J/A+A/632/A36 Strong lensing models of 8 CLASH clusters (Caminha+, 2019)

Strong lensing models of eight CLASH clusters from extensive spectroscopy:
accurate total mass reconstructions in the cores.
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Vanzella E., Annunziatella M., Broadhurst T., Delgado-Correal C.,
Demarco R., Koekemoer A.M., Lombardi M., Maier C., Verdugo M., Zitrin A.
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=2019A&A...632A..36C (SIMBAD/NED BibCode)

ADC_Keywords: Clusters, galaxy ; Redshifts

Keywords: galaxies: clusters: general - gravitational lensing: strong -
dark matter

Abstract:
We carry out a detailed strong lensing analysis of a sub-sample of eight galaxy clusters of the Cluster Lensing And Supernova survey with Hubble (CLASH), in the redshift range of $z_{cluster}$=[0.23-0.59], using extensive spectroscopic information, primarily from the Multi Unit Spectroscopic Explorer (MUSE) archival data and complemented with CLASH-VLT redshift measurements. The observed positions of the multiple images of strongly lensed background sources are used to constrain parametric models describing the cluster total mass distributions. Different models are tested in each cluster depending on the complexity of its mass distribution and on the number of detected multiple images. Four clusters show more than five spectroscopically confirmed multiple image families. In this sample, we do not make use of families that are only photometrically identified, in order to reduce model degeneracies between the values of the total mass of a cluster and of the source redshifts, and systematics due to the potential misidentifications of some multiple images. For the remaining four systems, we use additional families without any spectroscopic confirmation to increase the number of strong lensing constraints up to the number of free parameters in our parametric models. We present spectroscopic confirmation of 27 multiply lensed sources, with no previous spectroscopic measurements, spanning over the redshift range of z_{src}=[0.7-6.1]. Moreover, we confirm an average of 48 galaxy members in the core of each cluster, thanks to the high efficiency and large field of view of MUSE. We use this information to derive precise strong lensing models, projected total mass distributions and magnification maps. We show that, despite having different properties (i.e., number of mass components, total mass, redshift, etc), the projected total mass and mass density profiles of all clusters have very similar shapes, when rescaled by independent measurements of M200c and R200c. Specifically, we measure the mean value of the projected total mass of our cluster sample within 10 (20)% of R200c to be 0.13 (0.32) of M200c, with a remarkably small scatter of 5 (6)%. Furthermore, the large number of high-z sources and the precise magnification maps derived in this work for four clusters add up to the sample of high-quality gravitational telescopes to be used to study the faint and distant Universe.

Description:
The cluster sample presented in this work has been observed by the CLASH survey, using the ACS and WFC3 cameras onboard HST, in 16 filters from the UV through the NIR.

Up to now, a total of 11 CLASH clusters have been observed by MUSE in different programmes. In previous works, we have used deep observations on three targets, MACS J1206, Abell 1063 and MACS J0416 (Caminha et al. 2016A&A...587A..80C, 2017, Cat. J/A+A/600/A90, 2017A&A...607A..93C), where the last two clusters are also part of the HFF initiative. In this work, we make use of archival MUSE data from the ESO programme IDs 095.A-0525, 096.A-0105, 097.A-0909 and 098.A-0590 (P.I. J.-P. Kneib) on the remaining eight clusters.

The observations were carried out during the period between 2015-June and 2017-January, with observation blocks (OBs) consisting of two exposures of ~1465 seconds.

File Summary:

FileName	Lrecl	Records	Explanations
ReadMe	80	.	This file
table2.dat	64	961	Full redshift catalogue
tablea2.dat	91	150	Information on the spectroscopically identified multiple images
list.dat	97	160	List of model files
MACSJ0329-P2-shear/*	0	14	MACS J0329.7-0211 P2 model results
MACSJ0329-P2-shear_mcmc/*	0	6	MACS J0329.7-0211 P2 input files
MACSJ0429-P1/*	0	14	MACS J0429.6-0253 P1 model results
MACSJ0429-P1_mcmc/*	0	6	MACS J0429.6-0253 P1 input files
MACSJ1115-P1/*	0	14	MACS J1115.9+0129 P1 model results

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MACSJ1115-P1_mcmc/*     0        6   MACS J1115.9+0129 P1 input files
MACSJ1311-P1/*     0       14   MACS J1311.0-0310 P1 model results
MACSJ1311-P1_mcmc/*     0        6   MACS J1311.0-0310 P1 input files
MACSJ1931-P2_circular/*     0       14   MACS J1931.8-2635 P2 model results
MACSJ1931-P2circularmcmc/*     0        6   MACS J1931.8-2635 P2 input files
MACSJ2129-P2/*     0       14   MACS J2129.4-0741 P2 model results
MACSJ2129-P2_mcmc/*     0        6   MACS J2129.4-0741 P2 input files
RXJ1347-P2-shear/*     0       14   RX J1347.5-1145 P2 model results
RXJ1347-P2-shear_mcmc/*     0        6   RX J1347.5-1145 P2 input files
RXJ2129-P1/*       0       14   RX J2129.7+0005 P1 model results
RXJ2129-P1_mcmc/*     0        6   RX J2129.7+0005 P1 input files
```

See also:
J/A+A/600/A90 : MACS J0416.1-2403 redshift catalogue (Caminha+, 2017)

Byte-by-byte Description of file: table2.dat

Bytes	Format	Units	Label	Explanations
1- 26	A26	---	Muse	ID build from the cluster name and object RA and Dec, ANNNN-JHHMMSS.ss+DDMMSS.ss (1)
28- 38	F11.7	deg	RAdeg	Observed right ascension (J2000)
40- 50	F11.7	deg	DEdeg	Observed declination (J2000)
52- 57	F6.4	---	z	Spectroscopic redshift
60	I1	---	q_z	[2/9] Redshift quality flag (2)
64	I1	---	Mult	Number of entries of the same object in this catalogue used to indicate multiply lensed sources

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Note (1): Cluter names as follows:
M0329 = MACS J0329.7-0211
M0429 = MACS J0429.6-0253
M1115 = MACS J1115.9+0129
M1311 = MACS J1311.0-0310
M1931 = MACS J1931.8-2635
M2129 = MACS J2129.4-0741
R1347 = RX J1347.5-1145
R2129 = RX J2129.7+0005
Note (2): Redshift quality flag as follows:
2 = likely
3 = secure measurement
9 = single line measurement
4 = field star

Byte-by-byte Description of file: tablea2.dat

Bytes	Format	Units	Label	Explanations
1- 10	A10	---	Cluster	Cluster name
12- 20	A9	---	ID	Multiple image designation
22- 33	F12.8	deg	RAdeg	Right ascension (J2000)
35- 49	F15.11	deg	DEdeg	Declination (J2000)
51- 56	F6.4	---	zMUSE	? Muse redshift
59- 64	F6.4	---	zp1	? Previous redshift
65- 67	A3	---	r_zp1	Reference for zp1 (1)
69- 73	F5.3	---	zp2	? Previous redshift
76	A1	---	r_zp2	Reference for zp2 (1)
78	A1	---	---	
79- 83	F5.3	---	zp3l	? Lower value of previus redhsift interval
84	A1	---	---	[-]
85- 89	F5.3	---	zp3u	? Upper value of previus redhsift interval
90	A1	---	---	
91	A1	---	r_zp3l	Reference for zp3 (1)

Note (1): References as follows:
a = Spectroscopic redshifts from Belli et al. (2013ApJ...772..141B)
b = Spectroscopic redshifts from CLASH-VLT (Rosati et al., in prep.)
c = Spectroscopic redshift from Vanzella et al. (in prep.)
d = Spectroscopic confirmation from Huang et al. (2016ApJ...823L..14H)
e = Photometric redshift limits from Molino et al. (2017MNRAS.470...95M)
f = Independent spectroscopic confirmations from Ravindranath & Ho (2002ApJ...577..133R), Bradac et al. (2008ApJ...681..187B), Halkola et al. (2008A&A...481...65H)
g = Spectroscopic redshift from Cohen & Kneib (2002ApJ...573..524C)
h = Spectroscopic redshift obtained from the public GLASS catalogues Treu et al. (2015, Cat. J/ApJ/812/114)

Byte-by-byte Description of file: list.dat

Bytes	Format	Units	Label	Explanations
1- 51	A51	---	FileName	Name of the file (1)
53- 97	A45	---	Title	Title of the file

Note (1): all files related to the strong lens models in the paper
Caminha+2019 A&A accepted (https://arxiv.org/abs/1903.05103).
Please note that the 'gold' sample, i.e. the clusters with good SL constraints
consists of RXJ2129, MACS1931, MACS0329 and MACS2129.
The 'silver' sample lacs of a large number of SL constraints and is composed
by MACS1115, MACS0429, RXJ1347 and MACS1311. In the future some of these
clusters might have updated SL models in the view of new data.

The folder names are the same model IDs of the paper.
The names ending with *_mcmc have the lenstool input files and the chains
(bayes.dat files).
The other folders contain the best fit configuration file and convergence,
shear and magnification maps. All the quantities are rescaled to DLS/DS=1.
If you use the information in these files please cite the paper Caminha+2019
A&A accepted (https://arxiv.org/abs/1903.05103), and for any further
question contact the author via the e-mail gbcaminha(at)gmail.com

History:
25-Nov-2019: From Gabriel Bartosch Caminha, gbcaminha(at)gmail.com
27-Jan-2020: tablea2.dat added

Acknowledgements:
when using these redshifts, please acknowledge the papers
Caminha et al. 2019 (arXiv:1903.05103), and the VLT programme IDs 095.A-0525,
096.A-0105, 097.A-0909 and 098.A-0590

(End) Patricia Vannier [CDS] 16-Oct-2019

*The document above follows the rules of the Standard Description for Astronomical Catalogues; from this documentation it is possible to generate **f77** program to load files into arrays or line by line*