J/ApJ/811/29 GLASS. IV. Lensing cluster Abell 2744 (Wang+, 2015)

The Grism Lens-Amplified Survey from Space (GLASS).
IV. Mass reconstruction of the lensing cluster Abell 2744 from Frontier Field imaging and GLASS spectroscopy.

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=2015ApJ...811...29W (SIMBAD/NED BibCode)

ADC_Keywords: Clusters, galaxy ; Gravitational lensing ; Redshifts ; Photometry, HST ; Spectroscopy
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Abstract:
We present a strong and weak lensing reconstruction of the massive cluster Abell 2744, the first cluster for which deep Hubble Frontier Fields (HFF) images and spectroscopy from the Grism Lens-Amplified Survey from Space (GLASS) are available. By performing a targeted search for emission lines in multiply imaged sources using the GLASS spectra, we obtain five high-confidence spectroscopic redshifts and two tentative ones. We confirm one strongly lensed system by detecting the same emission lines in all three multiple images. We also search for additional line emitters blindly and use the full GLASS spectroscopic catalog to test reliability of photometric redshifts for faint line emitters. We see a reasonable agreement between our photometric and spectroscopic redshift measurements, when including nebular emission in photometric redshift estimations. We introduce a stringent procedure to identify only secure multiple image sets based on colors, morphology, and spectroscopy. By combining 7 multiple image systems with secure spectroscopic redshifts (at 5 distinct redshift planes) with 18 multiple image systems with secure photometric redshifts, we reconstruct the gravitational potential of the cluster pixellated on an adaptive grid, using a total of 72 images. The resulting mass map is compared with a stellar mass map obtained from the deep Spitzer Frontier Fields data to study the relative distribution of stars and dark matter in the cluster. We find that the stellar to total mass ratio varies substantially across the cluster field, suggesting that stars do not trace exactly the total mass in this interacting system. The maps of convergence, shear, and magnification are made available in the standard HFF format.

Description:
The two position angles (P.A.s) of Grism Lens-Amplified Survey from Space (GLASS) data analyzed in this study were taken on 2014 August 22 and 23 (P.A.=135) and 2014 October 24 and 25 (P.A.=233), respectively.

The Hubble Frontier Fields initiative (HFF, P.I. Lotz) is a Director's Discretionary Time legacy program with HST devoting 840 orbits of HST time to acquire optical ACS and NIR WFC3 imaging of six of the strongest lensing galaxy clusters on the sky. All six HFF clusters are included in the GLASS sample.

The Spitzer Frontier Fields program (P.I. Soifer) is a Director's Discretionary Time program that images all six strong lensing galaxy clusters targeted by the HFF in both warm IRAC channels (3.6 and 4.5um).

File Summary:

FileName	Lrecl	Records	Explanations
ReadMe	80	.	This file
table1.dat	100	179	Multiply lensed arc systems identified in the Abell 2744 field
table2.dat	137	114	Emission line detection results on multiply and singly lensed sources (57 systems)

See also:
J/ApJ/812/114 : Grism Lens-Amplified Survey from Space (GLASS) I. (Treu+, 2015)
J/MNRAS/452/1437 : Abell 2744 strong-lensing analysis (Jauzac+, 2015)
J/ApJ/800/18 : HST/WFC3 observations of z~7-8 galaxies in A2744 (Atek+, 2015)
J/ApJS/207/24 : GOODS-S CANDELS multiwavelength catalog (Guo+, 2013)
J/ApJS/199/25 : CLASH sources for MACS1149.6+2223 (Postman+, 2012)
J/ApJ/728/27 : Chandra and AAOmega observations of Abell 2744 (Owers+, 2011)
J/A+A/500/947 : Spectroscopy and photometry in A2744 and A2537 (Braglia+, 2009)
J/A+A/449/461 : Radial velocities in A2744 (Boschin+, 2006)
J/ApJ/627/32 : Gravitationally lensed arcs in HST WFPC2 archive (Sand+, 2005)
J/AJ/112/1335 : Hubble Deep Field observations (Williams+ 1996)
http://glass.physics.ucsb.edu/ : GLASS home page
http://www.stsci.edu/~postman/CLASH : CLASH home page
http://www.stsci.edu/hst/campaigns/frontier-fields/ : HST FF home page
http://archive.stsci.edu/prepds/frontier/lensmodels/ : HFF lens models page
http://ssc.spitzer.caltech.edu/warmmission/scheduling/approvedprograms/ddt

/frontier/ : Spitzer FF

Byte-by-byte Description of file: table1.dat

Bytes	Format	Units	Label	Explanations
1- 4	F4.1	---	ID	[1.1/60.3] Arc identifier (1)
6	A1	---	f_ID	[e] Flag on 2.2 (2)
8- 10	A3	---	r_ID	Arc reference (3)
12- 20	F9.7	deg	RAdeg	Right ascension in decimal degrees (J2000)
22- 31	F10.6	deg	DEdeg	Declination in decimal degrees (J2000)
33- 37	F5.2	mag	F140W	[22.1/30.6]? HST/WFC3 NIR F140W magnitude (4)
39- 43	F5.2	---	z	[1.2/10]? Spectroscopic redshift
45	A1	---	f_z	[fgh] Flag on z for 46.1 (5)
47- 51	F5.2	---	zBayes	[0.01/11.9]? Redshift obtained from hierarchical Bayesian modeling (6)
53- 56	F4.2	---	b_zBayes	[0.7/4.7]? 68% lower limit on zBayes
57	A1	---	---	[-]
58- 61	F4.2	---	B_zBayes	[2/9.5]? 68% upper limit on zBayes
63	I1	---	q_zBayes	[0/1]? z_{Bayes} quality (1=secure) (7)
65- 70	F6.3	---	CChi2	[0/16.6]? Color-χ^2 value (see equation 1)
72	I1	---	Morph	[0/8] Morphology criterion (8)
74	I1	---	Cont?	[0/1] Contaminated? (9)
76	I1	---	Sys	[0/1]? System pass flag
78	I1	---	Img	[0/1] Image pass flag (10)
80- 87	F8.2	---	Magf	[1.4/53874]? Flux Magnification μ (11)
89- 93	F5.2	---	b_Magf	[1.4/61.7]? 68% lower limit on Magf
94	A1	---	---	[-]
95-100	F6.2	---	B_Magf	[1.6/624]? 68% upper limit on Magf

Note (1): Systems 15, 16, and 17 are not included in the table or the lens model because they belong to northern subclumps with >1arcminute separation from the cluster center shown in Figure 3. The coordinates of these systems can be found in Richard et al. (2014MNRAS.444..268R).

Note (2):
e = Due to the use of a fixed SExtractor detection image at F160W, 2.2 was not detected with even the most aggressive SExtractor detection settings, i.e., the "hot" mode settings. Upon visual inspection in other HST bands; however, the object is clearly separated and unmistakably belongs to system 2.

Note (3): References correspond to the most recent quote in the literature as follows:
G = this work,
J = Jauzac et al. (2015MNRAS.452.1437J),
T = Johnson et al. (2014ApJ...797...48J),
R = Richard et al. (2014MNRAS.444..268R),
C-B = Clement et al. (2015, in preparation),
Z = Zitrin et al. (2014ApJ...793L..12Z),
L = Lam et al. (2014ApJ...797...98L),
I = Ishigaki et al. (2015ApJ...799...12I)
System 60 is identified in this work for the first time.

Note (4): Objects for which F140 W magnitudes are not reported are not detected by SExtractor.

Note (5): Flag on z as follows:
f = The redshift of this system comes from the geometric constraint by Zitrin et al. (2014ApJ...793L..12Z).
g = Note that arc systems 1 and 55 have the same physical origin and therefore have the same z_{spec} through our identification of arc 1.3 (object ID #336).
h = Systems 2 and 56 have also the same physical origin and z_{spec} is measured through arc 56.1 (object ID #888).

Note (6): This value is the mode of the combined posterior probability distribution. For systems that fulfill the selection criteria and do not have a spectroscopic redshift, this is the redshift assigned to the system in the lens model.
Note that z_{Bayes}=0.01 is assigned if the posterior distribution of photometric redshift declines monotonically from 0, and is thus considered highly uncertain.

Note (7): Quality 0 indicates that z_{Bayes} is unreliable due to $z_{Bayes}<z_{cluster}$ and/or there exists strong multi-modality in the posterior probability distribution of photometric redshift and/or only one image was used to compute z_{Bayes}.
Quality 1 indicates that z_{Bayes} is secure.

Note (8): The grading scheme based on morphological similarity is:
4 = Image is definitely part of the system.
3 = Image is very likely part of the system.
2 = Image is potentially part of the system.
1 = Image is very unlikely part of the system.
0 = Image is definitely not part of the system.
Two inspectors (A.H. and M.B.) independently assign a grade to each image. The inspectors use several RGB images of the full HFF depth that span the full HST spectral coverage to assign the grade for each image. The two grades are then summed to get the reported morphology grade. Examples of multiple images that receive high and low morphology grades are shown in the Appendix.
See also section 4.1 for further explanations.

Note (9): Contaminated objects are only required to fulfill the morphology criterion M>5, but they are not used to compute z_{Bayes}.

Note (10): Arc images with pass flag=1 fulfill Color+Morphology+Contamination criteria and $z_{Bayes}>z_{cluster}$ and z_{Bayes} single-valued.

Note (11): Best-fit magnification derived from resampling the multiple image systems themselves and their photometric redshifts from the combined posterior distributions.

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

Bytes	Format	Units	Label	Explanations
1- 5	I05	---	GLASS	[00111/02400] GLASS identifier
7- 10	F4.1	---	ID	[1.3/56.1]? Arc identifier
12- 22	F11.9	deg	RAdeg	Right ascension in decimal degrees (J2000)
24- 36	F13.9	deg	DEdeg	Declination in decimal degrees (J2000)
38- 42	F5.2	mag	F140W	[18.4/27.2] HST/WFC3 NIR F140W magnitude
44- 47	F4.2	mag	e_F140W	[0.01/0.2] F140W 1σ uncertainty
49- 52	F4.2	---	zph	[0.01/3.7] Photometric redshift
54- 57	F4.2	---	E_zph	[0.01/3.8] Positive 1σ uncertainty on zph
59- 62	F4.2	---	e_zph	[0.01/3.3] Negative 1σ uncertainty on zph
64- 67	F4.2	---	zsp	[0.3/4.9] Spectroscopic redshift
69	I1	---	Q	[2/4] Quality (1)
71- 73	I3	deg	PA	[135/233] Position angle
75	I1	---	Nl	[0/3]? Number of lines
77- 93	A17	---	Line	Line(s)
95- 99	F5.1	---	Flux1	[0.2/112.4]? Line flux for first Line
101-104	F4.2	---	e_Flux1	[0.4/3]? Flux1 1σ uncertainty
106-109	F4.1	---	Flux2	[0.6/26.2]? Line flux for second Line
111-113	F3.1	---	e_Flux2	[0.5/1.1]? Flux2 1σ uncertainty
115-118	F4.1	---	Flux3	[1.5/14.8]? Line flux for third Line
120-122	F3.1	---	e_Flux3	[0.5/0.8]? Flux3 1σ uncertainty
124-127	F4.2	---	Magf	[1.4/6.4]? Flux magnification μ (2)
129-132	F4.2	---	b_Magf	[1.4/5.9]? 1σ lower limit on Magf
133	A1	---	---	[-]
134-137	F4.2	---	B_Magf	[1.4/7.9]? 1σ upper limit on Magf

Note (1): The first part of this table consists of emission line identifications for the arcs of quality levels 4, 3, and 2, whereas the second part is comprised of only high-confidence (quality 3 or 4) emission line objects newly discovered during the blind search procedure, as described in Section 4.3.

Note (2): Magnifications of multiply lensed objects are calculated assuming redshift z_{spec}, which was only used in the lens model for quality >2 objects.

History:
From electronic version of the journal

References:

Treu et al.	Paper I.	2015ApJ...812..114T	Cat. J/ApJ/812/114
Jones et al.	Paper II.	2015AJ....149..107J	
Schmidt et al.	Paper III.	2016ApJ...818...38S	
Wang et al.	Paper IV.	2015ApJ...811...29W	This catalog.
Vulcani et al.	Paper V.	2015ApJ...814..161V	
Hoag et al.	Paper VI.	2016ApJ...831..182H	Cat. J/ApJ/831/182
Vulcani et al.	Paper VII.	2016ApJ...833..178V	Cat. J/ApJ/833/178
Vulcani et al.	Paper VIII.	2017ApJ...837..126V	
Morishita et al.	Paper IX.	2017ApJ...835..254M	Cat. J/ApJ/835/254
Wang et al.	Paper X.	2017ApJ...837...89W	
Schmidt et al.	Paper XI.	2017ApJ...839...17S	

(End) Emmanuelle Perret [CDS] 12-Feb-2016