MAD MAX:
Deep Extragalactic Fields

- Science drivers: *WFC3 is not enough!*
- Lessons from the MAD SV pilot

  (SV prop: Smail, Marchetti, Kolb, Merrifield, Wardlow, Haeussler)
- MAD MAX extragalactic surveys

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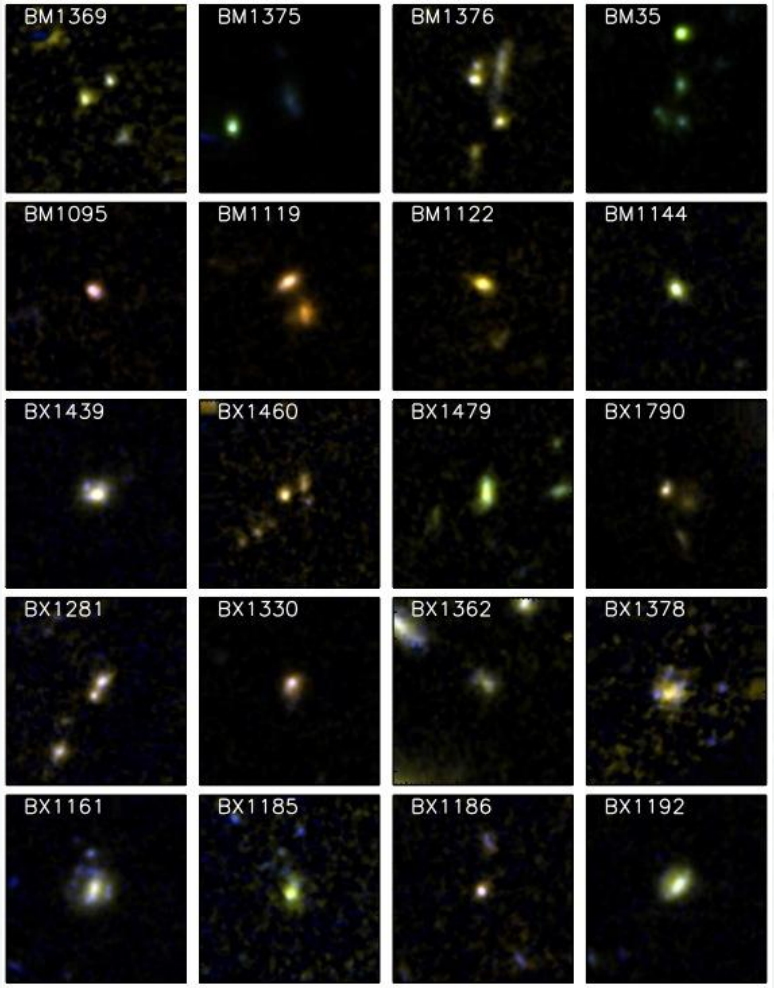
MAD MAX:
Extragalactic Science Drivers

- Red-and-dead (passive) galaxies at z=1.5-2.5 indicate significant star formation at z>3 (GMASS, etc)

- Unfortunately at z>3 the 4000A/Balmer breaks move beyond H-band (e.g. WFC3) so existing high resolution morphologies are biased against old underlying stellar populations. To identify and morphologically classify the structure of the "old" stellar pop (disk/bulge/clumpy) needs K-band

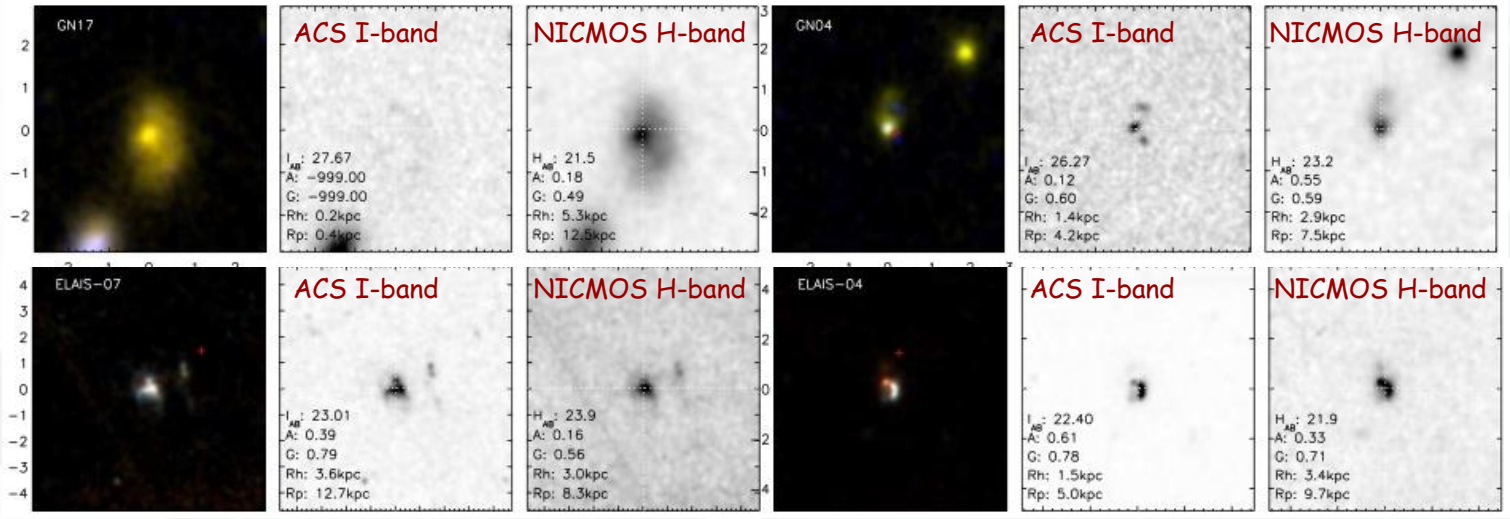


HST ACS/NICMOS, I/H true color images of z=2-3 star-forming galaxies. Apparent clumpiness may be in part due to differential K correction for young UV-bright and UV-faint old stars.

MAD MAX:
Extragalactic Science Drivers

- Dust obscuration is also an increasing problem for most active SF galaxies at high-z. These may be the progenitors of the most massive local galaxies (Ellipticals).

- Again need to image them at longest possible wavelengths to understand their structures: do they possess de Vaucoleurs profiles, are they mergers (or just appear that way due to patchy UV transmissions).



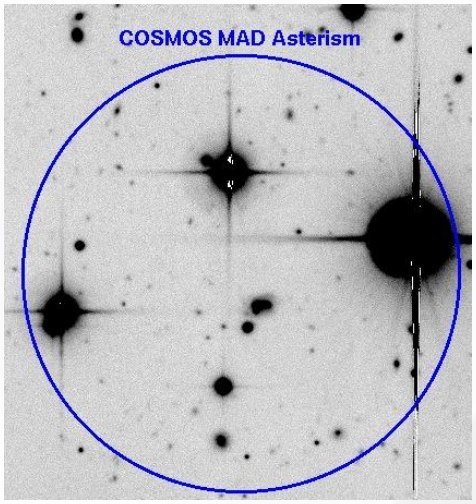
HST ACS/NICMOS, I/H true color images of submillimetre galaxies at z~2-3 (high-z ULIRGs). The effects of dust are visible in the relative I/H brightness and the presence of blue clumps. Several appear to be mergers, but this may be due to patchy dust obscuration.

MAD SV

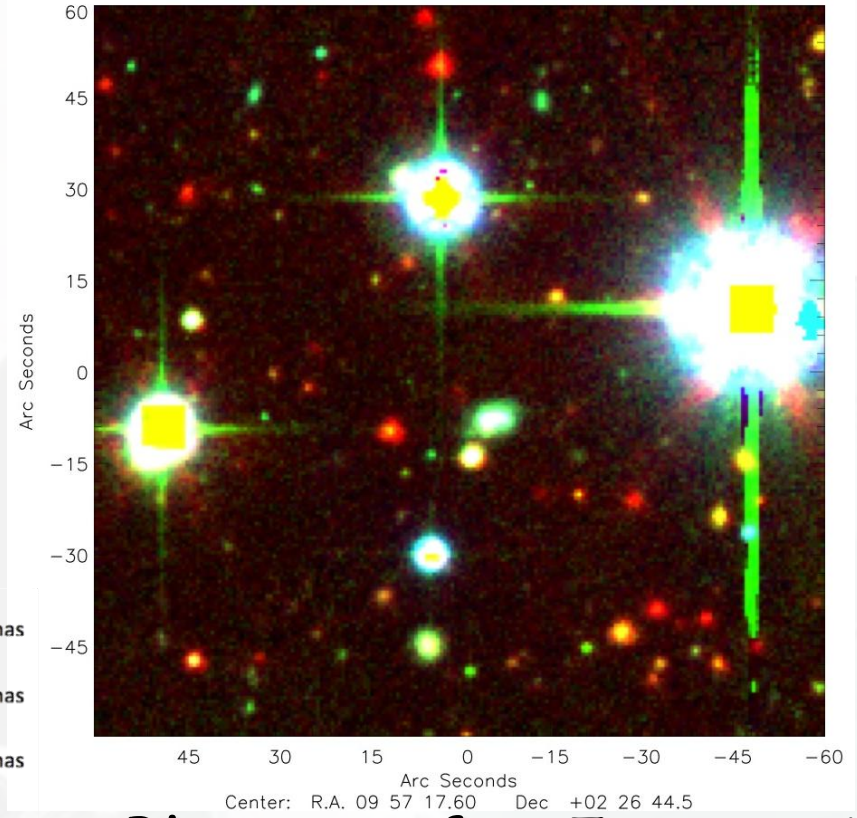
- MAD SV proposal to exploit the archival data in deep extragalactic fields by combining MAD K-band morphologies with multiwavelength datasets covering X-ray-UV/Opt-N/M/FIR-Radio +photo-z
- Goal was to derive restframe optical structural information on a sample ~40-50 galaxies (half at z>1) in a single MAD pointing to track growth of disks and bulges in typical field galaxies.
- We searched for MAD-asterisms (3xV<12 stars) in ~10 deg^2 of HST-imaging: COSMOS, ECDFS + 5,000 individual HST ACS/WFPC2 pointings

MAD SV: COSMOS Deep Field

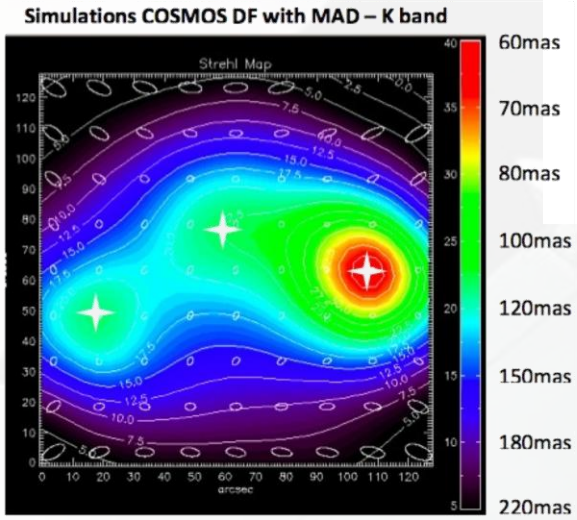
- We found only **one** example (in COSMOS)



The MAD FoV on Subaru I-band image + model FWHM predictions in 0.8" seeing

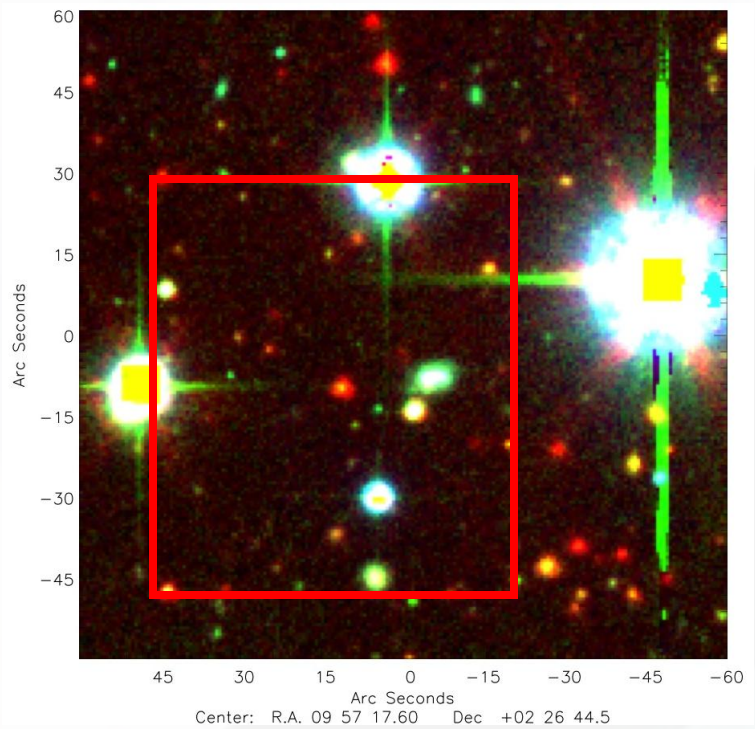


A true color u, I, IRAC 3.6um image of the COSMOS asterism using archival imaging (GALEX, Subaru, Spitzer). There are ~20 z>1 galaxies visible in this field, including several very red (old or dusty) galaxies.

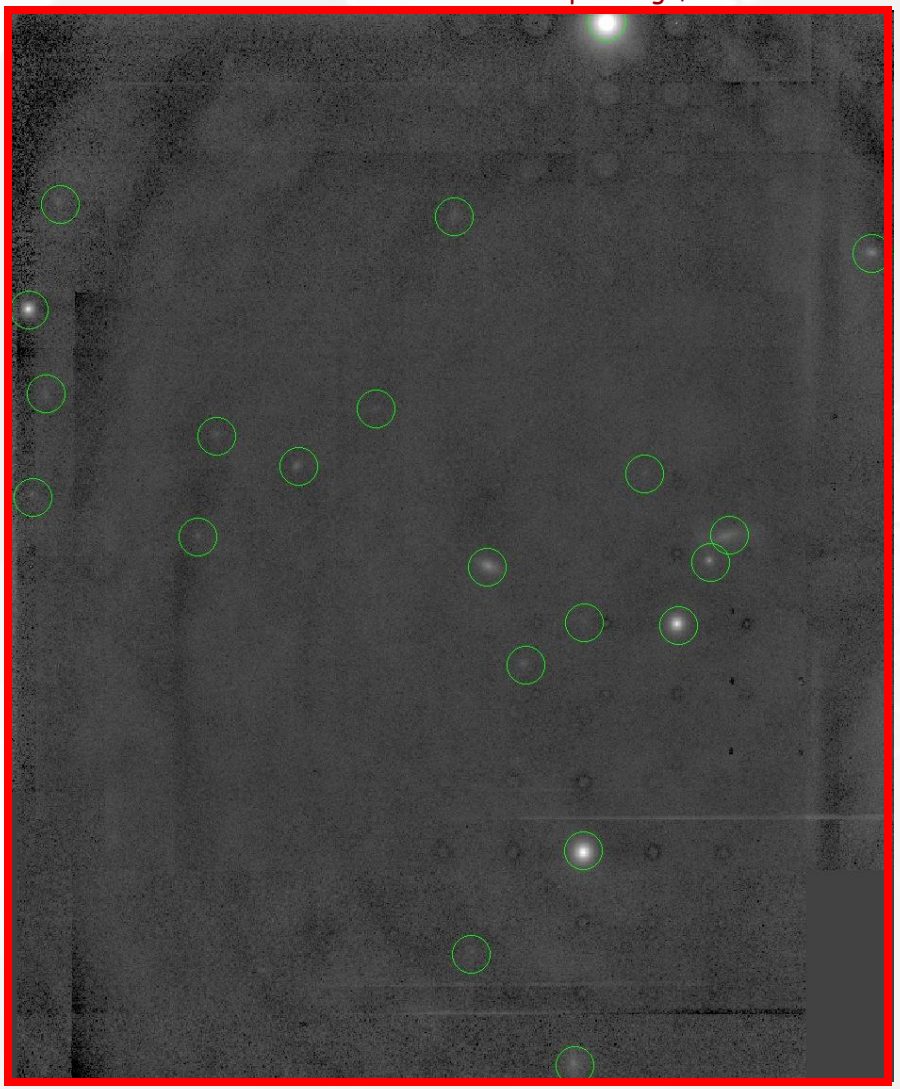


- Plan was for 5-point K-band mosaic with 10hr total exposure
- Unfortunately only got ~3hr

MAD SV: COSMOS Deep Field



The MAD COSMOS SV K-band mosaic of 2 pointings, each ~1.5hr.



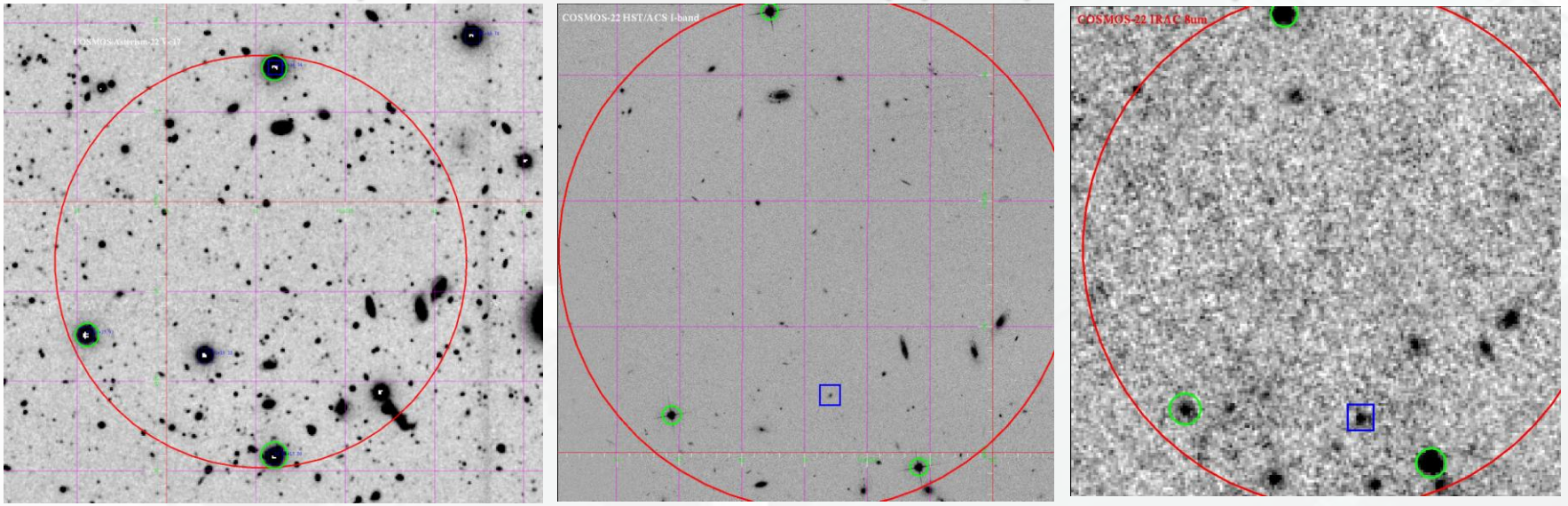
- Detected 17 galaxies, 4 stars. But only ~25% with sufficient S/N to determine morphology (Note: poor flatfield)

MAD SV: Lessons Learnt

- Problem is combination of small extragal survey fields and rarity of V<12 asterisms
- Plus bright stars are usually avoided - so in COSMOS the asterism was **not** imaged by HST/ACS because of bright stars
- MAD MAX benefits from fainter stars by both larger sky coverage and less saturation
- To get deep we also need better flatfielding (i.e. remove the scattered light)
- Don't compete with WFC3 (so concentrate on K)

MAD MAX

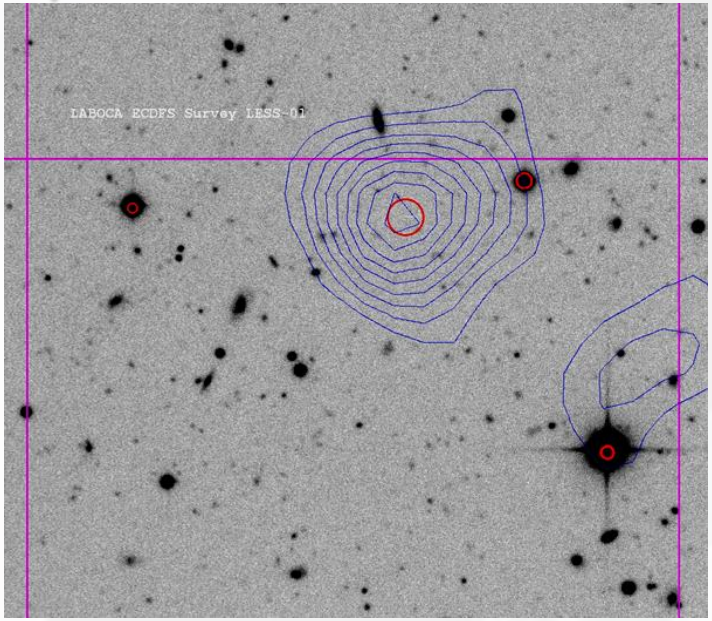
- There are roughly 22x more stars to V<17 than V<12 in a typical deep field. So **many** more opportunities to find triple (or double) asterisms
- Searched just COSMOS and ECDFS for triples with V<17, <120" and roughly equilateral. Found ~70 examples (and 2,500 appropriate pairs).

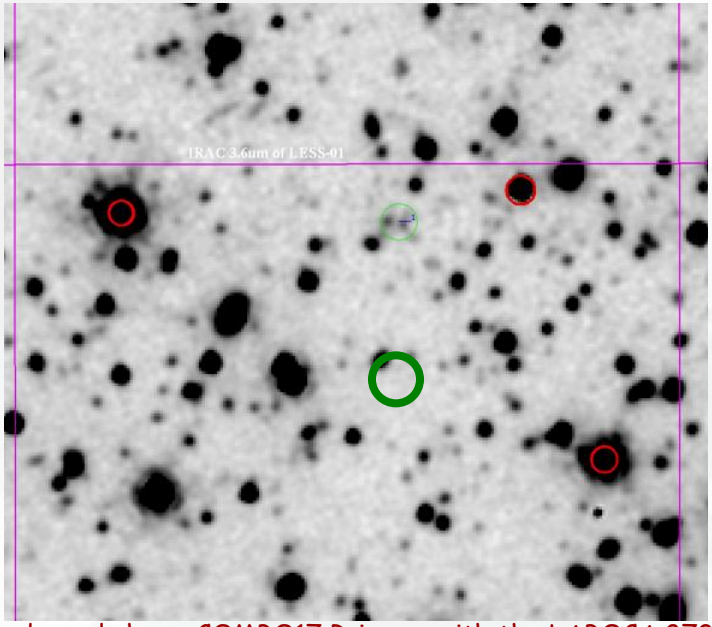


An example asterism from COSMOS (NGS are green circles). Left-hand panel shows Subaru I-image, centre is HST ACS I-band and right-hand is IRAC 8um - with an extremely red, z>1 galaxy identified by the blue square.

MAD MAX

- Another example - this one from the Extended Chandra Deep Field South (ECDFS). This shows an asterism around the position of a bright but very red, submm source.





An example asterism from ECDFS (NGS are bold red circles). Left-hand panel shows COMBO17 R-image with the LABOCA 870um contours overlayed, right-hand is IRAC 3.6um - with the extremely red counterpart to the submm source identified by the green circle. MADMAX would be able to derive a precise morphology for this very dusty, apparently interacting pair of galaxies.

- MAD MAX's grasp means it can be used as a general tool for extragalactic studies.

A MAD MAX Survey

- MAD MAX allows us to exploit the huge archival datasets in COSMOS/ECDFS (10:00-01, 03:30-27) to study the structural evolution (disk/bulge) in field galaxies out to z~1-2 and the morphologies of more distant galaxies, z~3, free from biases due to K-corrections or dust.

- A single 5-hr pointing would reach S/N>10 on ~20 galaxies to K=21 (or S/N>25 for ~10 gals to K=20) in 1 arcmin^2.

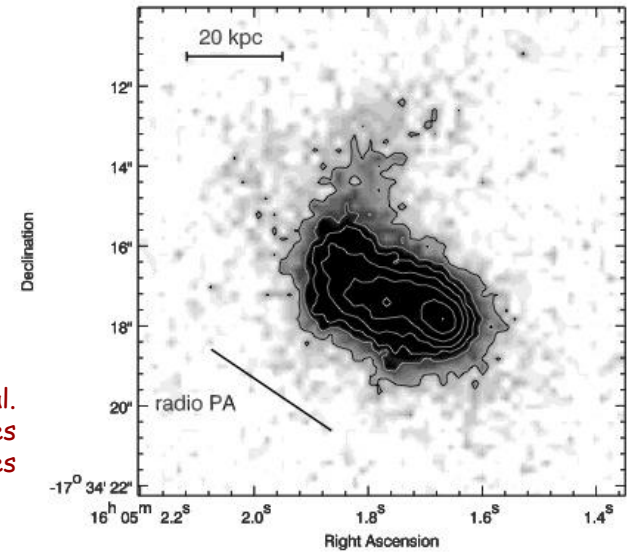
- 10 pointings (50hr+overheads) would yield a sample of ~100-200 galaxies out to z~3 with high-quality MADMAX+HST morphologies, photo-z, stellar masses, SFRs, etc - sufficient to subdivide into 3-5 redshift bins to track evolution.

The End

MAD MAX

- High-redshift radio galaxies (HzRG) host large black holes as a result they are proposed to be progenitors of most massive local ellipticals. There is also growing evidence they live in dense environments (proto-clusters).
- Search around HzRGs for suitable stars: all z>2 HzRGs (not QSOs) at Dec<10 with 2-3 V<17 stars within 60"
- Four good candidates (but only with double-stars)

PKS1602-17 z=2.04
NVSSJ095357-203652 z=2.83
PDFJ011001.3-460818 z=3.06
NVSSJ010534+050111 z=3.50



The Lyman-alpha halo around PKS1602-17 from Venemans et al. (2007). This is evidence for a structure on 100-kpc scales around this massive galaxy, which may include other galaxies whose morphologies would be accessible with MAD.