Blind Wide Area Surveys:

Where Will We Find Redshifted Atomic and Molecular Absorption?

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OPTICALLY SELECTED INTERVENING ABSORBERS

With neutral hydrogen column densities of $N_{HI} > 10^{20}$ cm^{-2} and precisely determined redshifts, the detection of 21-cm in damped Ly-α absorbers (DLAs) should be like shooting fish in a barrel

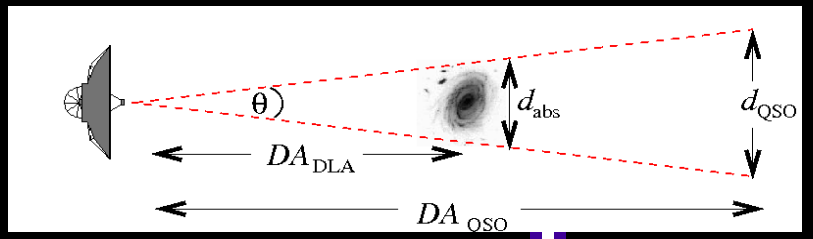
However 21-cm tends to be detected in MgII ($0.2 < z < 2.2$) rather than Ly-α ($z > 1.7$) absorbers

LINE STRENGTH

$$\int \tau \, dv / N_{HI} \propto f/T_{spin}$$

SPIN TEMP.-COVERING FACTOR DEGENERACY

Low covering factor, $f < 1$

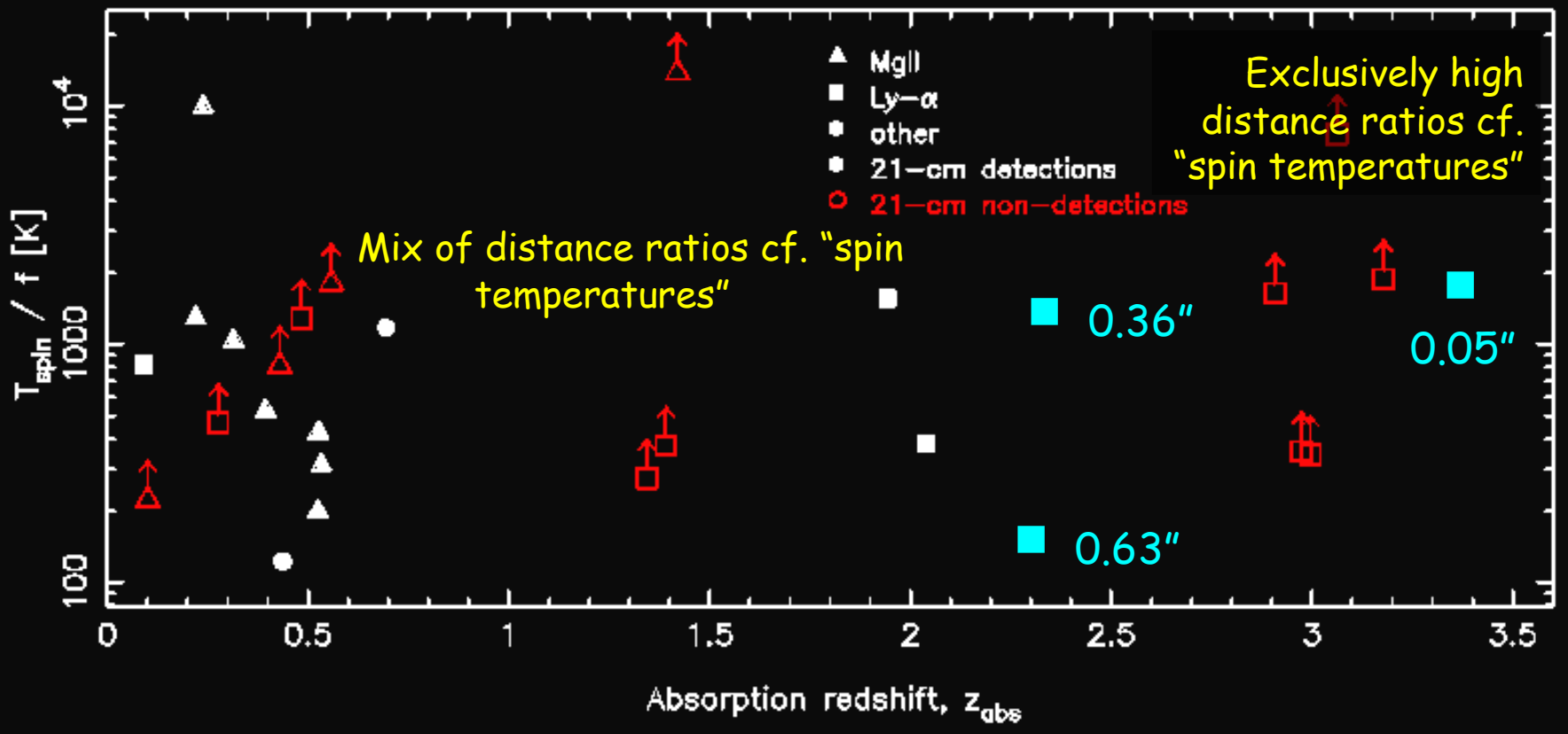


Effective coverage of background quasar much reduced at $z_{abs} > 1$

Above z ~ 1.6 angular diameter distance decreases with increasing redshift in a flat expanding universe

Curran & Webb MNRAS 371, 356 & Curran et al., MNRAS 382, 1331

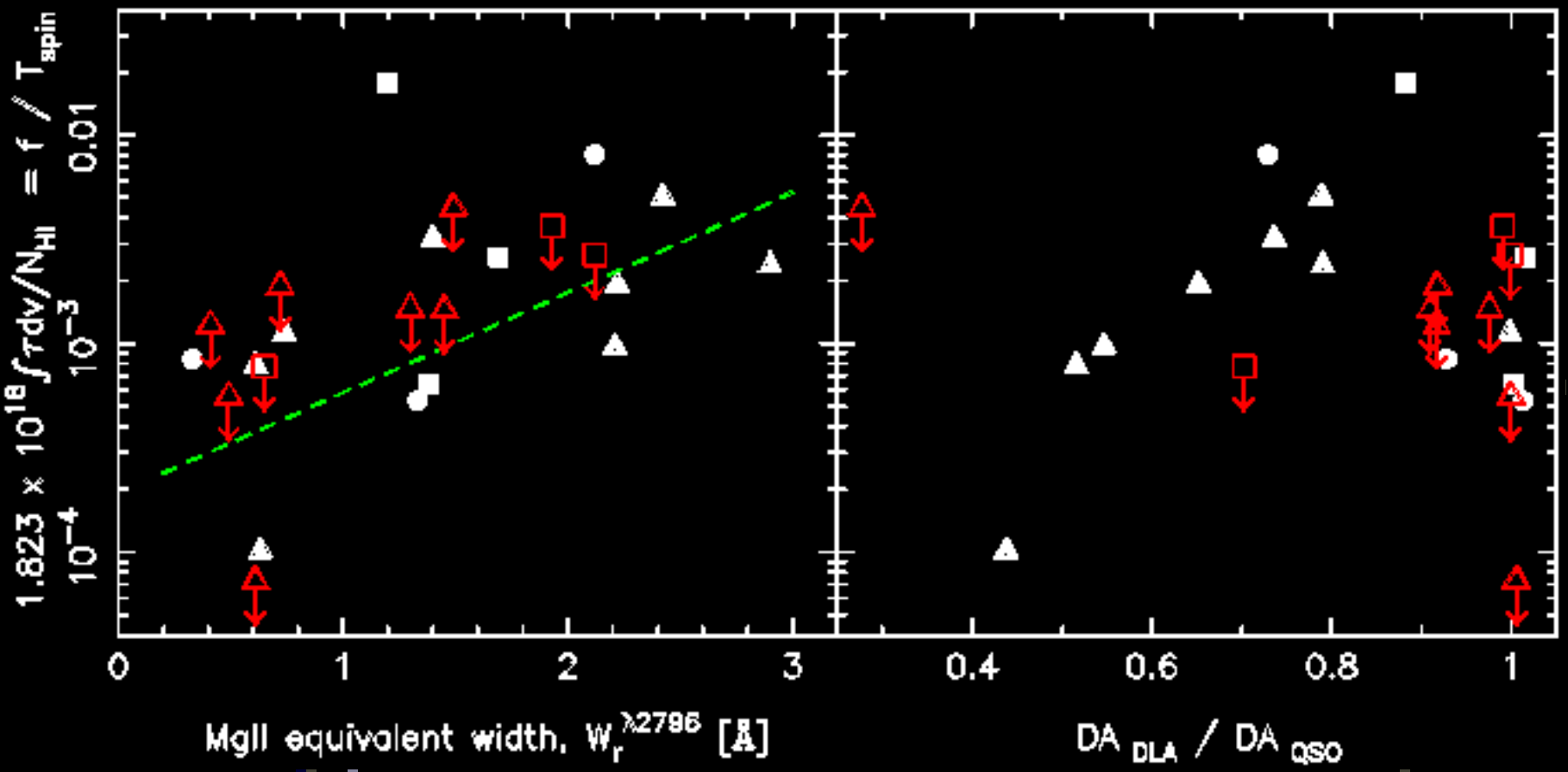
Reproduces "spin temperature" distribution of Kanekar & Chengalur, A&A 399, 857



Strong evidence of a dominant covering factor effect introduced by the geometry of a flat expanding universe

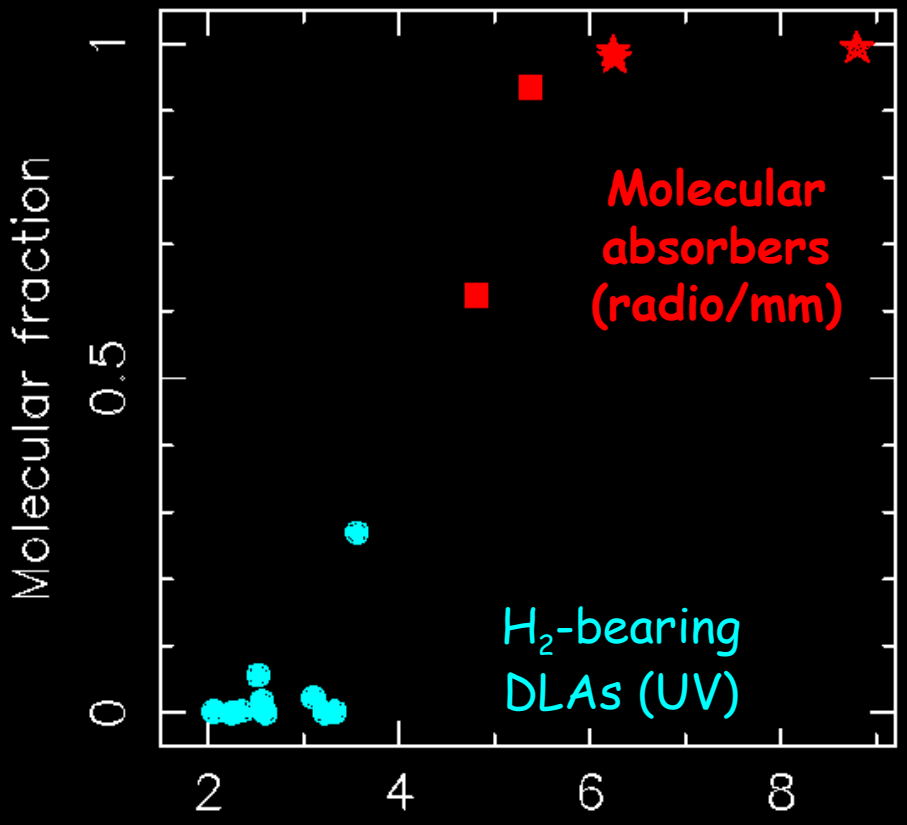
Curran et al., MNRAS 356, 1509 predicted that despite high "spin temperatures", 21-cm should be readily detectable at high redshift towards compact background emission regions

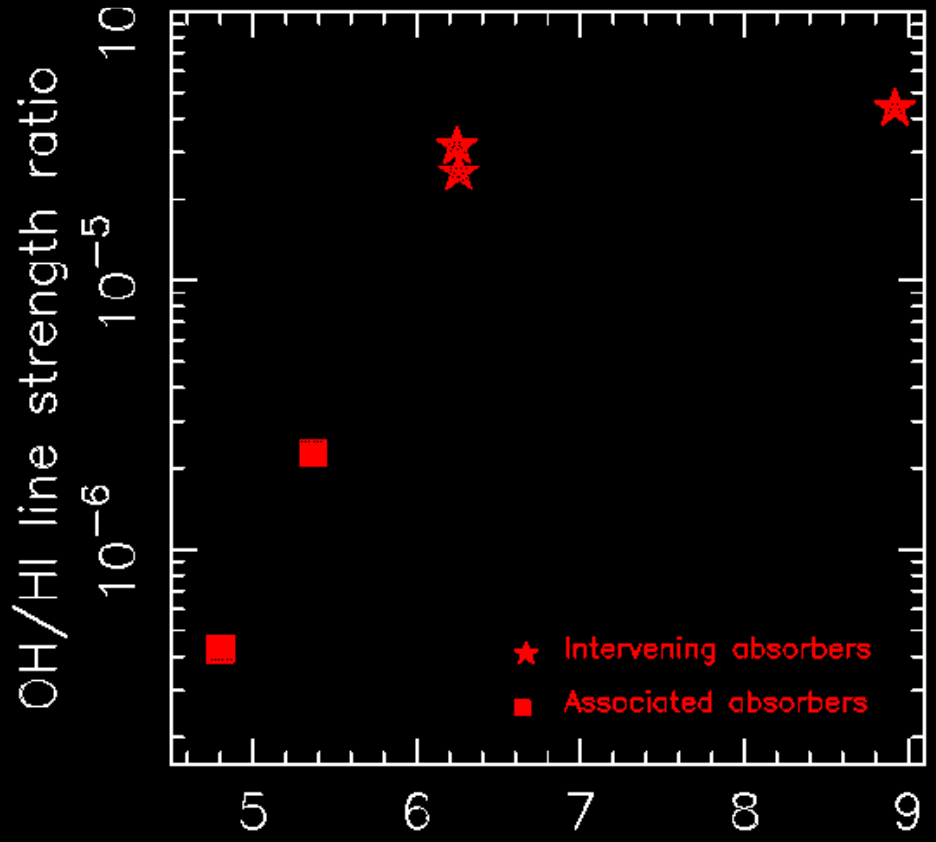
Not only is there a preference for 21-cm absorption in MgII systems (due to their low redshifts), but we find a correlation between the line strength and the Mg II equivalent width in DLAs (Curran et al., MNRAS 382, 1331).



The fact that the non-detections span similar equivalent widths while being undetected may be due to them generally being at high distance ratios and thus have systematically lower covering factors.

However, a rotational transition has never been detected in a DLA
(see Curran et al. MNRAS 352, 563 and references therein)





Strong indication that reddening of quasar light is due to dust in absorber, as traced by the molecules (Curran et al., MNRAS 371, 431)

DLAs not "red enough" to be detected with current radio telescopes – need SKA for anything with $V - K < 5$ ($N_{OH}/N_{HI} < 10^{-6.5} \cdot [f_{OH}/f_{HI}] \cdot [T_{spin}/T_{ex}]$)

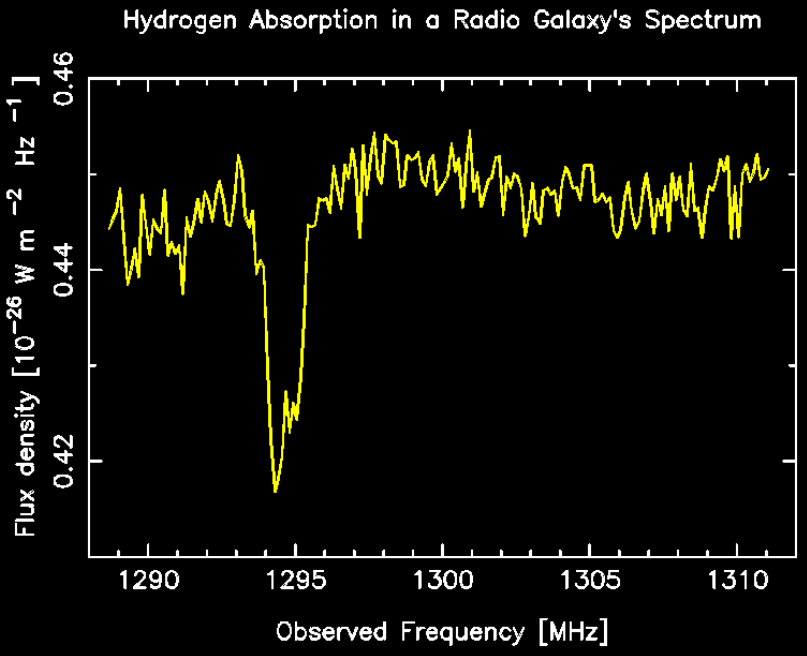
VERY RED (RADIO SELECTED) ABSORBERS

- i.e. intervening or associated with quasar/radio galaxy

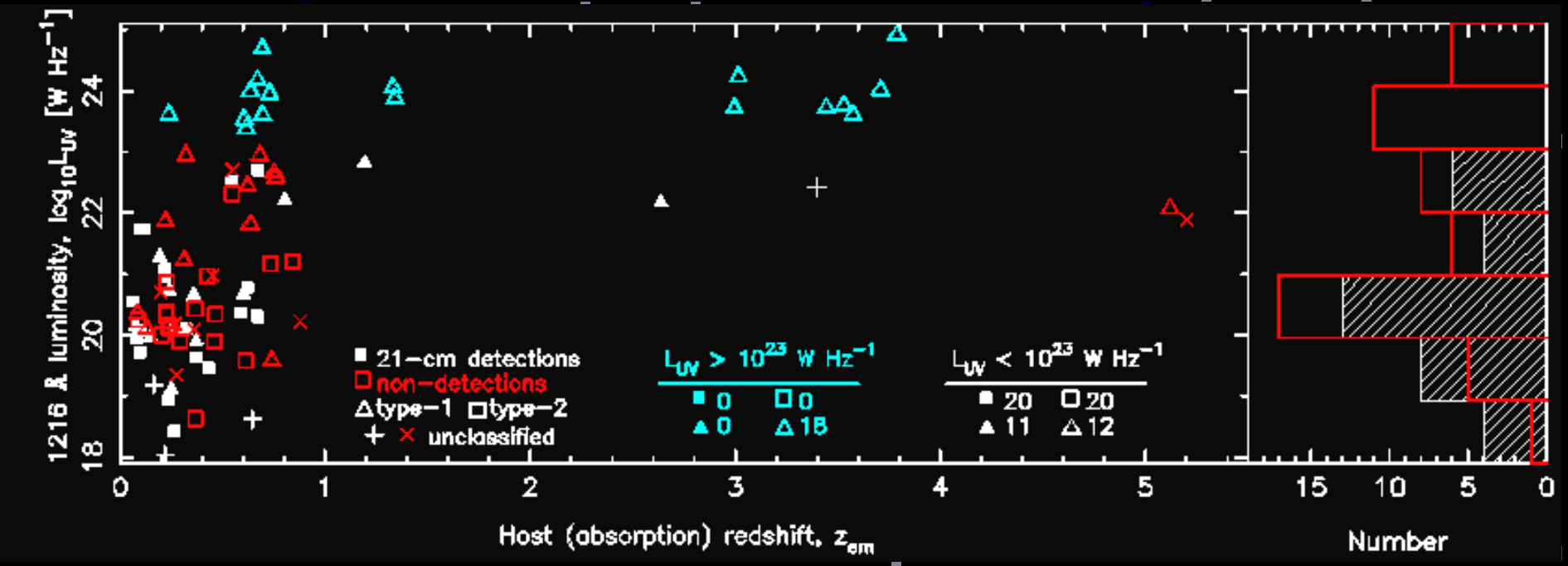
No optical spectrum - absorption causing the reddening could be anywhere at $z_{abs} \leq z_{em} \Rightarrow$ ***SPECTRAL SCAN***

Not feasible with current instruments – wide instantaneous bandwidths of SKA (pathfinders) ideal for this

Other option – ASSOCIATED absorption in host radio galaxy/quasar



BUT FIRST HAVE TO FIND 21-cm ABSORPTION



No HI 21-cm absorption at $L_{UV} > 10^{23}$ W Hz^{-1}

At $L_{UV} < 10^{23}$ W Hz^{-1} ***both*** type-1 and type-2 objects exhibit a 50% detection rate ⇒ unified schemes of AGN cannot account for this

Therefore absorption probably arises in large-scale disk/outflow which is *randomly oriented wrt the circumnuclear obscuring torus* – again, this is a covering factor effect

Curran et al., MNRAS 391, 765 and Curran & Whiting (arXiv:0902.3493)

In summary in searching for redshifted radio lines should target...

1. HI 21-cm in intervening absorption systems...

- Usually optically selected, but wide bandwidths will facilitate blind surveys, although the normalised 21-cm line strength $\propto$ Mg II equivalent width
- Due to geometry expect very high detection rates at $z_{abs} \leq 1$

2. HI 21-cm in associated absorption systems ...

- At $z_{em} \geq 1 \Rightarrow B \geq 19$, $z_{em} \geq 2 \Rightarrow B \geq 21$, $z_{em} \geq 3 \Rightarrow B \geq 23$
- Selects $L_{UV} \leq 10^{23}$ W Hz^{-1}, but still only 50% detection rate

3. OH in either...

V – K > 5 (B – K > 6) at least for pathfinders

i.e. the dimmest/reddest sources are best and so blind surveys much more suitable than targetting optically selected samples