IDCS J1426+3508:

DISCOVERY OF A MASSIVE, IR-SELECTED GALAXY CLUSTER AT Z = 1.75

(Stanford, S.A. et al., ApJ in press/arXiv:1205.3786v1)

SUNYAEV–ZEL'DOVICH MEASUREMENT OF A MASSIVE IR-SELECTED CLUSTER AT Z = 1.75

(Brodwin, M. et al., ApJ in press/arXiv:1205.3787v1)

COSMOLOGICAL IMPLICATIONS OF A MASSIVE, STRONG LENSING CLUSTER AT *Z* = 1.75

(Gonzalez, A.H. et al., Accepted to ApJ/arXiv:1205.3786v1)

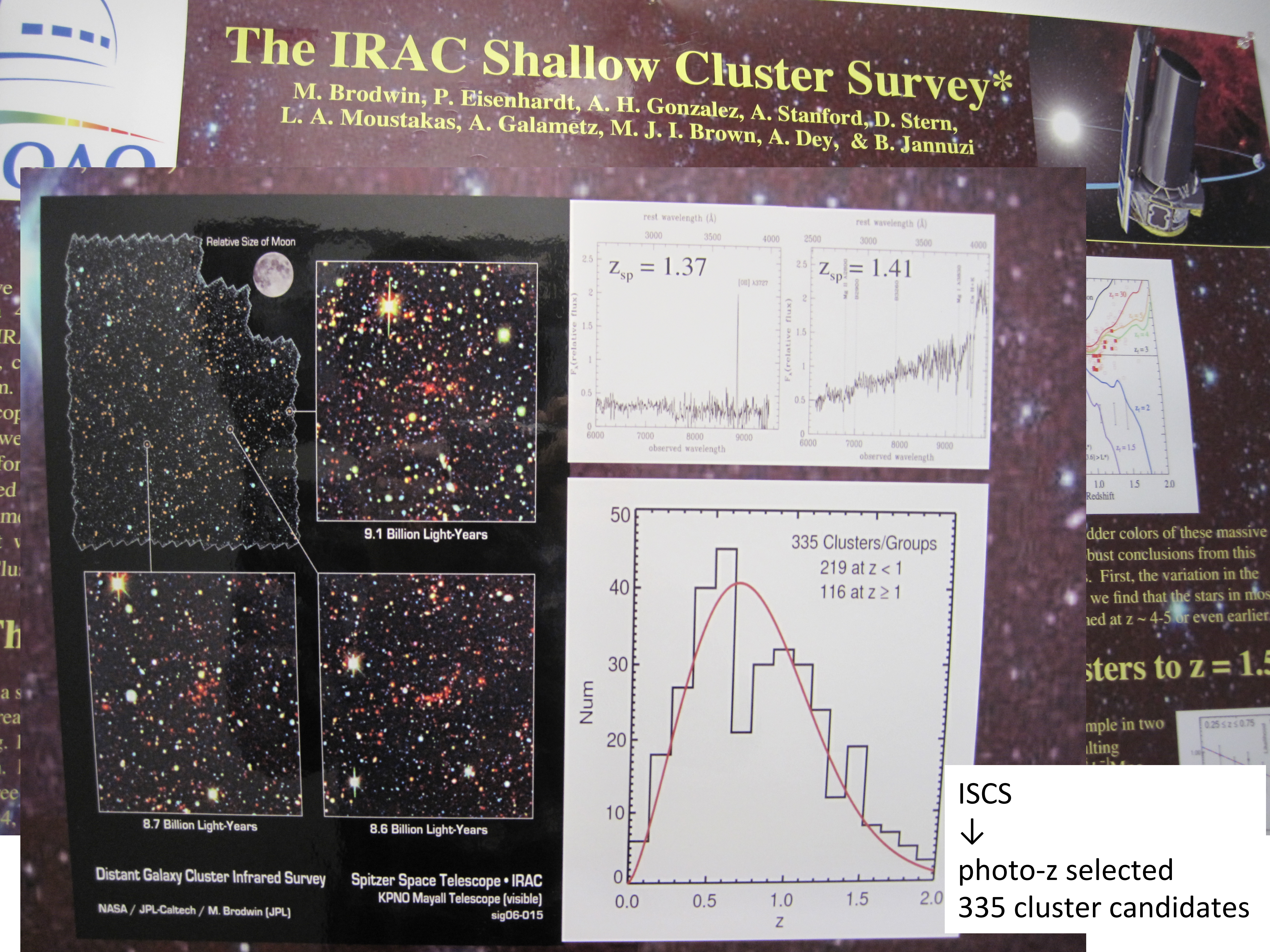
雑誌会　6/27/2012

馬渡健（D1）

Why are distant clusters searched?

- For cosmological use

- For understanding galaxy evolution



ISCS

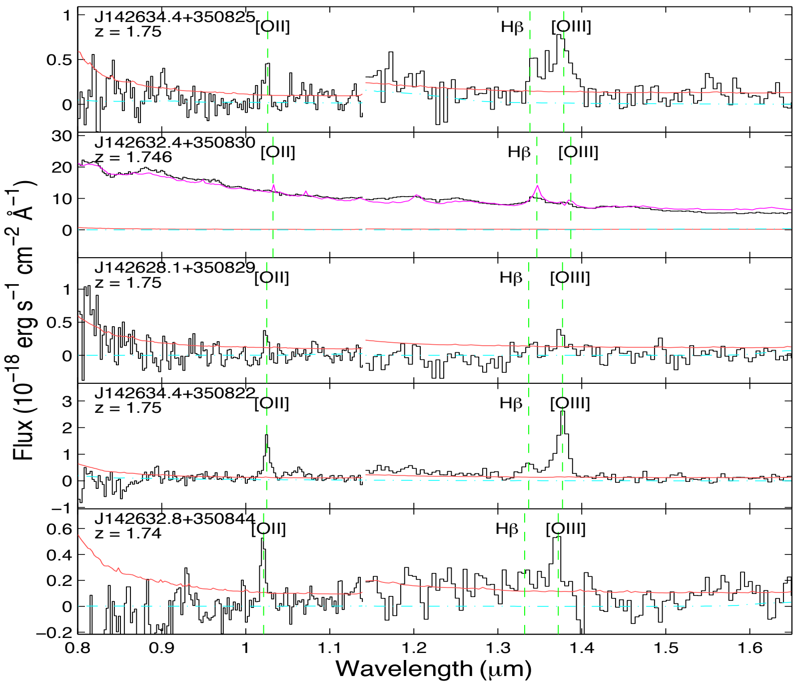
↓

photo-z selected

335 cluster candidates

DISCOVERY OF A MASSIVE, IR-SELECTED GALAXY CLUSTER AT Z = 1.75

- Spectroscopic confirmation of cluster members using KECK/LRIS and **WFC3/slitless**



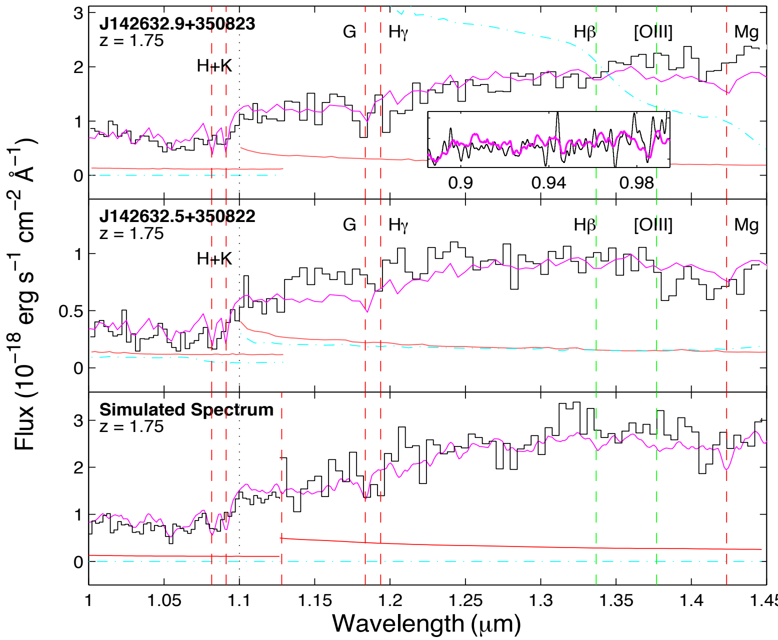


FIG. 3.— WFC3 spectra of the two cluster members with early-type spectra in the top two panels; the bottom panel shows a simulated spectrum, described in the text, for reference. The solid black histograms are the spectra from the G102 and G141 grisms. The dot-dashed blue line is the estimation of contamination from overlapping spectra which is subtracted off in the final stage of reduction. The solid red line is the 1-σ flux error. The vertical green lines are the expected locations of the [OII]λ3727, Hβ, and [OIII]λ5007 lines. The vertical red lines are the expected locations for the following absorption features: Ca H+K, the G-band, Hγ, and MgIIλ2800. The magenta lines represent the SDSS LRG template fitted to the observed spectra. The inset spectrum in the top panel shows the LRIS spectrum (black solid line) in the vicinity of the D4000 break, along with the template fit (magenta solid line), solidifying the reality of this feature seen in the grism spectrum.

FIG. 2.— WFC3 spectra of the five cluster members that exhibit emission lines are plotted above. The solid black histograms are the spectra from the G102 and G141 grisms. The dot-dashed cyan line is the estimate of contamination from overlapping spectra which is subtracted off in the final stage of reduction. The solid red line is the 1-σ flux error. The vertical green lines which are labeled are the detected or expected emission from the [OII]λ3727, Hβ, and [OIII]λ5007 lines at the nominal cluster redshift. The bright, power-law spectrum second from the top is a QSO, previously identified in AGES optical spectroscopy (Kochanek et al., in preparation); in this panel a QSO template (SDSS; Vanden Berk et al. 2001) is shown by the magenta line.

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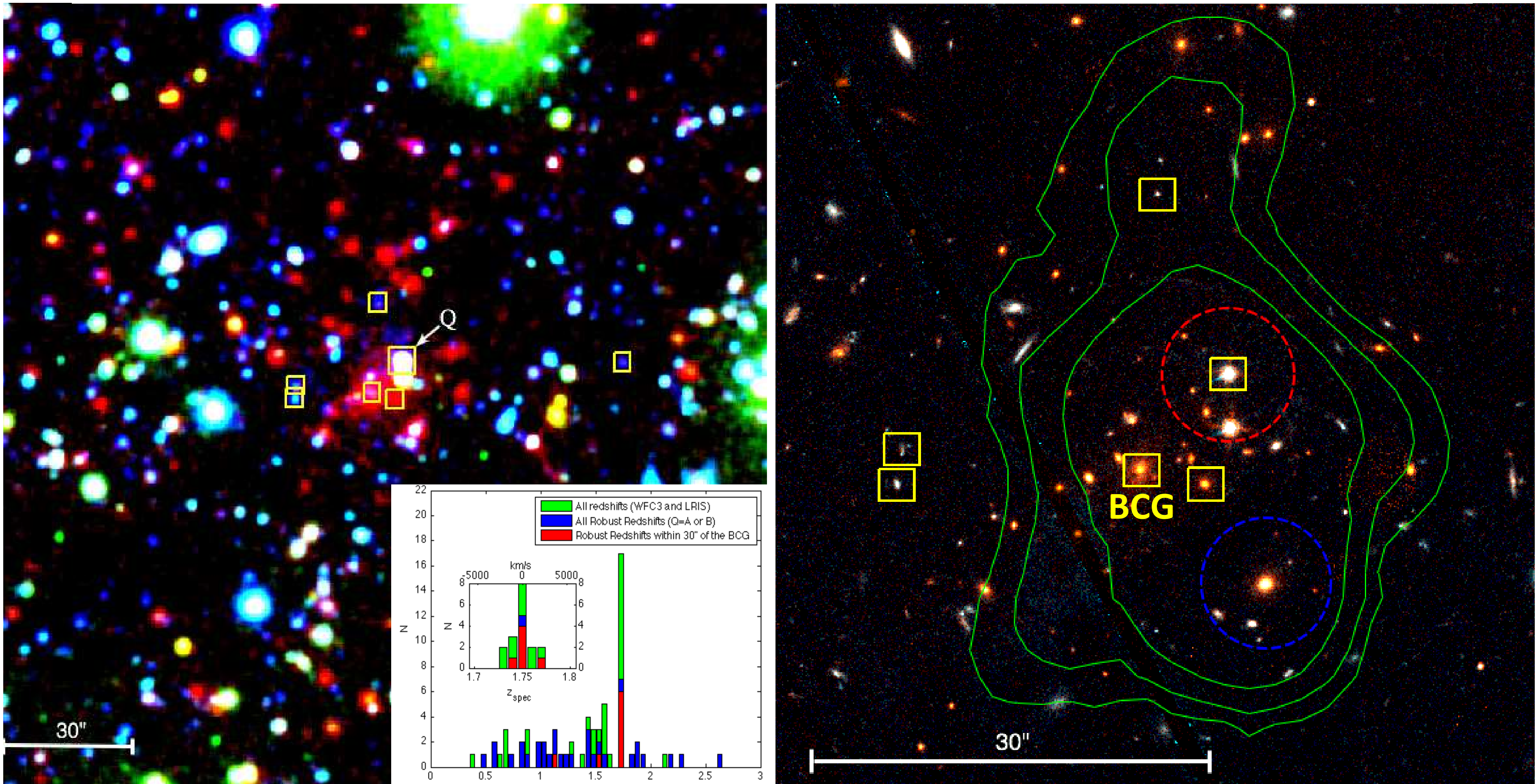

'IG. 1.— (left) Color image covering 3 × 3 arcmin using imaging from the NDWFS B_W and I, and IRAC 4.5 μm data centered on ID
426+3508. The Q marks the quasar in the cluster. (right) Pseudo-color HST image made from the ACS/F814W and WFC3/F16(
ages with the green contours illustrating the X-ray emission. The dashed red circle is centered on the quasar in the cluster, and the b
shed circle is centered on a non-member radio-loud AGN. The radii of these two dashed circles is 5 arcsec, the same size as was used
ısk these point sources in the X-ray analysis. In both panels the yellow boxes are spec-z confirmed members, and a 30″ (260 kpc) sc
r is given.

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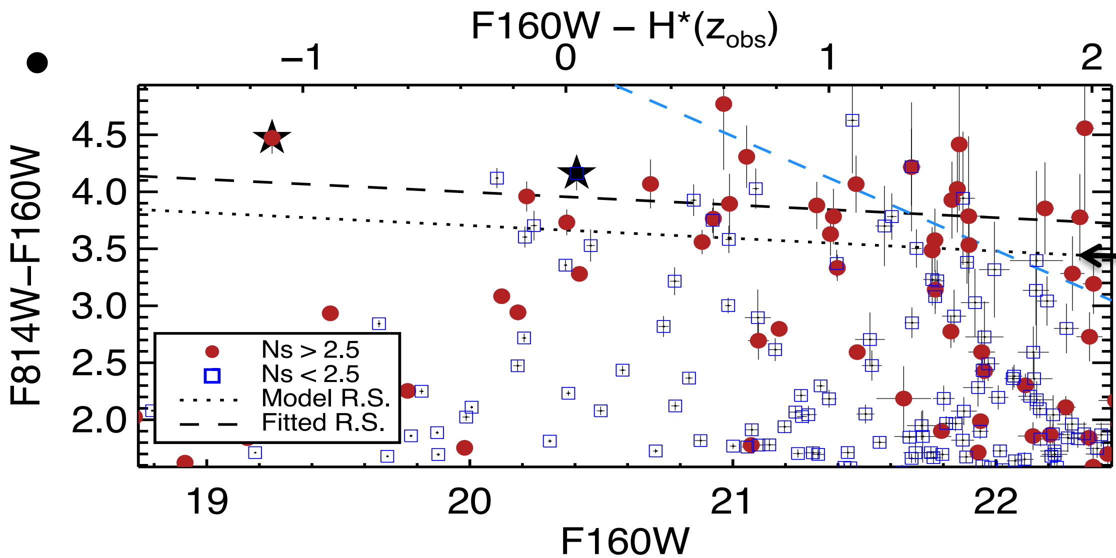
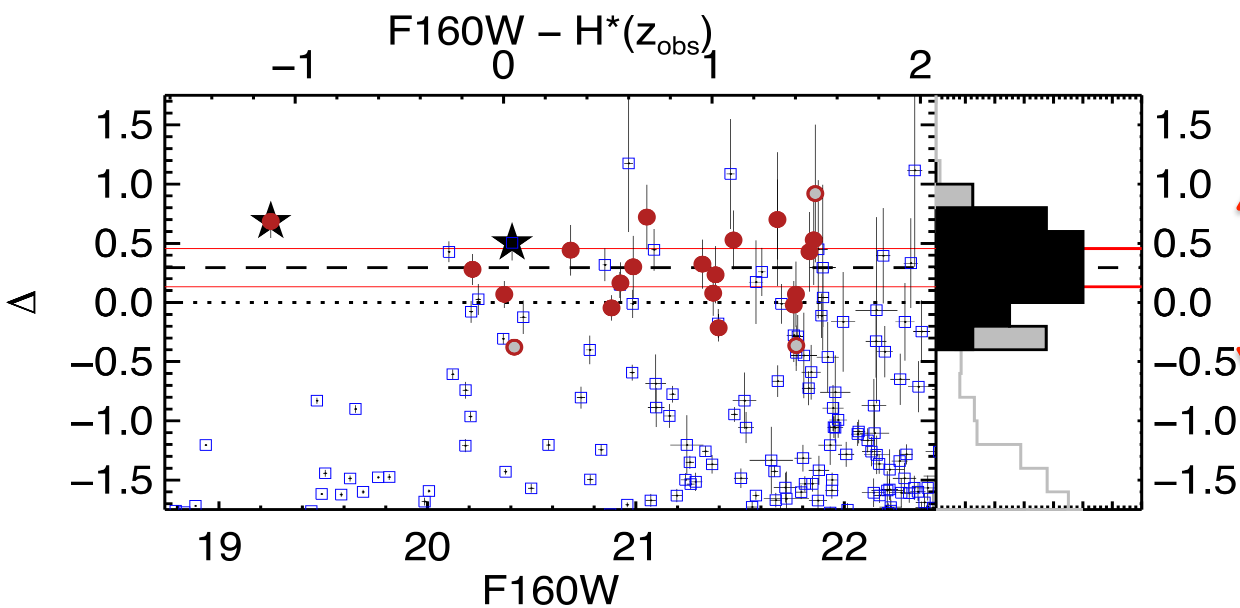
※From X-ray counts, total mass of the cluster : $M_{200} = (5.6\pm1.6)\times10^{14}\ M_{sun}$

- 

Coma model with $z_f = 3$

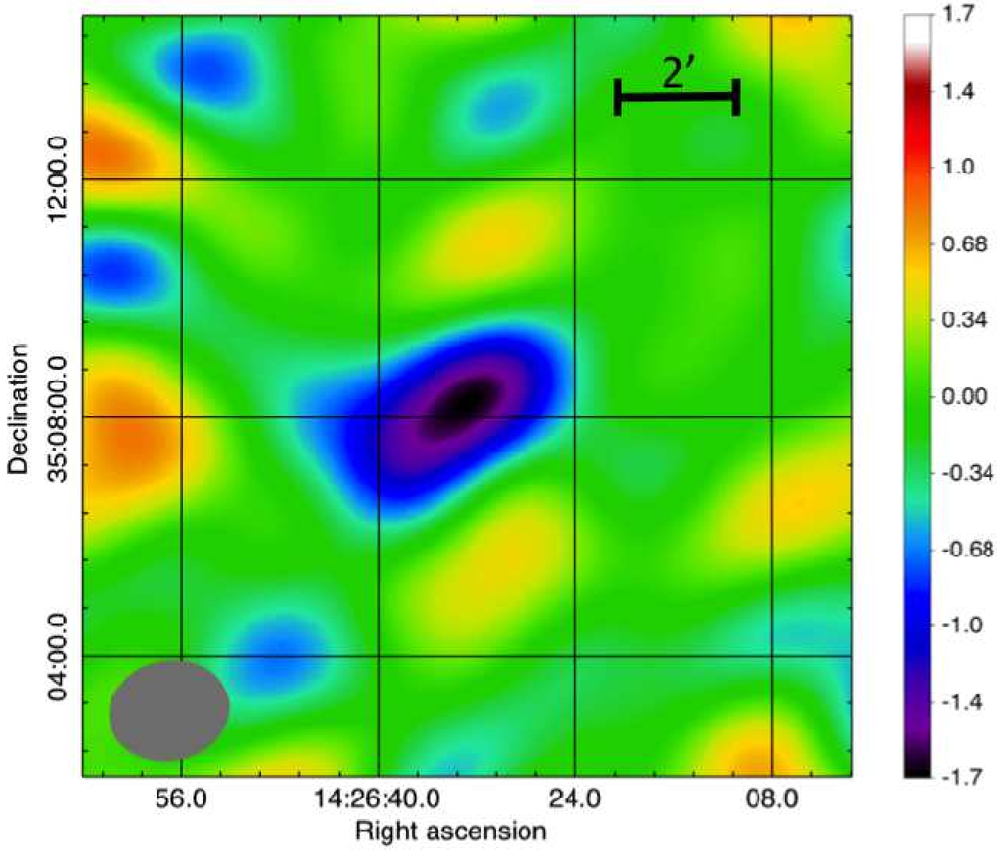


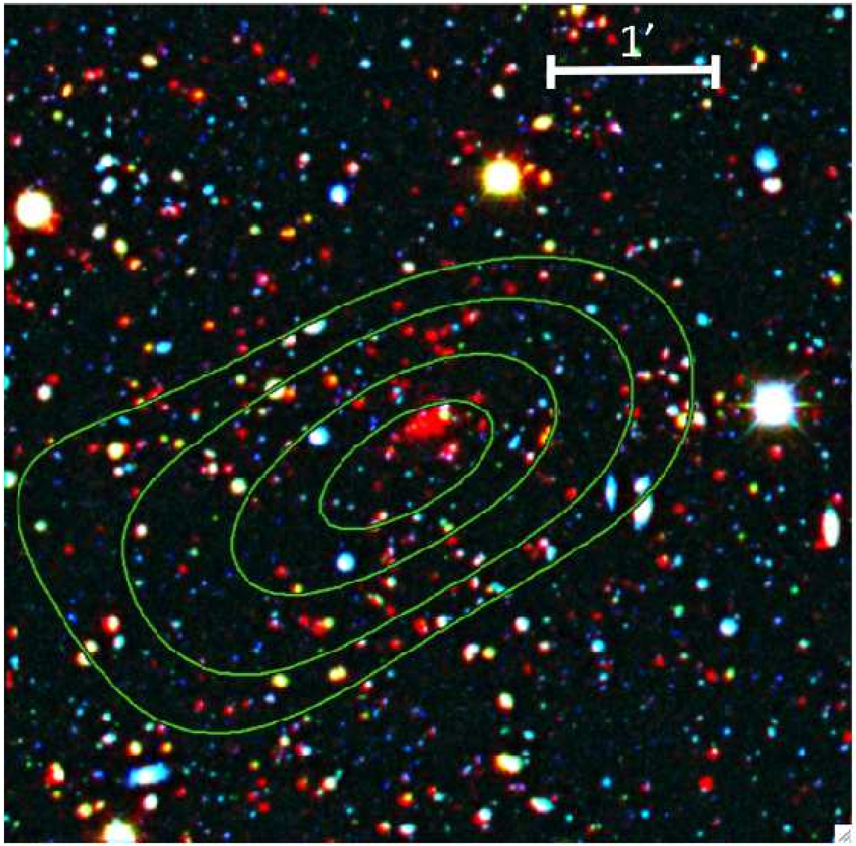
Def of red sequence galaxies : $-0.5<\Delta<1.0 \wedge$ sersic n > 2.5

SUNYAEV–ZEL'DOVICH MEASUREMENT OF A MASSIVE IR-SELECTED CLUSTER AT Z = 1.75

- Detection of SZ decrement

  using Sunyaev-Zel'dovich Array (SZA)/31GHz (8GHz passband)





SUNYAEV–ZEL'DOVICH MEASUREMENT OF A MASSIVE IR-SELECTED CLUSTER AT Z = 1.75

- by far the most distant cluster with an SZ detection (5.3σ)

$M_{200,c}$ = (4.1±1.1)×10^{14} M_{sun} ∙∙∙ consistent with the mass estimated from X-ray counts

- test whether a cluster is rare enough to falsify ΛCDM model

: "the exclusion curve formalism"

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IDCS J1426.5+3508 falsify ΛCDM at the 95% level ??

or

Simply somewhat lucky (maybe)

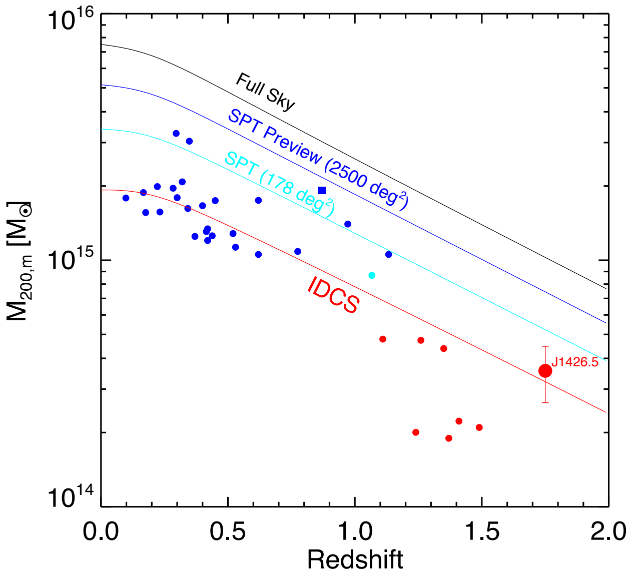


Figure 2. M11-style plot showing the mass and redshift of IDCS J1426.5+3508 (large red circle), along with other $z > 1$ ISCS clusters (Brodwin et al. 2011; Jee et al. 2011, small red circles) and SPT clusters (Williamson et al. 2011, small blue circles; Brodwin et al. 2010, small cyan circle). The solid red curve is the 95% exclusion curve for the IDCS area. The cyan, blue and black curves are the exclusion curves for the currently published full depth SPT survey (178 deg^2, Vanderlinde et al. 2010), the 2500 deg^2 SPT preview survey of Williamson et al. (2011) and the full sky, respectively. The square symbol represents cluster SPT-CL J0102-4915, first reported as ACT-CL J0102-4915 (Menanteau et al. 2010). We plot this cluster at the spectroscopic redshift of $z = 0.870$ reported in Menanteau et al. (2012). All clusters are color-coded to the appropriate exclusion curve.

SUNYAEV–ZEL'DOVICH MEASUREMENT OF A MASSIVE IR-SELECTED CLUSTER AT Z = 1.75

- Evolution to the Present day

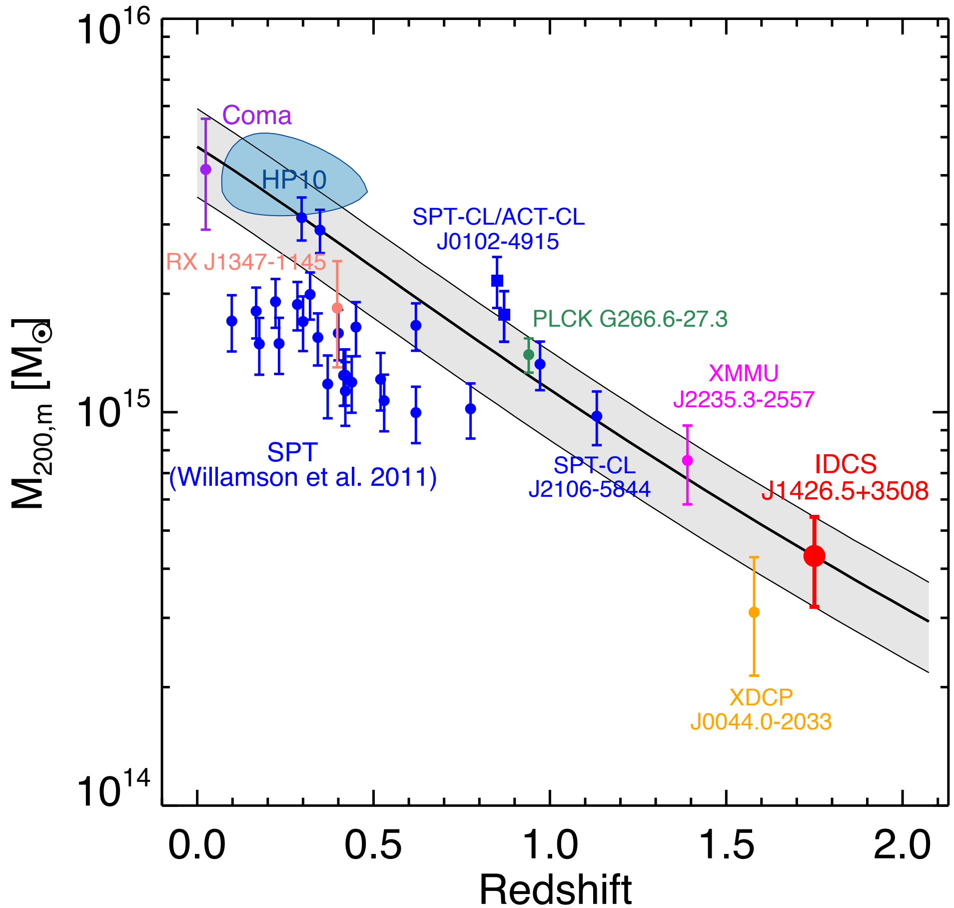


Figure 3. Predicted mass growth of IDCS J1426.5+3508 vs. redshift based on abundance matching. IDCS J1426.5+3508 is the large red circle and the predicted growth in its mass is shown as a thick black line. The 1 σ errors, stemming from the mass measurement errors, are shown as the shaded region. An assortment of the rarest, most massive clusters found at all redshift is shown for comparison and discussed in the text. SPT-CL J0102-4915 was first reported as ACT-CL J0102-4915 by Menanteau et al. (2010) and Marriage et al. (2011). The independent mass measurements from both surveys are plotted as the square symbols for this cluster at the spectroscopic redshift (z = 0.8701) reported in Menanteau et al. (2012). IDCS J1426.5+3508 is consistent with being a member of the most extreme population of virialized structures in the Universe.

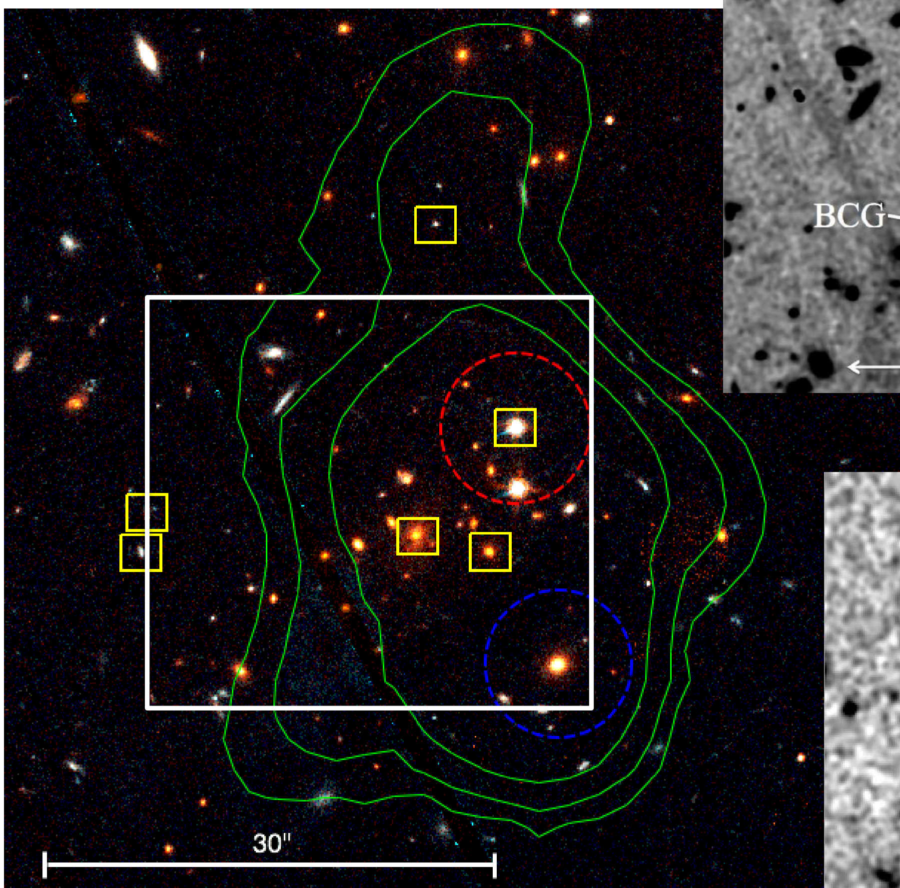
COSMOLOGICAL IMPLICATIONS OF A MASSIVE, STRONG LENSING CLUSTER AT Z = 1.75

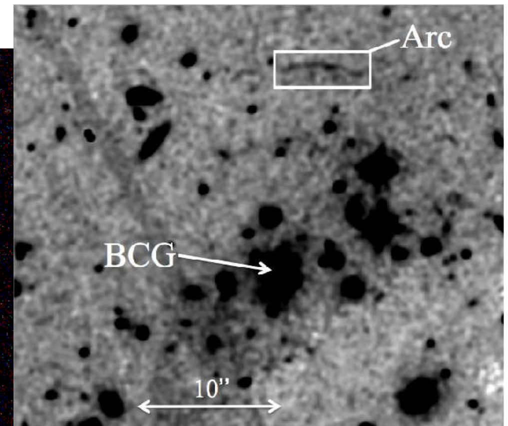
- Discovery of a giant arc
  using **HST/ACS,WFC3 (F814W,F160W)**

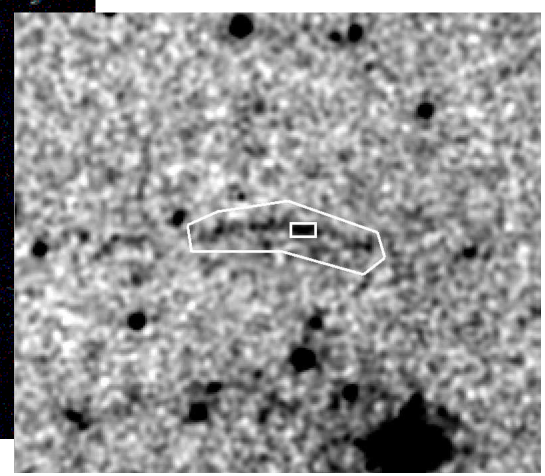
F814W=24.3±0.3
F160W=23.8±0.2
F814W-F160W=0.25±0.13

θ=14”.6±0”.2

the curvature is consistent with the centroid being nearly coincident with the BCG







COSMOLOGICAL IMPLICATIONS OF A MASSIVE, STRONG LENSING CLUSTER AT Z = 1.75

- Cluster mass: enclosed mass ($M_{a,<125kpc}$) and total mass ($M_{200,c}$)

$$M_{\rm a} = \pi \Sigma_{\rm c}\, \theta_{\rm a}^2, \qquad \Sigma_{\rm c} = \frac{c^2}{4\pi G}\frac{D_{\rm S}}{D_{\rm L} D_{\rm LS}}.$$

assume that mass profile of DM halo : Gao+08

ellipticity, e_m=0.32

M_{200}

※GEMINI and HST spectroscopy detect neither continuum nor any emission lines

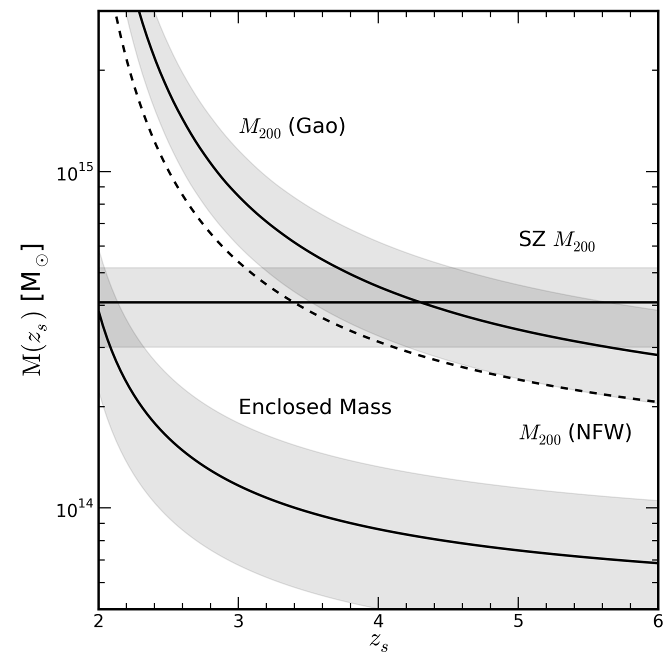


FIG. 2.— Mass of IDCS J1426.5+3508 as a function of redshift of the lensed source. The lower curve corresponds to the mass enclosed within the arc, with the shaded region denoting the uncertainty associated with the offset of the BCG relative to the cluster potential. The upper curve is the inferred M_{200} assuming the Gao et al. (2008) prescription for the concentration and an ellipticity $e_{\rm m} \simeq 0.32$ for the cluster dark matter halo. In this case the uncertainty denoted by the shaded region is dominated by the intrinsic scatter in the distribution of halo ellipticities. We also overplot as a dashed line the inferred mass if one instead uses the original NFW prescription for the halo concentration (which can be considered a lower bound). The horizontal line and associated uncertainties correspond to the M_{200} derived from Sunyaev-Zel'dovich observations. In this case the uncertainties do not include the potential systematic bias associated with extrapolating SZ scaling relations to higher redshift.

COSMOLOGICAL IMPLICATIONS OF A MASSIVE, STRONG LENSING CLUSTER AT Z = 1.75

- probability for strong lensing cluster to exist

$$\tau_q(z_S) = \frac{1}{4\pi D_S} \int_{z_L}^{z_S} dz \int_0^{+\infty} dM\, n(M,z) \left| \frac{dV(z)}{dz} \right| \sigma_q(M,z).$$

$$N_q(m) = 4\pi\, n_S(m) \int_{z_L}^{+\infty} p(z_S, m) \tau_q(z_S) dz_S,$$

"this arc should not exist"

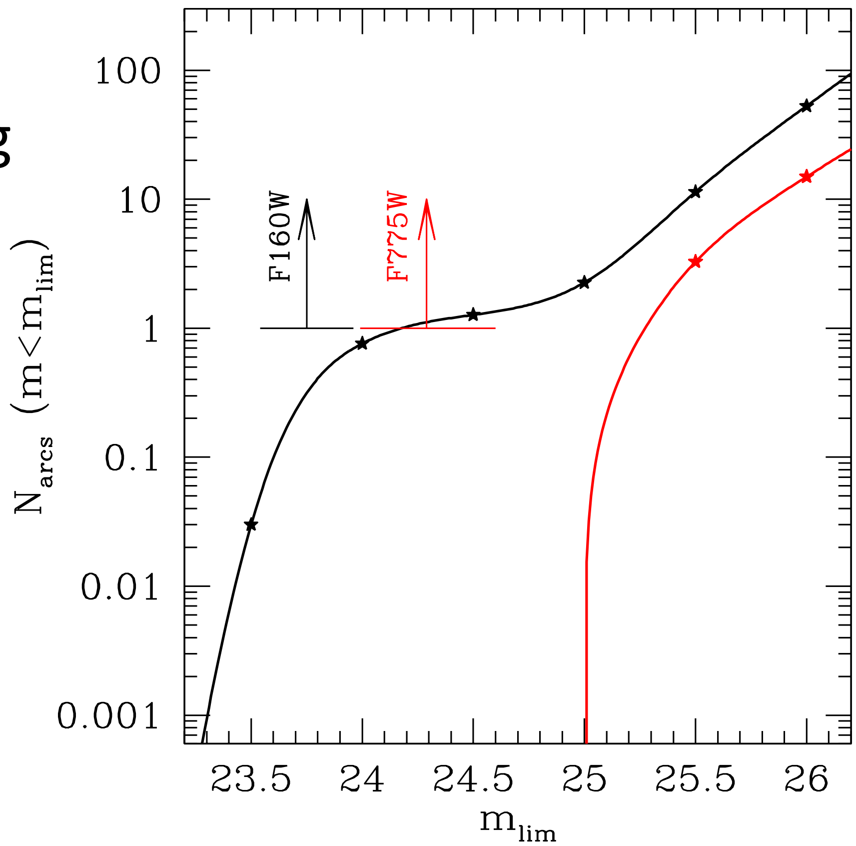


FIG. 3.— Predicted number of giant arcs over the entire sky as a function of magnitude in F775W and F160W for clusters at $z > 1.75$. The points correspond to the results from our simulations, while the curves are spline interpolations between the data points. The arrows represent the all-sky lower limits derived from the observed arc in IDCS J1426.5+3508, with the width at the bottom of the arrows corresponding to the photometric uncertainty. We note that finding one arc per 8.82 deg^2 would correspond to $\sim$ 4700 arcs all-sky.