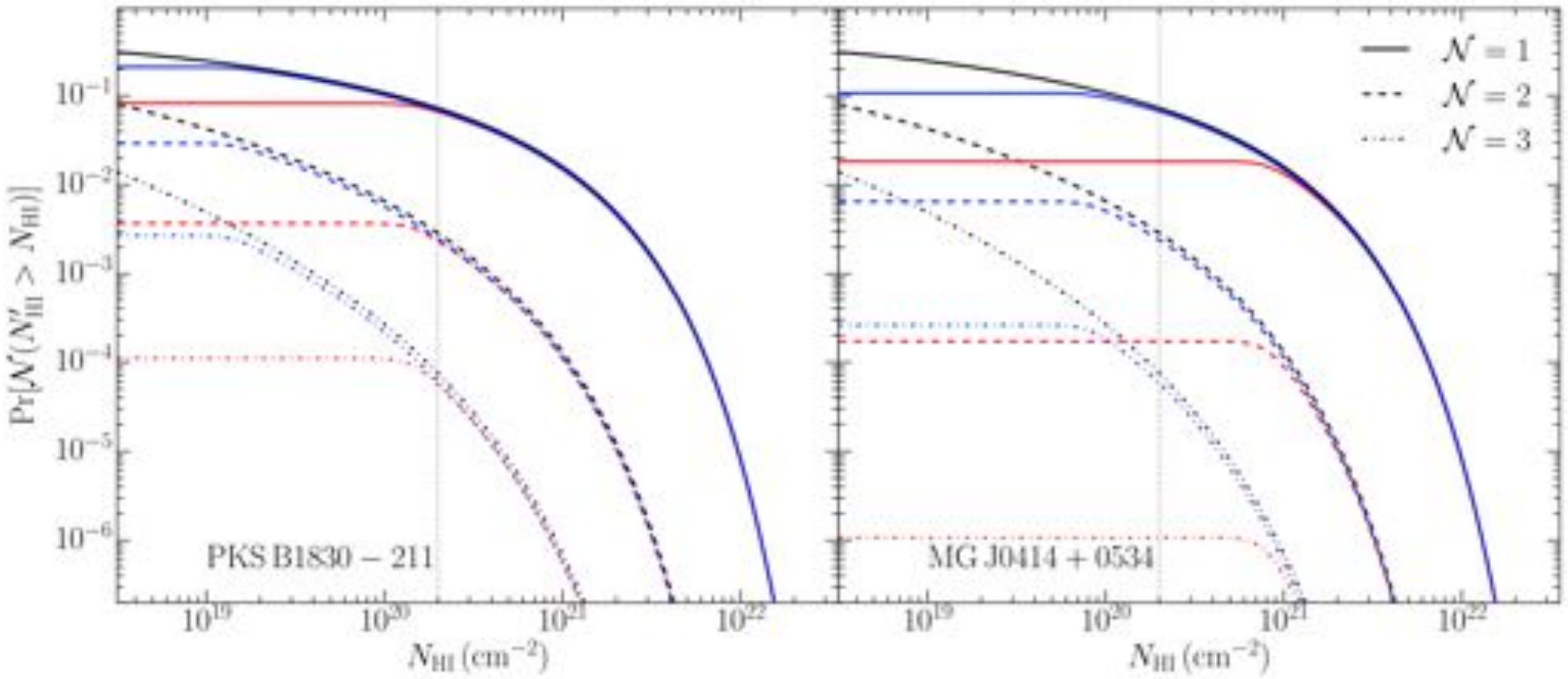


(Allison et al. 2016a – in prep.)

The expected number of intervening absorbers at $z < 1$



The expected number of intervening absorbers at $z < 1$



(Allison et al. 2016a – in prep.)

Any questions?

Thanks!