The first catalog of strong lenses in the COSMOS field

Cécile Faure, Jean-Paul Kneib
extract from: Faure et al. 2007, submitted to ApJ

Abstract:

We present a catalog of 67 new strong galaxy-galaxy lens candidates discovered by visual inspection of the ACS-F814w images of the COSMOS field. The arcs and multiple images have been found around massive early type galaxies with $0.2 \leq z \leq 1.0$ and $M_v \leq -20$ mag, and the arc radius are typically ≤5”

The Hubble Space Telescope COSMOS survey:

The COSMOS survey (PI N. Scoville) covers a region of 1.64 square degree in the equatorial plane. It includes the largest contiguous high resolution astronomical imaging survey ever performed from space. The multi-wavelength coverage of the field with ground based (Subaru, CFH, VLA, JCMT, IRAM) and space based (HST, XMM, Chandra, Spitzer) telescopes make this survey a great opportunity to locate and study more strong galaxy-galaxy lensing events.

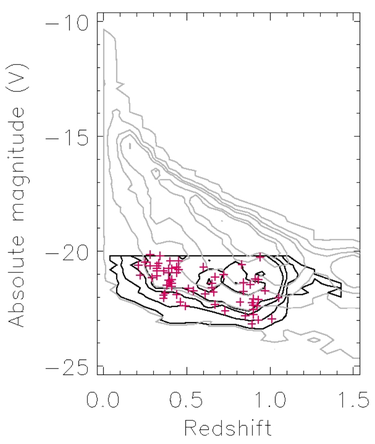

Fig 1: Galaxies of the COSMOS field: V_j- band absolute magnitude versus photometric redshift. Grey lines: all galaxies in the entire photometric catalog. Black lines: catalog of potential lensing galaxies. Red crosses: the lensing galaxy candidates.

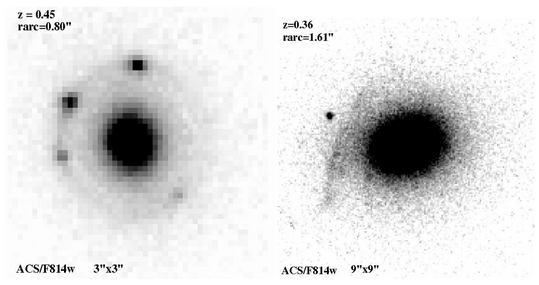

Fig 2: Two strong lens candidates from the COSMOS sample.

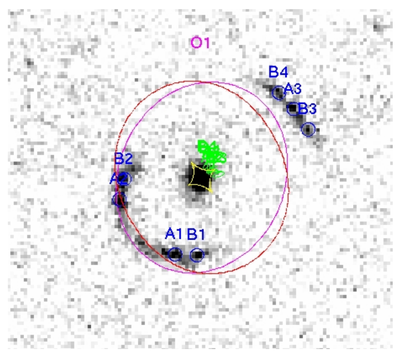

Fig 3: Lens model SIE+shear of a candidate (with LensTool).

Supplementary tests:

- color images:
  using ground based images to check for color differences between the multiple image candidates and between the lensing galaxy candidate and the potentially background lensed galaxy
- subtraction of a galaxy surface brightness model of the foreground galaxy to determine the galaxy morphology and the configuration of the potentially lensed background galaxy

We identified 67 strong galaxy galaxy lens candidates : 47 have a single arc and 20 have multiple images (Fig. 1, 2, 4). The distribution of the arc radius of the candidates is displayed in Fig. 5.

Search method:

The lens candidates have been found by visual inspection of a preselected sample of potential lensing galaxies, for which photometric redshifts where measured (with 8 bands, Capak et al. 2007, Mobasher et al. 2007).
From the initial catalog of 278,819 galaxies, we selected the potential lensing galaxies according to the following criteria :

- photometric redshift : $0.2 \leq z \leq 1.0$, to ensure that the galaxy will produce lens events
- luminosity : Mv≤-20mag, to select the brightest galaxies, that are also likely to be the more massive ones
- galaxy type : early type as fitted from the SED when compiling the photometric redshifts as they are likely the more massives galaxies, and have a light profile easy to subract.

We end up with 9452 bright elliptical galaxies, that we inspect visually, searching for arc like features and multiple images.

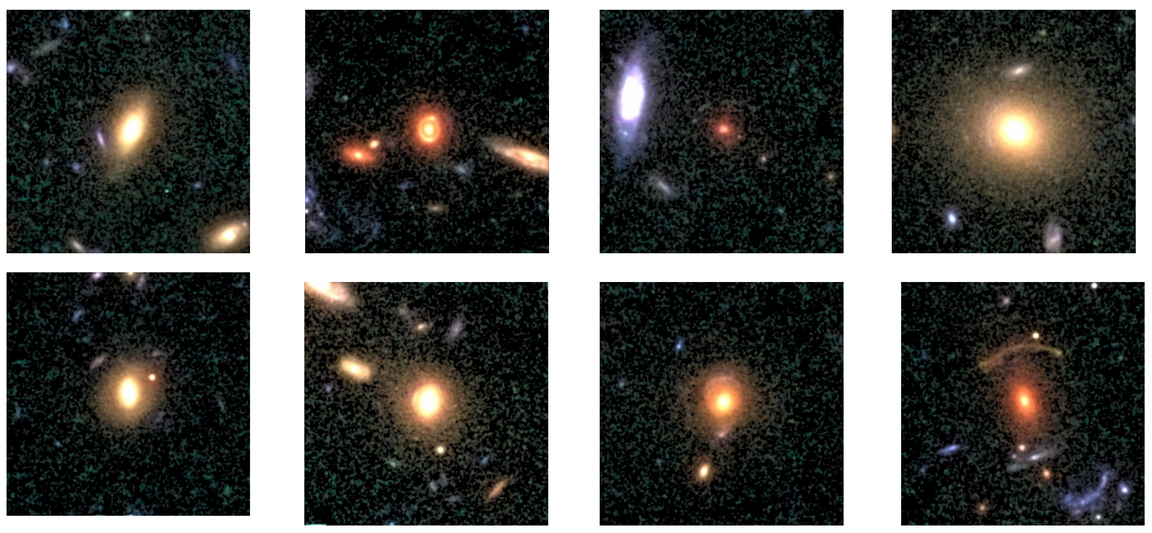

Fig 4: Subaru color images of 8 lens candidates, sharped with the ACS images. (10”x10”)

Analysis:

We have made a simple mass model of the lens potential (SIE+external shear) (Fig 3, using Lenstool Kneib et al. 1996, Jullo et al. 2007) to derive the Einstein radius of the lens candidates and compare the present sample to the strong galaxy-galaxy samples in the SLACS survey and in the CASTLES database (Fig. 5).

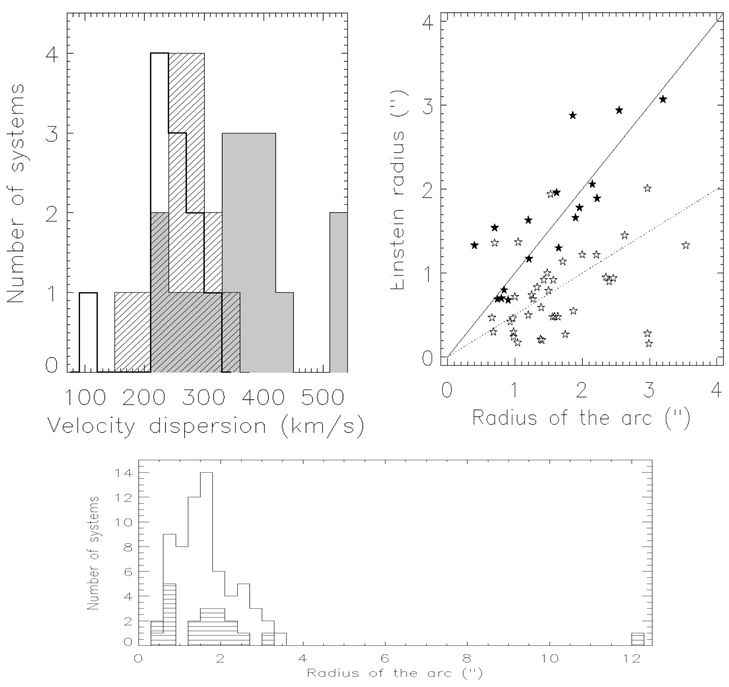

Fig 5: Left panel: the velocity dispersion of the lens candidates with multiple images in the COSMOS field (filled in grey), of the lensing galaxies in the CASTLES database (solid lines) and in the SLACS surveys (hashed histogram). **Right panel:** The Einstein radius versus the arc radius of the strong lens candidates. The empty stars represent the single arc systems, and the black stars, the multiple image systems. **Bottom panel:** the arc radius distribution of the single arc systems (solid line) and of the multiple image systems (hashed histogram).

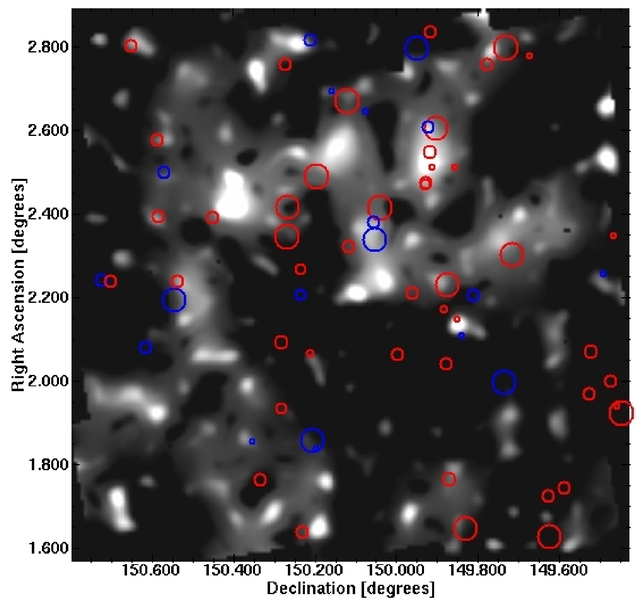

Fig 6: The strong lens candidates projected in the COSMOS conver-gence map (bright spots are picks of mass), Massey et al. 2007. The red circles are the single arc systems, the blue circles are the multiple image and long curved arc systems. The size of the circle reflect the size of the arc radius: small circles for systems with $r_{arc} \leq 1$”, medium circles for systems with 1” $< r_{arc} \leq 2$”, large circles for systems with $r_{arc} > 2$”.

Results and conclusion:

The COSMOS sample of strong lenses, gives a robust lower limit of of the occurrence of lens events that can be expected to be found in current and future space based surveys: ~10 systems per square degree or ~200,000 strong lenses in the whole sky with an HST like resolution. This sample is valuable to test the robustness of algorithm developped to search automatically for strong lenses. The present set of strong lenses will be compared to the convergence map of the field (Fig 6) to study the relation between lensing galaxies and their environment (Faure et al. 2007, Letter to ApJ, in prep.).

References: Capak et al. 2007, arXiv:0704.2430; Faure et al. 2007, submitted to ApJ; Jullo et al. 2007,arXiv:0706.0048; Kneib et al. 1996, ApJ 471,643; Massey et al. 2007, Nature 445,286; Mobasher et al. 2006, arXiv:astro-ph/0612344 **Lenstool:** http://www.oamp.fr/cosmoslogy/lenstool