Strong galaxy-galaxy lenses in COSMOS

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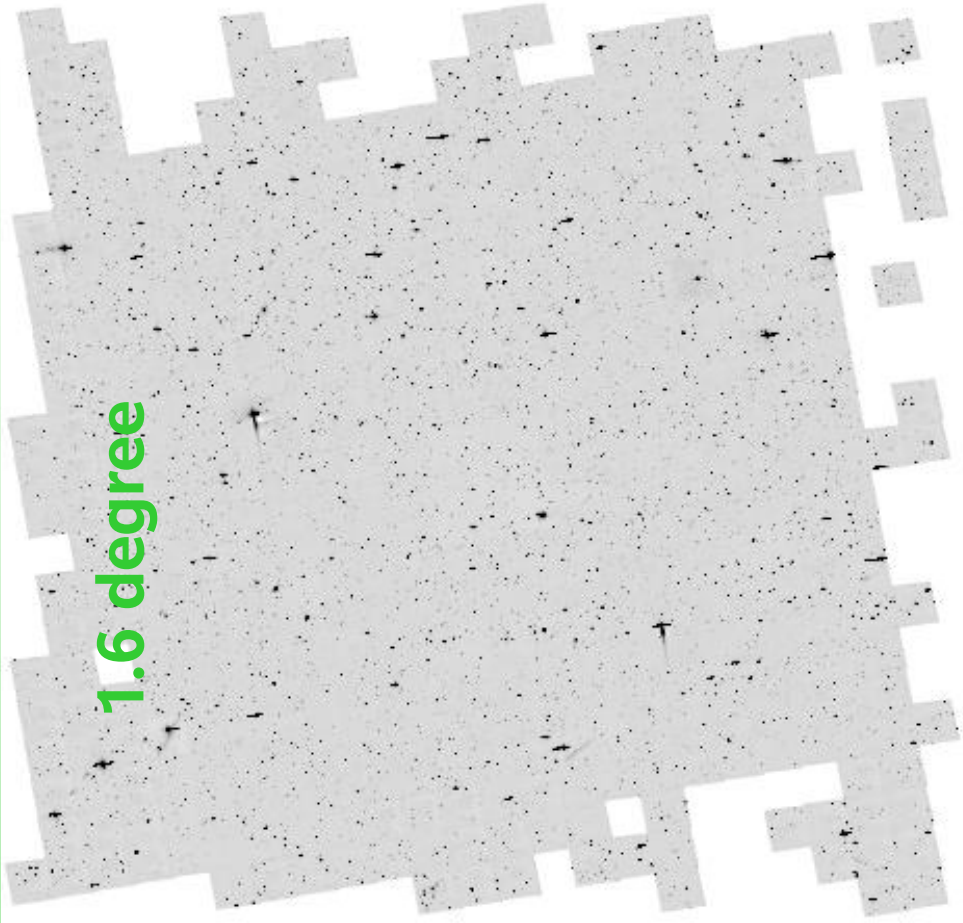
1) The COSMOS survey



(Shown: 477 orbits as of mid May2005)

HUBBLE Treasury Data

PI: N. Scoville 590 orbits

ACS/F814W (~ 1.6 sq. deg)

+ NICMOS-3/F160W

SUPRIME@ Subaru

PI:Y. Taniguchi

1.5x1.5 deg

0.7" ~seeing

BVgriz bands

MEGACAM@ CFHT

u*,i*

Seeing < 1.0”

Ground: VLA,JCMT,IRAM

Space: XMM,Chandra,Spitzer

2) The search for strong galaxy-galaxy lenses

➡ 278526 galaxies with z-phot *(Mobasher et al. 2007)*

Visual inspection of potential lensing galaxies in ACS I-band stamp images of 10”x10”:

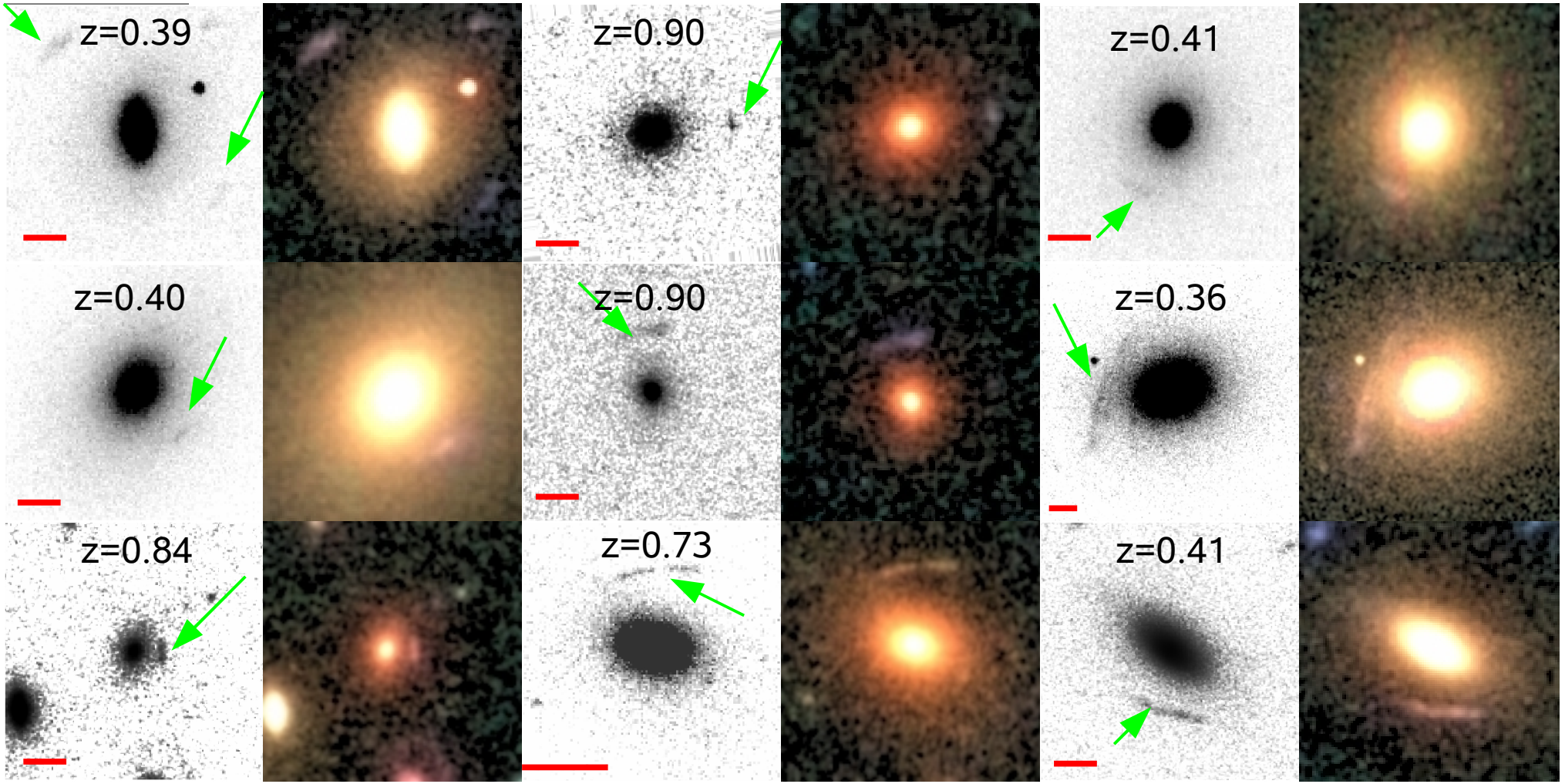
- **photometric redshift:** $0.2 \leq z \leq 1.0$
- **luminosity:** $M_V < -20.$ mag
- **galaxy type**: early-type as fitted from the SED when computing the photo-z

➡ 9452 galaxies in **parent catalog**

➡ 337 lens candidates after ACS inspection

➡ 67 lens candidates after color criterion and galaxy light profile fit and subtraction (47 single arcs and 20 multiple images)

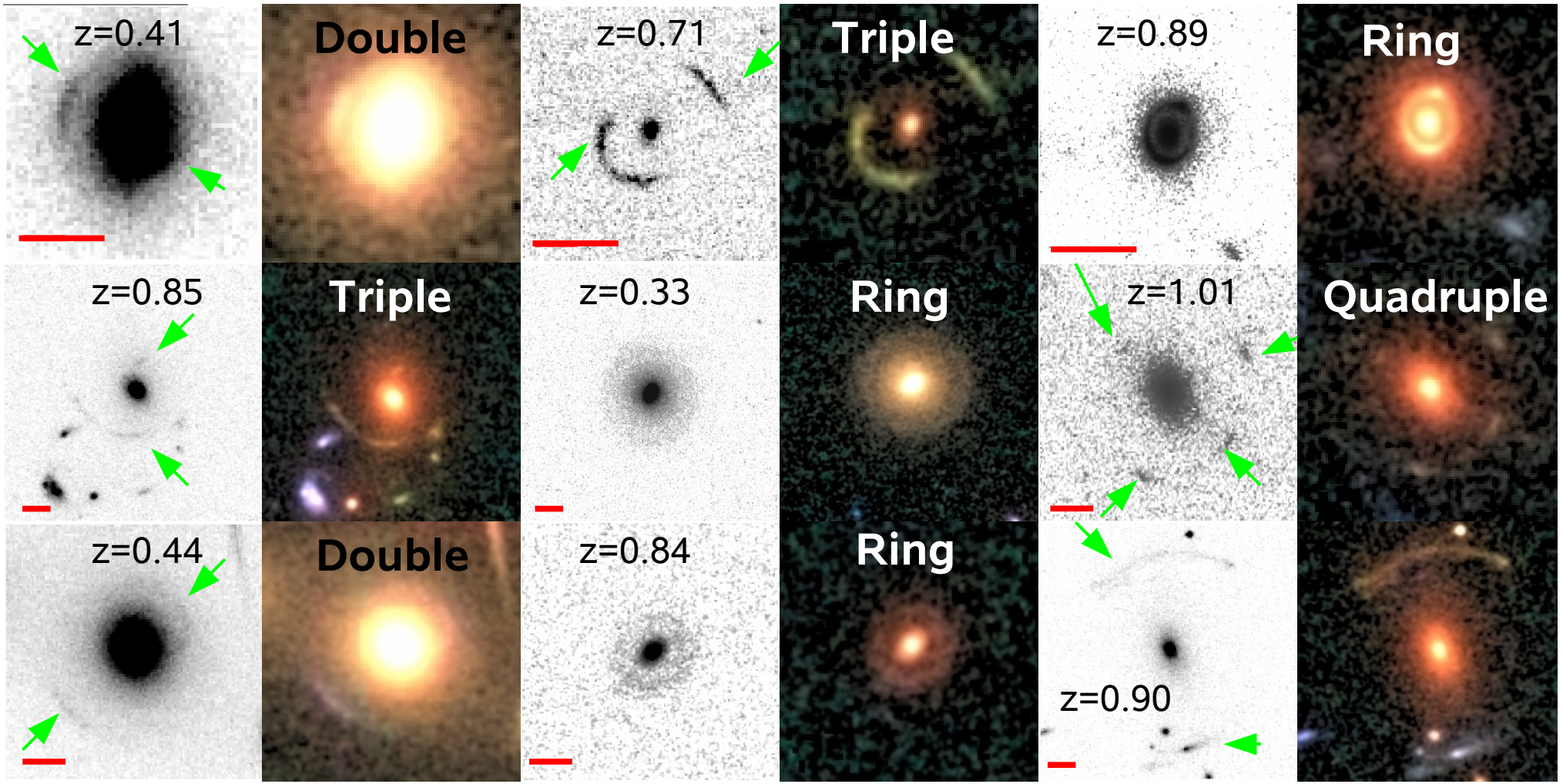
3) Some candidates: single arc systems



— 1 arc-second

ACS-F814w / Subaru-B_j,r^+,z^+ images sharpened with the ACS images

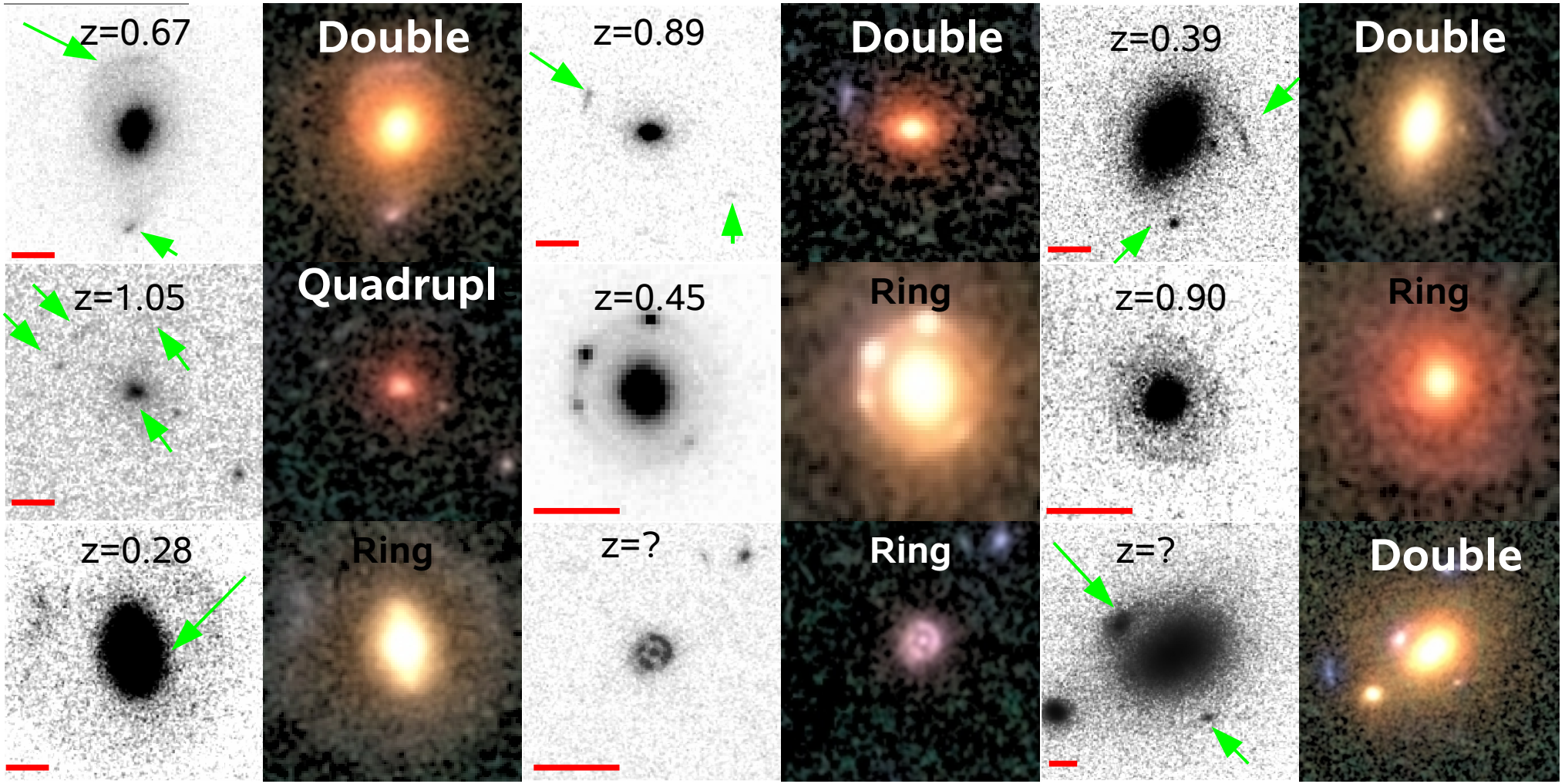
Some candidates: best systems



— 1 arc-second

ACS-F814w / Subaru-B_i,r^+,z^+ images sharpened with the ACS images

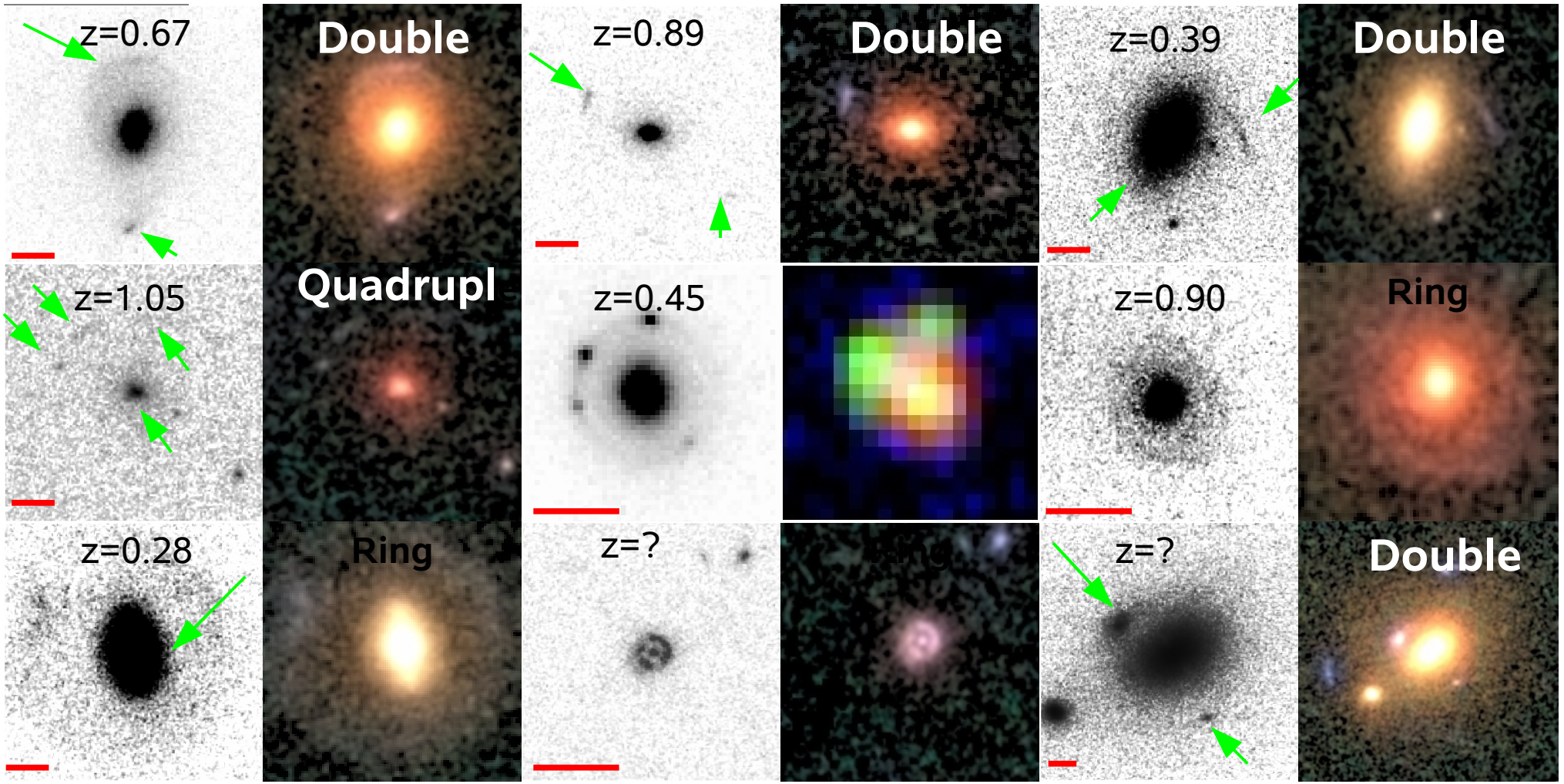
best candidates 2



— 1 arc-second

ACS-F814w / Subaru-Bj,r+,z+ images sharpened with the ACS images

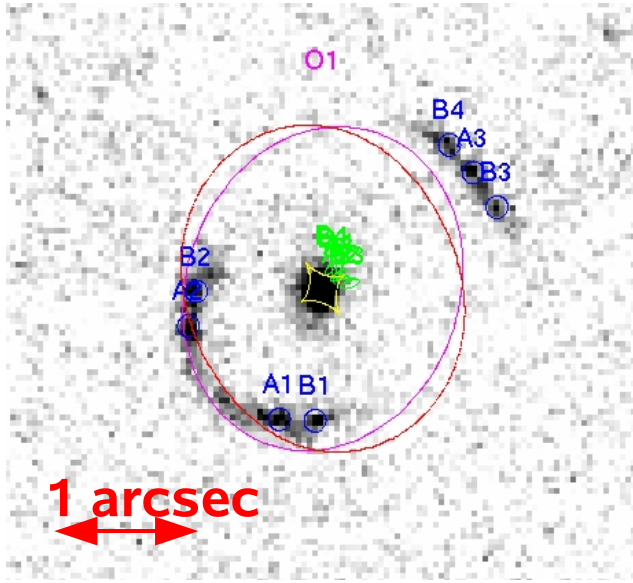
best candidates 2



— 1 arc-second

ACS-F814w / Subaru-B^j,r^+,z^+ images sharpened with the ACS images

4) Lens modelling

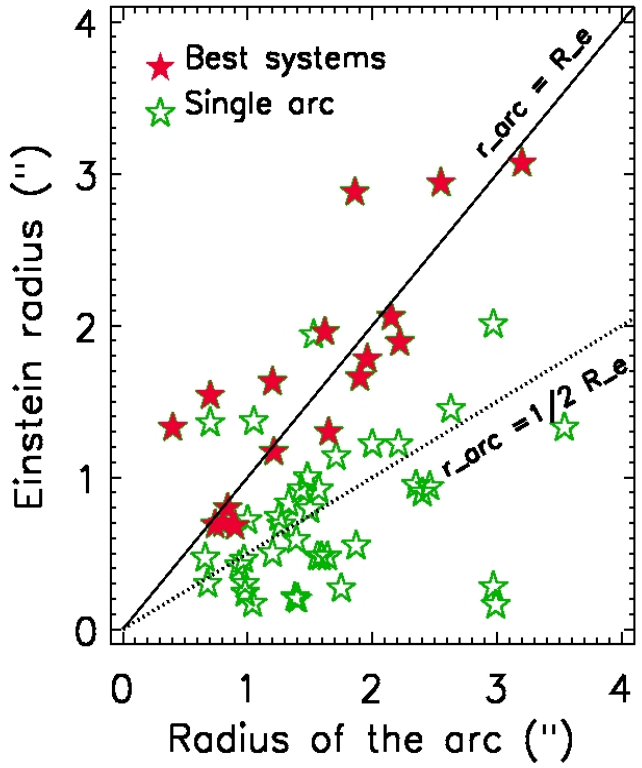


- **Lens model SIE+γ**

(LensTool, *Kneib et al 1993, Jullo et al 2007*)
assuming: $z_s = 2.z_L$

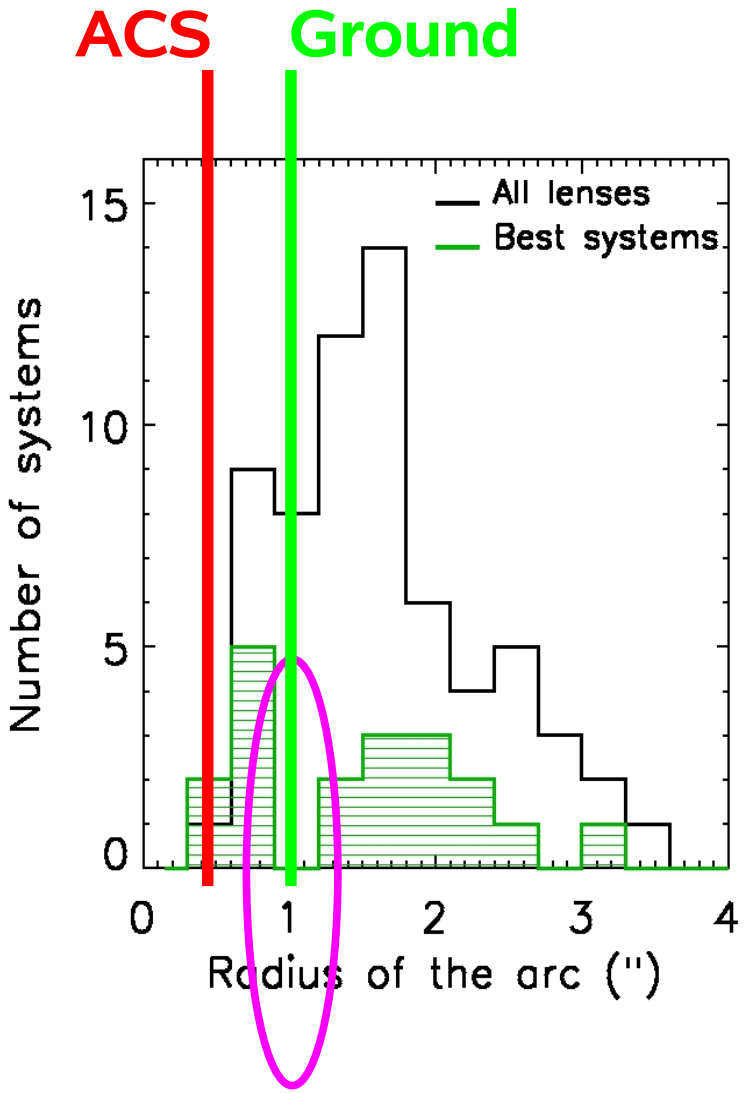
- **Measurement of the Einstein radius**, or equivalent mass within the Einstein radius

➡ ***Confirmation of the single/multiple images classification***



➡ Measuring redshifts is key for proper mass models (zCOSMOS and FORS1-MOS data)

Some properties of the sample



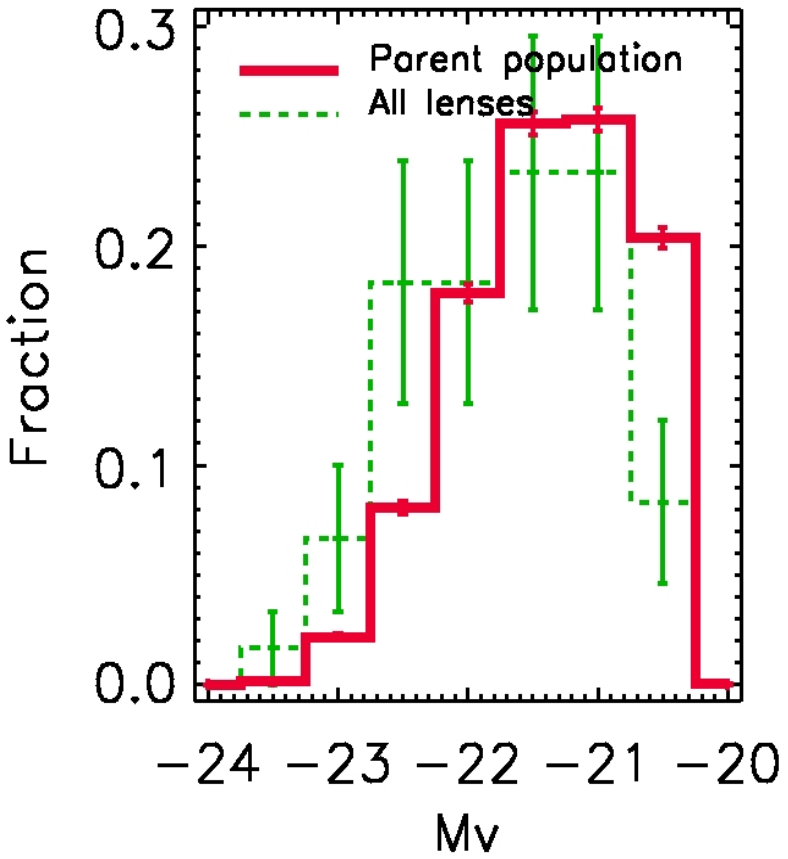
Lack of multiple image systems with r_{arc}~1"!

- transition between ACS high resolution images to ground color images

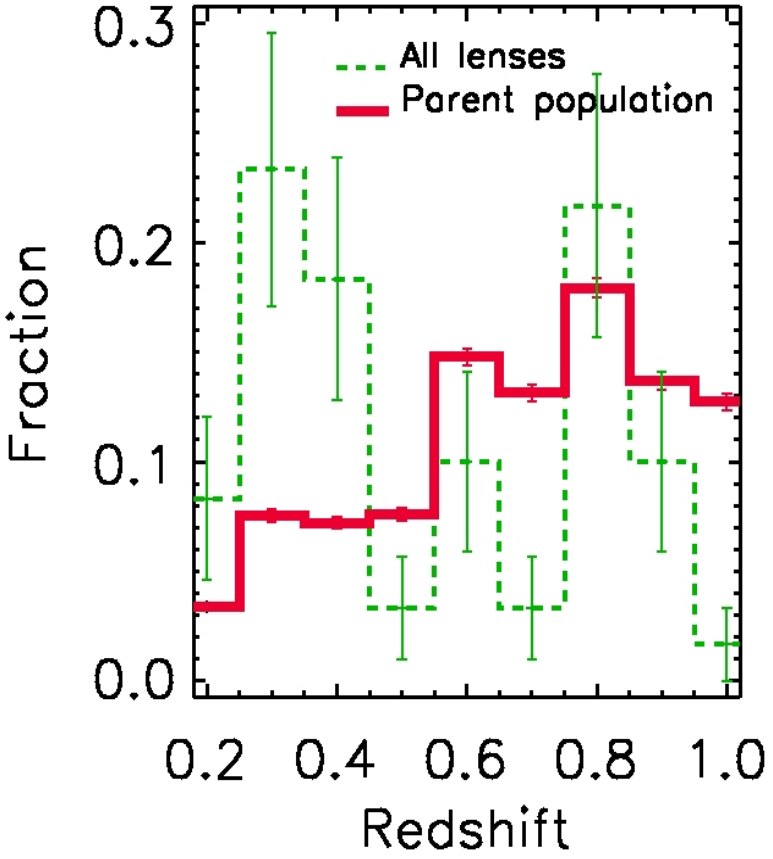
-some of the single arcs systems are multiple?

-incompletness of the lens sample

Some properties of the sample 2



lensing galaxies brighter than the parent population



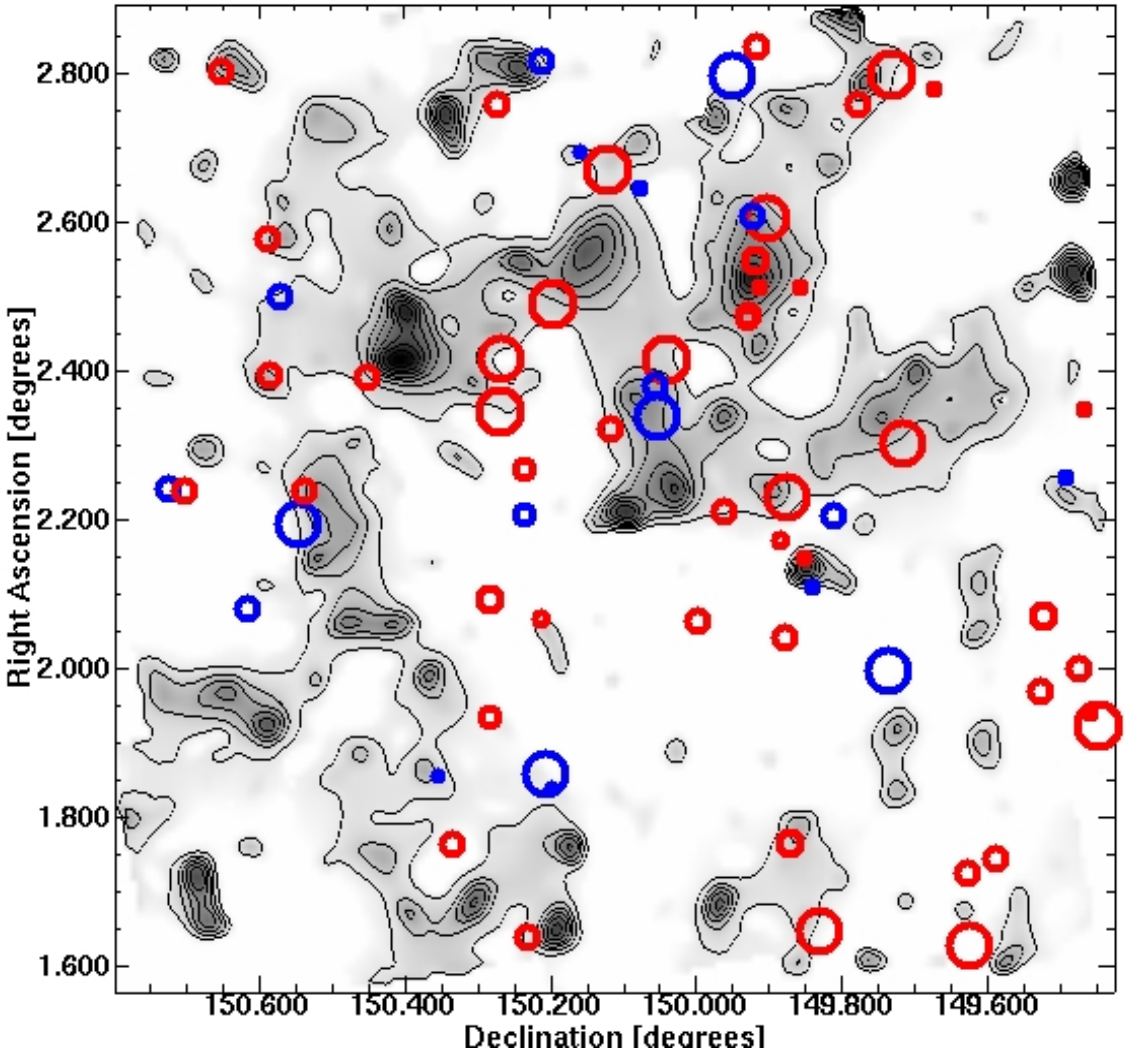
2 peaks?

Kosmogorov-Smirnov test: 92% prob the same distribution

(poissonian noise)

5) Strong lenses in the mass map

Blue: best lenses Red: single arcs



Size depends on arc radius

small: r_{arc}<1”

medium: 1” ≤r_{arc}<2”

large: 2” ≤r_{arc}<5”

We define three regions:

« empty »:

κ<0.4% <=> 70% field

« filament »:

0.4≤ κ <2% <=>26% field

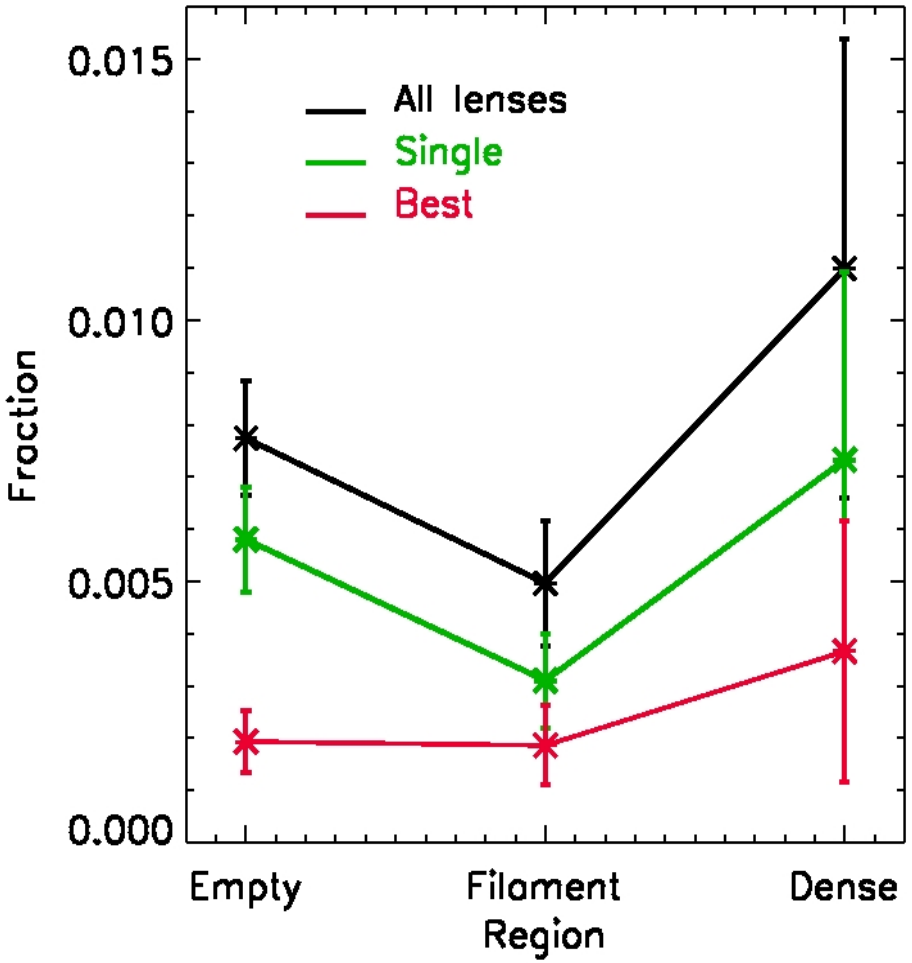
« dense »:

κ> 2% <=> 4% field

(peak at ~4.5%)

Convergence map: *Massey et al. 2007*

A) The strong lenses versus the parent population:



In complex environment:

33+/-1 % of all candidates

41+/-2 % of the best candidates

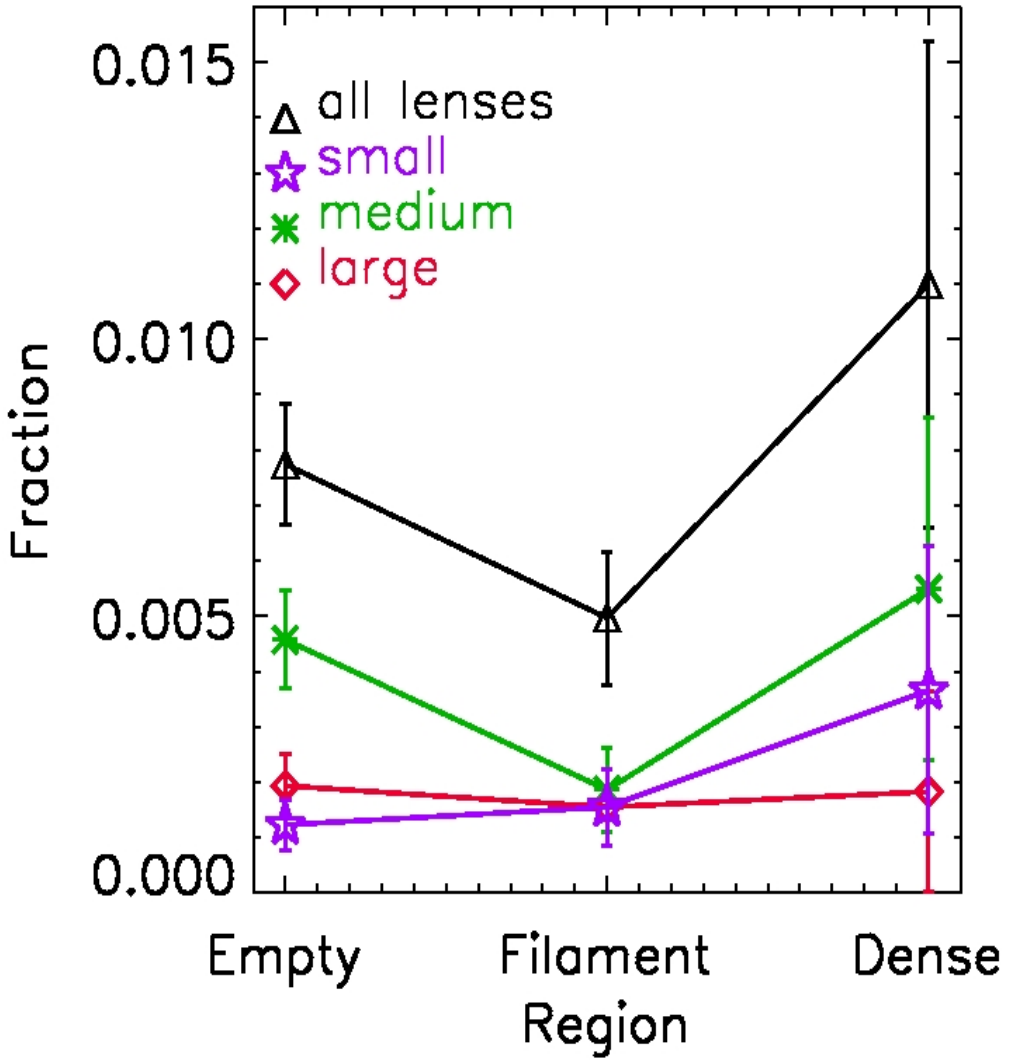
30+/-1 % of the single arc

Bright elliptical galaxies that are strong lenses:

- "complex": 1.5+/-0.5 %
- "empty": 0.7+/-0.1 %
- 0.2≤z<0.5: 1.7+/-0.3 %
- 0.5≤z≤1.0: 0.3+/-0.1 %

filament+dense=**complex** environment

B) Distribution of the strong lenses according to their arc radius:



small:
r_{arc}<1” (14 lenses)
medium:
1”≤r_{arc}<2” (35 lenses)
large:
r_{arc}≥2” (17 lenses)

20+/-20 % of our best candidates
(or 6+/-6 % of all lenses)
with "large" arc radius (2"≤r_{arc}<5") are in
a "dense" environment (κ>0.016)

Simulations by *Oguri,Keeton & Dalal. 2005*:
15% to 60% of lenses with 2≤r_{arc}<5" should be in environment with κ≥0.1
us: 0% of the candidates 8-(

...?!?

- Catalog of strong lens candidates incomplete
- Small galaxy groups favorable to this regime of arc radius
- Efficiency of double layer lenses understimated in simu ?
  => Numerical simulations by *Wambsganss, Bode & Ostriker 2005*, predicts 20 to 40% of lenses to be double layers

Preliminary results on Galaxy-Galaxy weak lensing in COSMOS by Alexie Léauthaud

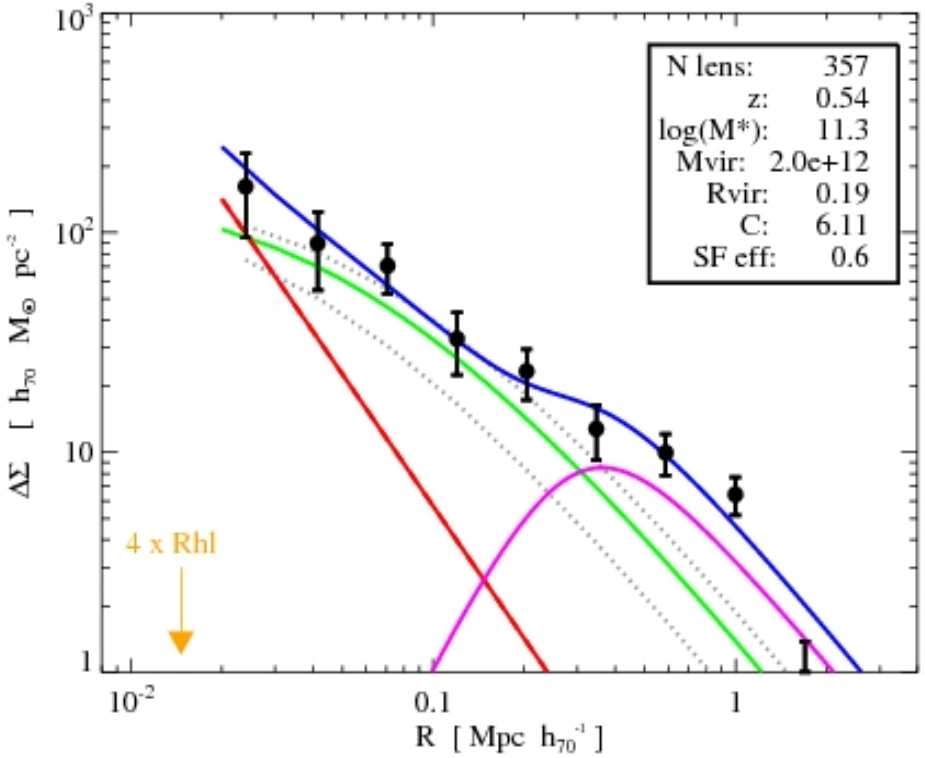
$$\Delta\Sigma = \Delta\Sigma_b + \Delta\Sigma_{NFW} + \alpha.\Sigma_{NC}$$

$\Sigma_{b:}$ Baryonic contribution determined by the stellar mass

Σ_{NFW} : NFW profile assumed for dark matter halos.

α : Fraction of galaxies in sub-halos.

$\Sigma_{NC:}$ Off centered 'group' contribution.



Summary

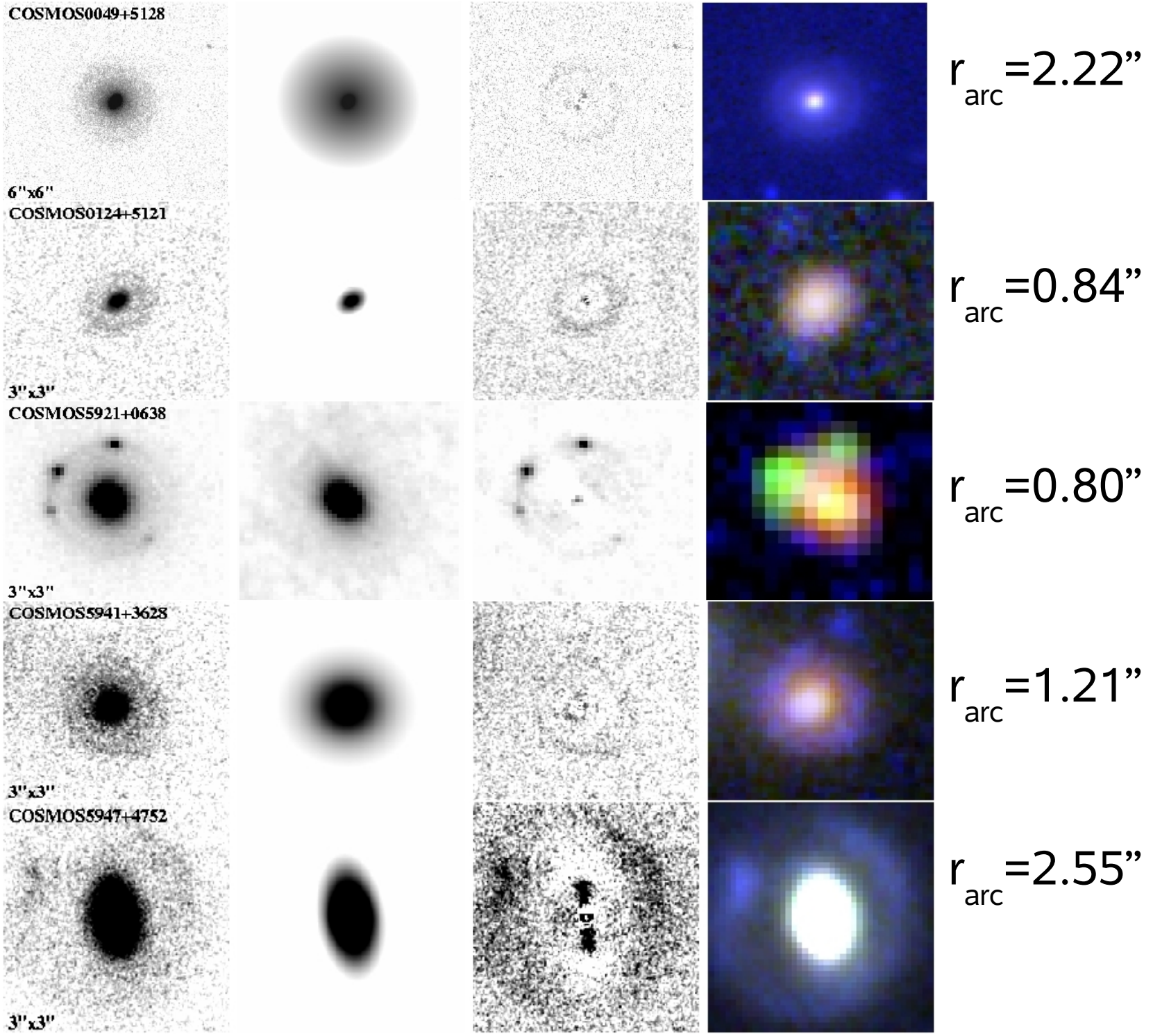
On the sample

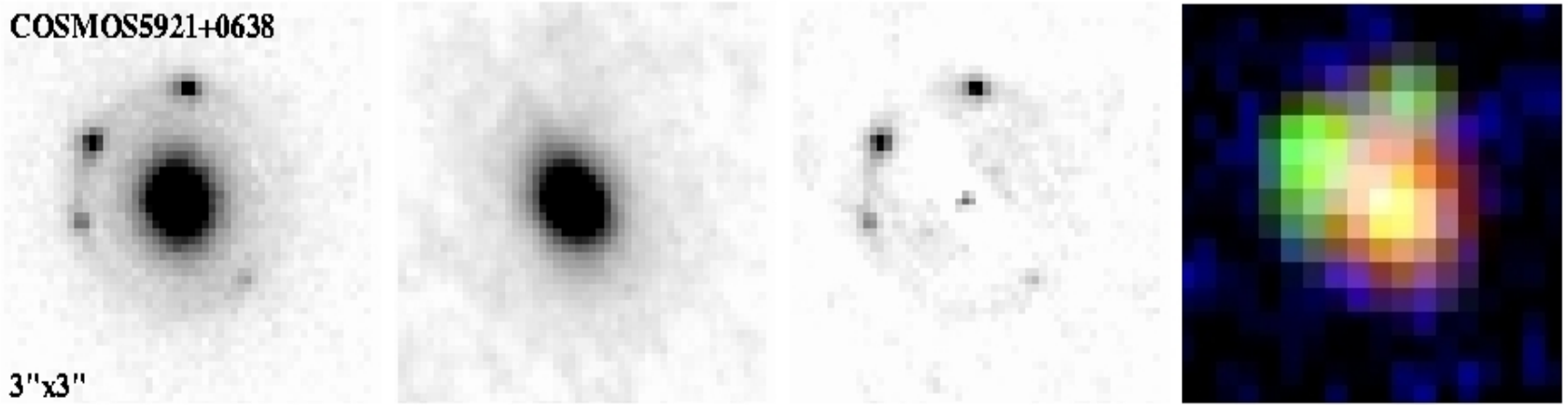
- new sample of strong lens candidates
- lower limit in occurrence of strong lenses in space surveys
- valuable sample to test robustness of semi-automatic detection software (**Haggles**, *P. Marshall et al. 2007*)

On the comparison with the mass map and with the parent population

- 30% to 40% of the lensing galaxy candidates are in complex environment
- 1.5% of the bright elliptical galaxies are strong lensing galaxy candidates if they are in a complex environment
- lens candidates are ~0.5 mag brighter than the parent population of galaxies
- may be two peaks in the redshift distribution
- the arc radius size is not correlated with the large scale structures in the regime of arc radius probed

(Faure et al. 2007, ApJ - Faure et al. 2007, Letter to ApJ)


COSMOS0049+5128
6"x6"
COSMOS0124+5121
3"x3"
COSMOS5921+0638
3"x3"
COSMOS5941+3628
3"x3"
COSMOS5947+4752
3"x3"
r arc =2.22”
r arc =0.84”
r arc =0.80”
r arc =1.21”
r arc =2.55”



Gim2D *(Simard 1998, Marleau et Simard 1998)*
sersic bulge + exponential disc