



Strong Lensing and Cluster Evolution (SLICE) with JWST: Early Results, Lens Models, and High-redshift Detections

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Abstract

We leverage JWST’s superb resolution to derive strong-lensing mass maps of 14 clusters, spanning a redshift range of $z \sim 0.25\text{--}1.06$ and a mass range of $M_{500} \sim 2\text{--}12 \times 10^{14} M_{\odot}$, from the Strong Lensing and Cluster Evolution (SLICE) JWST program. These clusters represent a small subsample of the first clusters observed in the SLICE program that are chosen based on the detection of new multiple-image constraints in the SLICE JWST NIRCам/F150W2 and F322W2 imaging. These constraints include new lensed dusty galaxies and new substructures in previously identified lensed background galaxies. Four clusters have never been modeled before. For the remaining 10 clusters, we present updated models based on JWST and Hubble Space Telescope imaging and, where available, ground-based spectroscopy. We model the global mass profile for each cluster and report the masses enclosed within 200 and 500 kpc. We report the number of new lensed source galaxies identified in the JWST imaging, which in one cluster is as high as 19 new lensed galaxies. The addition of new lensed source galaxies and constraints from substructure clumps improves the ability of strong-lensing models to accurately reproduce the interior mass distribution of each cluster. We also report the discovery of a candidate transient in a lensed image of the galaxy cluster SPT-CL J0516-5755. All lens models and their associated products are available for download at the Strong Lensing Cluster Atlas Data Base (<https://data.lam.fr/sl-cluster-atlas/>), which is hosted at Laboratoire d’Astrophysique de Marseille.

Unified Astronomy Thesaurus concepts: Strong gravitational lensing (1643); Galaxy clusters (584); Galactic and extragalactic astronomy (563)

1. Introduction

Clusters of galaxies are home to the largest gravitationally bound concentrations of mass in the Universe. Their deep potentials make them well suited to exploring the coevolution

and the assembly history of their constituents: dark matter (DM), intracluster plasma (or intracluster gas), galaxies, and free-floating stars (also known as intracluster light or ICL).

The exact nature of DM, the elusive but vital component of the Universe’s total mass budget, is not yet understood. As it has yet to be directly detected, the uncertainty surrounding its nature has left space for several models to develop beyond the current cosmological concordance model of the Universe, which considers cold DM, Λ CDM (D. H. Weinberg et al. 2013;



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T. M. C. Abbott et al. 2018; Planck Collaboration et al. 2020; L. Perivolaropoulos & F. Skara 2022). Galaxy clusters are excellent laboratories in which to test these theories, and to confront observations with model predictions for DM properties that are imprinted on the DM distribution and its spatial correlation with baryonic mass. Doing so requires studying the mass distributions in galaxy clusters across cosmic time, which in turn requires high-resolution mapping of the mass of galaxy clusters at different redshifts, mass ranges, and densities.

As DM and observable matter are inextricably linked, the evolution of the distribution of luminous matter across cosmic time can be used as an indirect probe of the evolution of structures and substructures of DM (P. Natarajan et al. 2017). Adding information from gravitational lensing, and strong lensing (SL) in particular, which relies on observations of background galaxies behind the cluster of interest, provides a more direct probe of the innermost parts of clusters, as it measures the total (dark and baryonic) mass distribution at the smallest spatial scales (e.g., a few kiloparsecs in the cluster plane) in cluster cores (P. Natarajan et al. 2024).

The high resolution and sensitivity of space-based imaging with the Hubble Space Telescope (HST) revolutionized SL science (J.-P. Kneib & P. Natarajan 2011). A prime example is the Hubble Frontier Fields program (J. M. Lotz et al. 2017), which, through investment in hundreds of HST orbits, ground- and space-based spectroscopy, and the entire SL community effort, brought cluster SL accuracy and precision to a new level (T. L. Johnson et al. 2014; J. Richard et al. 2014; M. Jauzac et al. 2015; K. Sharon & T. L. Johnson 2015; J. M. Diego et al. 2016; C. Grillo et al. 2016; M. Meneghetti et al. 2017; J. Priebe et al. 2017; J. D. Remolina González et al. 2018; G. B. Caminha et al. 2019; P. Bergamini et al. 2023a; A. Acebron et al. 2024). Other cluster surveys with HST, as well as targeted observations of single clusters, have demonstrated the power of SL to probe structures at different mass ranges, from the most massive clusters down to groups and even individual galaxies, and to use SL clusters as calibrated cosmic telescopes to magnify and study the Universe behind them (W. Zheng et al. 2012; D. Coe et al. 2013; A. Zitrin et al. 2014; J. R. Rigby et al. 2017; B. Salmon et al. 2018; K. Sharon et al. 2022).

SL science has taken yet another step forward in the era of JWST, owing to JWST’s sensitivity, wavelength coverage, and resolution at long wavelengths, which have enabled the discovery of new multiple images with remarkable precision (e.g., L. J. Furtak et al. 2022; P. Bergamini et al. 2023b; G. B. Caminha et al. 2023; G. Mahler et al. 2023). The increased number of constraints has resulted in high-resolution mass estimates for galaxy clusters (L. J. Furtak et al. 2024). The results from the first years of SL-enhanced JWST observations remarkably showcase its utility in probing the mass distribution in foreground structures (M. Pascale et al. 2022; L. J. Furtak et al. 2023; G. Rihtaršič et al. 2024; SMACS +more), discovering and studying galaxies at the highest redshifts (H. Atek et al. 2023; A. Adamo et al. 2024; M. Bradač et al. 2024; L. Mowla et al. 2024), and probing star-forming regions and stellar clumps at cosmic noon at spatial scales smaller than 100 pc (E. Vanzella et al. 2022, 2024; A. Claeysens et al. 2023, 2025; D. A. Forbes & A. J. Romanowsky 2023; A. K. Meena et al. 2023; T. E. Rivera-Thorsen et al. 2024; M. Messa et al. 2025; J. R. Rigby et al. 2025).

In this paper, we introduce the Strong Lensing and Cluster Evolution (SLICE) program (G. Mahler et al. 2026, in preparation), a large Cycle 3 JWST SURVEY program (#PID: 5594, PI: Mahler) designed to track the evolution of both the luminous and dark components of galaxy clusters over 8 Gyr of cosmic time, from $z \sim 0.2$ to $z = 1.9$. The program is obtaining NIRCIm imaging of targets drawn from a parent list of 182 clusters, selected primarily for their mass as determined from the Sunyaev–Zel’dovich (SZ) effect and X-ray mass proxies, and has at the time of publication observed a total of 124 clusters.

Through observations of clusters selected by mass to be on the same evolutionary track, SLICE aims to study: (1) the buildup of the stellar content in the brightest cluster galaxies (BCGs) and the ICL; and (2) the distribution of DM in clusters. The unique sensitivity and resolution of JWST in the infrared reveal old stellar populations, resolving numerous globular star clusters embedded in the ICL (e.g., J. M. Diego et al. 2023b; N. S. Martis et al. 2024), in addition to tidal fronts and other structures in the ICL (M. Montes & I. Trujillo 2022). The mapping of DM will be measured primarily via SL modeling but can also be inferred in non-SL clusters from the distribution of ICL (M. Montes 2022) and/or globular clusters, which are likely good tracers of the underlying DM density (M. G. Lee et al. 2010; Y. Ko et al. 2017; J. Yoo et al. 2025), as shown observationally with HST (M. Montes & I. Trujillo 2019) and in other studies using JWST imaging (M. G. Lee et al. 2022; J. M. Diego et al. 2024; N. S. Martis et al. 2024; S. Cha et al. 2025). The combination of these two science goals will reveal the coevolution of luminous matter and DM in the densest nodes of the cosmic web. By design, the program benefits from ancillary imaging data from space (HST for all targets, with X-ray for a subsample) and ground-based spectroscopy for many fields.

We present SL models of 14 clusters from SLICE, a first step in achieving the ultimate science goals of this program. These clusters were chosen from SL clusters observed in the first few months of SLICE observations and span almost the entire range of redshifts, masses, and Einstein radii of the parent sample. Four clusters have never been modeled in the literature using SL techniques, while the remaining clusters have published lens models based on HST imaging and other available data. We thus take the opportunity to revisit and update these models with new constraints or new lensing substructure features that are newly identified in JWST. Most of the new constraints were not visible in HST imaging, either because they are too red (e.g., dusty or high-redshift galaxies) or too faint to be robustly identified at the depth of the archival data. The models developed in this work will be made available to the community at the Strong Lensing Cluster Atlas Data Base,²⁴ hosted at Laboratoire d’Astrophysique de Marseille.

The paper is organized as follows. Section 2 presents the observations and data reduction of the JWST and HST observations used to create the SL mass models and the Chandra X-ray imaging of some of the clusters, used for the interpretation of the results. Section 3 presents the lens models for each cluster, and Section 4 details the findings for the number counts of the lensing features examined in this paper. In Section 5, we discuss how these models will be used in

²⁴ <https://data.lam.fr/sl-cluster-atlas/>

Table 1
SLICE JWST Observations

(1) Name	(2) α (J2000)	(3) δ (J2000)	(4) z	(5) M_{500} ($10^{14} M_{\odot}$)	(6) Obs. Number	(7) Obs. Date
A68	9.267227487	9.153556343	0.2546	5.76 ^a	16	2024-11-26
RXC J0232.2–4420	38.0701090	–44.3541290	0.2836	11.30 ^b	24	2024-10-23
SMACS J2031.8–4036	307.9669300	–40.6197000	0.3416	9.44 ^b	37	2024-10-14
MACS J0027.8+2616	6.9662000	26.2742000	0.365	11.70 ^c	39	2024-08-21
RXC J2211.7–0349	332.9307646	–3.82922895	0.397	12.31 ^a	52	2024-11-18
MACS J0553.4–3342	88.3512360	–33.71225900	0.412	11.33 ^b	55	2024-10-30
MACS J0358.8–2955	59.7201370	–29.92988500	0.425	8.81 ^b	58	2024-10-23
MACS J1621.4+3810	245.3500000	38.16740000	0.4631	14.48 ^c	71	2024-08-19
RCS2 032727–132623	51.8632708	–13.43938060	0.564	5.53 ^d	86	2024-09-30
MACS J2129.4–0741	322.3544372	–7.70892166	0.589	7.06 ^a	89	2024-10-03
PSZ1 G091.83+26.11	277.7835360	62.24809379	0.822	7.43 ^a	118	2024-09-08
RX J0152.7–1357	28.17764473	–13.95911996	0.8269	3.47 ^d	119	2024-08-26
SPT-CL J0516–5755	79.2397540	–57.91668800	0.9656	3.42 ^b	139	2024-08-29
SPT-CL J2011–5228	302.7786200	–52.47247800	1.064	3.10 ^b	149	2024-09-06

Notes. Summary of JWST observations from the SLICE program (#PID: 5594, PI: Mahler). The exposure time for all JWST images in both the NIRCам/F150W2 and NIRCам/F322W2 filters is 1836 s. Column (1): the name of the cluster. Columns (2) and (3): the R.A., α , and decl., δ , are given in degrees. Column (4): the cluster redshift. Column (5): the M_{500} mass, where the superscript indicates the reference used in our cluster selection, as below. Column (6): the SLICE program visit ID. Column (7): the observation date for the exposure. The superscripts and references for Column (5) are as follows:

^a Planck Collaboration et al. (2016);

^b S. Bocquet et al. (2019);

^c A. Repp & H. Ebeling (2018), converting the X-ray flux using Equation (2) from the formula presented in M. E. Anderson et al. (2015), where M_{500} is defined as the mass within a radius of R_{500} that has an overdensity of 500 times the critical mass density of the Universe at the cluster redshift; and

^d M. Hilton et al. (2021).

future SLICE analyses and introduce upcoming work that will be completed once the full SLICE sample has been observed.

We assume a standard Λ CDM cosmology, with $\Omega_M = 0.3$, $\Omega_\Lambda = 0.7$, and $H_0 = 70 \text{ km s}^{-1} \text{ Mpc}^{-1}$. All magnitudes are measured in the AB system unless stated otherwise.

2. Observations

2.1. SLICE JWST Imaging

The SLICE JWST SURVEY mode program (#PID: 5594, PI: Mahler) consists of NIRCам imaging using the filters F150W2 and F322W2, which are extrawide filters in the short-wavelength and long-wavelength channels, respectively, and which together cover the wavelength range between 1 and 4 μm . The program is designed as a large survey, with 182 possible targets, with 124 observed at the time of the publication of this paper. The observations are run in the Shallow 4 mode, with only Module B active, to reduce the volume of the data products that are downloaded from the spacecraft. An IntramoduleX 3 dithering pattern is employed to remove any chip gaps, and an additional three-point dithering pattern is employed using small-grid-dither to improve the point-spread-function sampling at shorter wavelengths. The observing time is calculated such that a signal-to-noise ratio ~ 3 is achieved for a point source at 29 mag, which equates to an equivalent exposure time of 1836 s in both the F150W2 and the F322W2 bands. This exposure time is consistent across all images in the SLICE program. Both the F150W2 and the F322W2 bands are observed simultaneously. JWST observations for the clusters studied in this paper are presented in Table 1, along with basic information about each cluster, including its redshift and a measurement for M_{500} that is drawn from various literature references, where M_{500} is defined as the mass within a radius of R_{500} that has an

overdensity of 500 times the critical mass density of the Universe at the cluster redshift.

We follow the procedure described in J. R. Rigby et al. (2023) for the NIRCам data reduction—as used for the JWST Early Release Science program TEMPLATES—which we describe briefly below. We use Level 1b products from MAST, using an STScI-adapted custom Python script. For the data reduction, we use scripts modified from the default JWST version (1.15.1; H. Bushouse et al. 2024) and the Calibration Reference Data System pipeline mapping (pmap) 1303. We process Level 2A data products to apply a custom destriping algorithm, to correct for $1/f$ noise and jumps between amplifiers. A complete description of this algorithm will be provided in the forthcoming survey paper (G. Mahler et al. 2026, in preparation). We then run the destriped images through the same modified pipeline, to generate Level 3 F150W2 and F322W2 dithered science-ready mosaics. The filters are WCS-matched to Gaia, as per the specifications of the default pipeline; HST data are aligned to JWST imaging within uncertainties. For more details on the various steps and systematics involved in this process, please refer to the complete description provided in J. R. Rigby et al. (2023).

2.2. HST Archival Imaging

Archival HST images for all the clusters presented in this paper were obtained from MAST. For SLICE targets that were previously observed as part of HST treasury programs—Relionization Lensing Cluster Survey (RELICS), D. Coe et al. 2019; Cluster Lensing And Supernova survey with Hubble (CLASH), M. Postman et al. 2012—we used the reduced data that were made available to the community by these projects. For all other targets, we reduced the HST imaging data to match the footprint, pixel scale, and WCS solution of the new JWST data, using standard procedures as part of

Table 2
Archival HST Observations

(1) Name	(2) Band	(3) PID	(4) Program Type	(5) Exp. Time (s)	(6) Obs. Date
A68	ACS/F814W	11591	GO	4880	2010-11-14
	WFC3/F110W	11591	GO	2612	2010-10-18
	WFC3/F160W	11591	GO	2412	2010-10-18
RXC J0232.2–4420	ACS/F606W	14096	GO/Treasury ¹	2075	2016-08-14
	ACS/F814W	14096	GO/Treasury ¹	2246	2016-07-05
SMACS J2031.8–4036	ACS/F606W	12166	SNAP	1200	2010-09-17
	ACS/F814W	12884	SNAP	1440	2012-11-14
	WFC3/F110W	12166	SNAP	706	2012-06-21
	WFC3/F140W	12166	SNAP	706	2012-06-21
MACS J0027.8+2616	ACS/F606W	12166	SNAP	1200	2010-10-02
	ACS/F775W	9770	GO	14370	2004-01-17
	WFC3/F110W	12166	SNAP	706	2010-11-18
	WFC3/F140W	12166	SNAP	706	2010-11-18
RXC J2211.7–0349	ACS/F606W	12166	SNAP	1200	2011-11-19
	ACS/F606W	14096	GO/Treasury ¹	2101	2015-11-25
	ACS/F814W	14096	GO/Treasury ¹	2124	2015-10-16
	ACS/F435W	12362	GO	4452	2012-01-05
MACS J0553.4–3342	ACS/F606W	12362	GO	2092	2012-01-05
	ACS/F814W	12362	GO	4572	2012-01-05
	ACS/F435W	12313	GO	4500	2011-02-19
MACS J0358.8–2955	ACS/F606W	12313	GO	2120	2011-02-19
	ACS/F814W	12313	GO	4620	2011-02-19
	ACS/F606W	12166	SNAP	1200	2011-07-21
MACS J1621.4+3810	ACS/F814W	12166	SNAP	1440	2011-09-08
	WFC3/F110W	12884	SNAP	706	2012-10-12
	WFC3/F140W	12884	SNAP	706	2012-10-12
	ACS/F814W	12371	GO	1080	2011-06-28
RCS2 032727–132623	WFC3/F125W	12267	GO	862	2011-03-01
	WFC3/F160W	12267	GO	862	2011-03-01
	ACS/F606W	12100	GO/Treasury ²	3728	2011-05-15
MACS J2129.4–0741	ACS/F814W	10493	GO	2168	2005-06-18
	ACS/F606W	15132	SNAP	1200	2018-08-27
PSZ1 G091.83+26.11	ACS/F814W	14098	SNAP	1200	2016-07-24
	ACS/F625W	9290	GTO/ACS	4750	2002-11-06
RX J0152.7–1357	ACS/F160W	14096	GO/Treasury ¹	1209	2017-01-26
	ACS/F606W	13412	SNAP	2320	2014-02-27
SPT-CL J0516–5755	ACS/F606W	14630	GO	2690	2017-03-18
SPT-CL J2011–5228	UVIS1/F606W	14630	GO	2676	2017-03-22

Note. Summary of primary archival HST observations that were used in this work. Column (1): the name of the cluster. Column (2): the camera and filter. Column (3): the PID for each observation. Column (4): the program type—General Observer (GO), Snapshot (SNAP), Large Treasury (GO/Treasury), or Guaranteed Time Observations allocated to the ACS team (GTO). Treasury programs are marked with a superscript “1,” referring to RELICS (D. Coe et al. 2019), or with a superscript “2,” referring to CLASH (M. Postman et al. 2012). Column (5): the exposure time. Column (6): the observation date. The list is not exhaustive: more data are available in the archive for many of the fields.

Astrodriizzle. We combined the calibrated subexposures taken with each filter—`_flt` for WFC3IR and `_flc` files for UVIS and the Advanced Camera for Surveys (ACS)—using a Gaussian kernel with a drop size `final_pixfrac = 0.8` and `final_refimage` set to the NIRCам F150W2 exposure. If needed, images were further aligned to better match the WCS solution of the NIRCам data using `tweakreg` and `tweakback`. A complete list of the HST images used in this paper is presented in Table 2.

2.3. Chandra X-Ray Imaging

We retrieved archival X-rays observations from the Chandra X-ray Observatory for a subsample of the clusters. These observations used the Advanced CCD Imaging Spectrometer

(ACIS) and are composed of observations obtained with the ACIS-I or ACIS-S configurations. Due to the limited number of counts for specific clusters, we included data obtained in FAINT mode in addition to the more robust VFaint one. We reduced the data with the routine implemented in the CIAO software environment (A. Fruscione et al. 2006, version 4.15). In particular, we used the WAVDETECT source-detection routine (P. E. Freeman et al. 2002) to automatically remove the X-ray point sources and create count maps in the [0.5, 7] keV band from the diffuse X-ray emission. We additionally employ the `csmooth` routine, which is a Chandra-focused adaptation of the ASMOOTH routine (H. Ebeling et al. 2006), to smooth the X-ray maps for the purpose of visual presentation. A complete list of the X-ray imaging used in this paper is given in Table 3.

Table 3
Archival Chandra Observations

Cluster	Obs. ID	Exp. Time (ks)	Obs. Date
RXCJ0232.2–4420	4993	23.40	2004-06-08
MACS J0027.8+2616	3249	9.98	2002-06-26
	14012	21.69	2012-09-24
MACS J0553.4–3342	5813	9.94	2005-01-08
	12244	74.06	2011-06-23
MACS J0358.8–2955	11719	9.65	2009-19-18
	12300	29.66	2010-11-26
	13194	19.97	2010-11-28
MACS J1621.4+3810	3254	9.85	2002-10-18
	3594	19.73	2003-08-22
	6109	37.55	2004-12-11
	6172	29.75	2004-12-25
	9379	29.91	2008-10-17
MACS J2129.4–0741	10785	29.75	2008-10-18
	3199	19.86	2002-12-23
	3595	19.87	2003-10-18
PSZ1 G091.83+26.11	18285	22.7	2016-06-19
RX J0152.7-1357	914	36.48	2000-09-08
	21703	39.56	2019-09-25
	22856	19.28	2019-09-26

Note. Summary of archival Chandra X-ray observations, available only for eight clusters.

3. SL Mass Modeling

In this section, we present SL models that are designed to recover the mass within the core of the observed galaxy clusters, using the positions of multiply imaged galaxies as constraints. These lens models are constructed primarily using *Lenstool* (E. Jullo et al. 2007), a parametric Markov Chain Monte Carlo (MCMC) modeling software that is described in more detail below. We also present lens models created using the hybrid modeling technique *WSLAP+* (J. M. Diego et al. 2005, 2007) for the galaxy clusters RCS2 032727–132623 (RCS 0327) and PSZ1 G091.83+26.11, which each have a large amount of lensed substructure visible in the JWST imaging, enabling the use of free-form methods like *WSLAP+*. We discuss the implementation of these two modeling algorithms in the sections for each cluster (Sections 3.4.9 and 3.4.11).

Regardless of the algorithm used, all SL modeling techniques attempt to find a foreground mass distribution that satisfies the lens equation everywhere in the field and that reproduces the observed locations of multiple images of each background source. The multiple images are therefore used as constraints in the lens modeling process. Multiple images are identified in the imaging data, usually by eye, owing to their similarity to each other. Since lensing is wavelength-invariant, counterimages should have the same colors (unless they are contaminated by foreground sources or obscured by dust). The morphology of two counterimages should be the same, after accounting for their different distortions, magnifications, and parity. Finally, the parity (e.g., mirroring) should be consistent with the expectations from SL geometry.

Counterimages and arc candidates are verified through spectroscopy. In a few cases, multiple images of the same background source were identified spectroscopically in integral field unit observations of the entire lensing field, such as with the Multi-Unit Spectroscopic Explorer (MUSE) on the Very Large Telescope (VLT; R. Bacon et al. 2010). These identifications may or may not have an optical counterpart at

the depth of the JWST/HST imaging. The superior resolution of space-based imaging allows for the identification and mapping of structure within multiple images and for mapping this substructure from one image to another. Substructure is most often in the form of emission clumps but can also be distinct dust lanes, spiral arms, or other features (e.g., C. Grillo et al. 2016; P. Bergamini et al. 2023a; D. J. Lagattuta et al. 2023). Where identified, the substructure can be used to increase the number of constraints. Table 8 tabulates the multiple images that are identified in each of the clusters presented in this paper. Where available, we list the spectroscopic, photometric, or model-optimized redshift, and multiple clumps within each image.

3.1. *Lenstool*

Lenstool is a parametric SL modeling algorithm, which uses MCMC formalism to explore the parameter space, identify the best-fit set of parameters, and estimate statistical uncertainties on the parameters and modeling outputs. We refer the reader to E. Jullo et al. (2007) for a full description of *Lenstool*. In short, the algorithm assumes that the foreground lens is comprised of a combination of mass halos, each described by a set of parameters. Some examples of parameterized mass halos include the Navarro–Frenk–White profile; isothermal profiles; and, most commonly used for clusters, the truncated pseudo-isothermal ellipsoidal mass distribution (dPIE; Á. Elíasdóttir et al. 2007; also sometimes referred to in the literature simply as PIEMD). Lensing constraints come from the positions and redshifts of sets of multiple images of the same lensed source. Where spectroscopic redshifts are not available, one can leave the redshift as a free parameter. Photometric redshifts or other information can be used to guide the posterior. The goodness-of-fit criterion is the image-plane scatter between the observed and predicted images of lensed sources (image-plane minimization) or the source-plane scatter between sets of predicted source locations of the same sources (E. Jullo et al. 2007). Unless otherwise noted, *Lenstool* models in this work assume the dPIE distribution, which has seven parameters: centroid x , y ; ellipticity e ; position angle θ ; core radius r_{core} ; cut radius r_{cut} ; and normalization σ_0 . Clusters are typically represented with one or more cluster-scale halos, supplemented with a number of galaxy-scale halos. Most of the parameters of the cluster-scale halos are allowed to vary, with the exception of the cut radius, which for clusters is far outside the projected radius where it can be constrained by the lensing observables. If fixing the cut radius, each cluster-scale halo adds six free parameters to the lens model. To keep the number of overall optimized parameters manageable, it is common to assume that galaxy-scale halos of cluster-member galaxies have similar locations, ellipticities, and position angles as the stellar mass distribution of the galaxies they represent, and that their mass and slope parameters can be linked to the luminosity of each galaxy through the parameterized S. M. Faber & R. E. Jackson (1976) scaling relations:

$$\begin{cases} \sigma = \sigma^* \left(\frac{L}{L^*} \right)^{1/4} \\ r_{\text{core}} = r_{\text{core}}^* \left(\frac{L}{L^*} \right)^{1/2} \\ r_{\text{cut}} = r_{\text{cut}}^* \left(\frac{L}{L^*} \right)^{1/2} \end{cases}$$

This scaling adds two free parameters to the model: r_{cut} and σ_0 . r_{core} has a minimal impact on mass models and is thus fixed

to 0.15 kpc (M. Limousin et al. 2005, 2007; Á. Elíasdóttir et al. 2007).

Lens modeling is typically done iteratively, starting with a simple lens model and the most obvious sets of multiple images. Preliminary lens models can be used to assist in the identification and confirmation of further lensed sources, which in turn are included as constraints in the next iteration. With more constraints, the complexity and flexibility of the model can be increased. The process continues until the model converges on a stable solution, where newly identified sources are reliably predicted by the model and/or adding complexity does not significantly improve the goodness of fit or change the model output that is being sought (e.g., projected mass density, magnification, time delay, etc.). Modeling choices such as the number of halos are continuously evaluated, especially when new evidence is obtained, such as newly measured spectroscopic redshifts. Unless stated otherwise, all `Lenstool` models presented in this paper are optimized in the image plane and are run for at least 5000 steps past burn-in. All models are constructed using a standard fiducial positional uncertainty in the field between 0".2 and 0".5. The fiducial positional uncertainty is selected for each model based on the number of constraints in the model, where models with a high number of individual constraints but a low number of spectroscopic redshifts (i.e., models with many lensed source galaxies whose redshifts are optimized within the model) are given more tolerance in the optimization procedure. This uncertainty does not reflect the accuracy of the astrometry seen in the JWST imaging, which is incredibly small; it instead reflects the scatter between predicted and observed images typical of parametric lens models (M. Limousin et al. 2025).

3.2. WSLAP+

This code was first described in J. M. Diego et al. (2005) and later expanded in J. M. Diego et al. (2007), to include weak lensing measurements as additional constraints. A further development is presented in I. Sendra et al. (2014), where the code migrated from its native free-form nature to a hybrid type of modeling, where prominent cluster-member galaxies are added into the lens model with a mass distribution that matches the observed light distribution.

WSLAP+ places Gaussians in a predetermined grid of positions in the lens plane. Each Gaussian contributes to the deflection field an amount that is proportional to its mass. This mass is optimized by the algorithm. A contribution from member galaxies is also precomputed, adopting a fiducial mass for them, which is later also optimized. A joint solution for the masses of the Gaussians, the renormalization of the mass of the member galaxies, and the unknown position of the lensed galaxies in the source plane is obtained by solving a system of linear equations:

$$\Phi = \Gamma X, \quad (1)$$

where Φ is an array containing the observed positions of the arcs, Γ is a known matrix, and X is the vector with all the unknowns—the masses in the Gaussian decomposition (M), the multiplicative factors for the fiducial mass of the member galaxies (C), and source positions (β_x and β_y). The solution is obtained using a quadratic programming optimization algorithm with the constraint $X > 0$; we refer the reader to

Table 4
Cluster Red-sequence Catalog

(1) Cluster	(2) Bands	(3) Scatter (σ)
A68	F110W/F814W	0.048
RXC J0232.2–4420	F105W/F814W	0.031
SMACS J2031.8–4036	F814W/F606W	0.034
MACS J0027.8+2616	F775W/F606W	0.120
RXC J2211.7–0349	F814W/F606W	0.029
MACS J0553.4–3342	F814W/F606W	0.035
MACS J0358.8–2955	F814W/F606W	0.043
MACS J1621.4+3810	F814W/F606W	0.027
RCS2 032727–132623	F814W/F606W	0.061
MACS J2129.4–0741	F814W/F606W	0.055
PSZ1 G091.83+26.11	F110W/F814W	0.044
RX J0152.7–1357	F160W/F625W	0.104
SPT–CL J0516–5755	F150W2/F606W	0.176
SPT–CL J2011–5228	F125W/F606W	0.121

Note. Column (1): the cluster. Column (2): the bands used to create the cluster-member catalog for each cluster are listed as pairs. Column (3): the scatter around the red sequence.

J. M. Diego et al. (2007) for full details of the optimization algorithm.

3.3. Selection of Cluster-member Galaxies

The cluster-member galaxies were selected photometrically, using the red-sequence technique (M. D. Gladders & H. K. C. Yee 2000). We generated a photometry catalog with Source Extractor (E. Bertin & S. Arnouts 1996) in two filters that bracket the 4000 Å break feature in typical elliptical galaxies at the cluster redshift. Galaxies were identified as cluster members based on their color with respect to the red sequence in a color–magnitude diagram. In most clusters, we used archival HST data for both filters; the specific filter selection changes, based on the availability of archival data and the cluster redshift (see Table 4 for complete information on the red-sequence construction). The exception is SPT–CL J0516–5755, for which only one archival HST filter is available. For this cluster, we used F150W2 as the red filter, as the 4000 Å break feature in this filter is comfortably red of F606W at the cluster redshift ($z = 0.9656$).

3.4. Cluster Models

In the following sections, we present details for each of the 14 clusters modeled in this paper. Images of the clusters and the SL constraints are shown in Figure 1. In the description for each model, we specify the number of unique lensed source galaxies. The “number of images” is the total number of multiple images of all lensed galaxies (not including clumps within the galaxies). Where clumps within a lensed galaxy (e.g., Figure 2) are used to constrain the model, the “number of positional constraints” accounts for multiple images of the individual clumps. Otherwise, the number of positional constraints equals the number of images of lensed galaxies used in the model. As an example, suppose we identify three lensed source galaxies in a cluster field. Source 1 has three multiple images and does not use any clumps as constraints. Source 2 has five multiple images and uses four clumps per

Table 5
Cluster Statistics Table

Cluster	No. of Lensed Galaxies	No. of Images ^a	No. of Positional Constraints ^b	No. of Tangential Arcs	No. of Radial Arcs	No. of z_{spec} Values	Model rms (arcsec)
A68	12	36	42	36	0	5	0".44
RXC J0232.2–4420	7	26	26	18	4	2	0".43
SMACS J2031.8–4036	15	53	67	49	4	13	0".40
MACS J0027.8+2616	4	19	31	19	0	2	0".48
RXC J2211.7–0349	10	32	45	28	4	1	0".57
MACS J0553.4–3342	21	57	102	57	0	4	0".66
MACS J0358.8–2955	6	16	16	16	0	2	0".21
MACS J1621.4+3810	5	16	22	12	4	0	0".26
RCS2 032727–132623	23	61	184	47	14	5	0".77
MACS J2129.4–0741	17	53	53	49	4	13	0".79
PSZ1 G091.83+26.11	5	19	89	16	3	0	0".47
RX J0152.7–1357	7	20	26	20	0	1	0".45
SPT–CL J0516–5755	10	25	53	25	0	0	0".21
SPT–CL J2011–5228	3	14	96	12	2	1	0".33

Notes. Number counts for various properties of the lens model presented in this paper.

^a The “No. of Images” column sums the multiple images of lensed galaxies (not including clumps).

^b The “No. of Positional Constraints” column sums the multiple images of all lensed features (including clumps) that were used to constrain the SL model.

image as constraints. Source 3 has three multiple images and uses two clumps per image as constraints. In this hypothetical cluster, the total number of lensed source galaxies is 3, the total number of images is 11 ($3 + 5 + 3$), and the total number of *positional constraints*²⁵ is 29 ($3 + 5 \times 4 + 3 \times 2$). If no clumps were used as constraints in Source 2 or Source 3, then the total number of images would be 11 ($3 + 5 + 3$), and the total number of *positional constraints* would also be 11 ($3 + 5 + 3$). Table 5 contains a summary of all the lensed source galaxies used as constraints in the models.

Table 6 provides mass estimates and Einstein radius measurements from the Lenstool models. The cluster best-fit and median parameters for each of the potentials and parameters in the Lenstool models are given in Table 7. The reported errors are calculated from the 68% confidence intervals for each parameter, which are optimized using a uniform prior. As a result, some error distributions are asymmetric. A complete list of the arcs and model redshifts for each cluster is given in Table 8. Candidate sources and arcs are not included in the count if they are not used as lensing constraints, but they are shown in the figures and in Table 8 for reference. All the lens models presented here are publicly available at the Strong Lensing Cluster Atlas Data Base,²⁶ which contains the mass maps (e.g., shear, convergence, and amplification) as well as parameter files used for the lens modeling (e.g., lists of constraints and cluster-member catalogs).

3.4.1. A68

A68, located at $z = 0.2546$, is optimized with a total of 12 lensed source galaxies (36 images and 42 lensing constraints), where 5 source galaxies have spectroscopic redshifts and 7 unknown redshifts are optimized within the model. A total of 206 cluster-member galaxies are fitted with a scaling relation (as described in Section 3.3) optimizing two parameters. The

reference luminosity L^* used in this relation is from the BCG of the cluster ($F814W = 17.94$). The model uses four potentials to optimize the mass of the cluster. The final model has an rms of 0".44, and the masses enclosed within 200 kpc and 500 kpc are $\sim 1.60 \times 10^{14} M_{\odot}$ and $\sim 4.90 \times 10^{14} M_{\odot}$, respectively. We provide a detailed description of the cluster modeling in the following paragraph.

A68 contains a wealth of lensed galaxies that are scattered between the two ends of its bimodal light distribution. We update the model presented in J. Richard et al. (2007), by doubling the number of constraints present in the model (from 21 to 42), which we accomplish by confirming candidates from J. Richard et al. (2007), such as the candidate Source C10 and the candidate lensing images C2c and C23c, which are designated in this paper as Sources #6 and #4, respectively. We add a total of nine new lensed source galaxies to the model. The resolution of the JWST imaging also reveals a great deal of substructure in the main lensed dusty galaxy in this cluster, which is here designated as Source #1. We are able to identify at least two different multiply imaged clumps within both the dual radial images and the third counterimage of this galaxy, which we incorporate into the model as constraints. This increases the total number of lensing constraints present within a single lensed image. We utilize the spectroscopic redshift measurements presented in J. Richard et al. (2007) for the five previously identified lensed source galaxies in this model. Reproducing all of the lensing constraints across the breadth of the cluster requires the inclusion of three cluster-scale DM halos in the model: one located at the BCG, one located in the northern portion of the cluster, and one located near the second-brightest galaxy in the cluster. We also separately optimize the parameters of the galaxy located next to the first image of Source #1, as well as the BCG. The model redshift predictions for the sources used as constraints in the model are under $z \sim 4$ in all cases.

3.4.2. RXC J0232.2–4420

RXC J0232.2–4420 (RXC0232), located at $z = 0.2836$, is optimized with a total of 7 lensed source galaxies (26 multiple

²⁵ We note that each positional constraint is a 2D vector, but we count each image of a lensed source (galaxy or clump) as a single position.

²⁶ The Strong Lensing Cluster Atlas Data Base (<https://data.lam.fr/sl-cluster-atlas/>) is hosted at Laboratoire d’Astrophysique de Marseille.

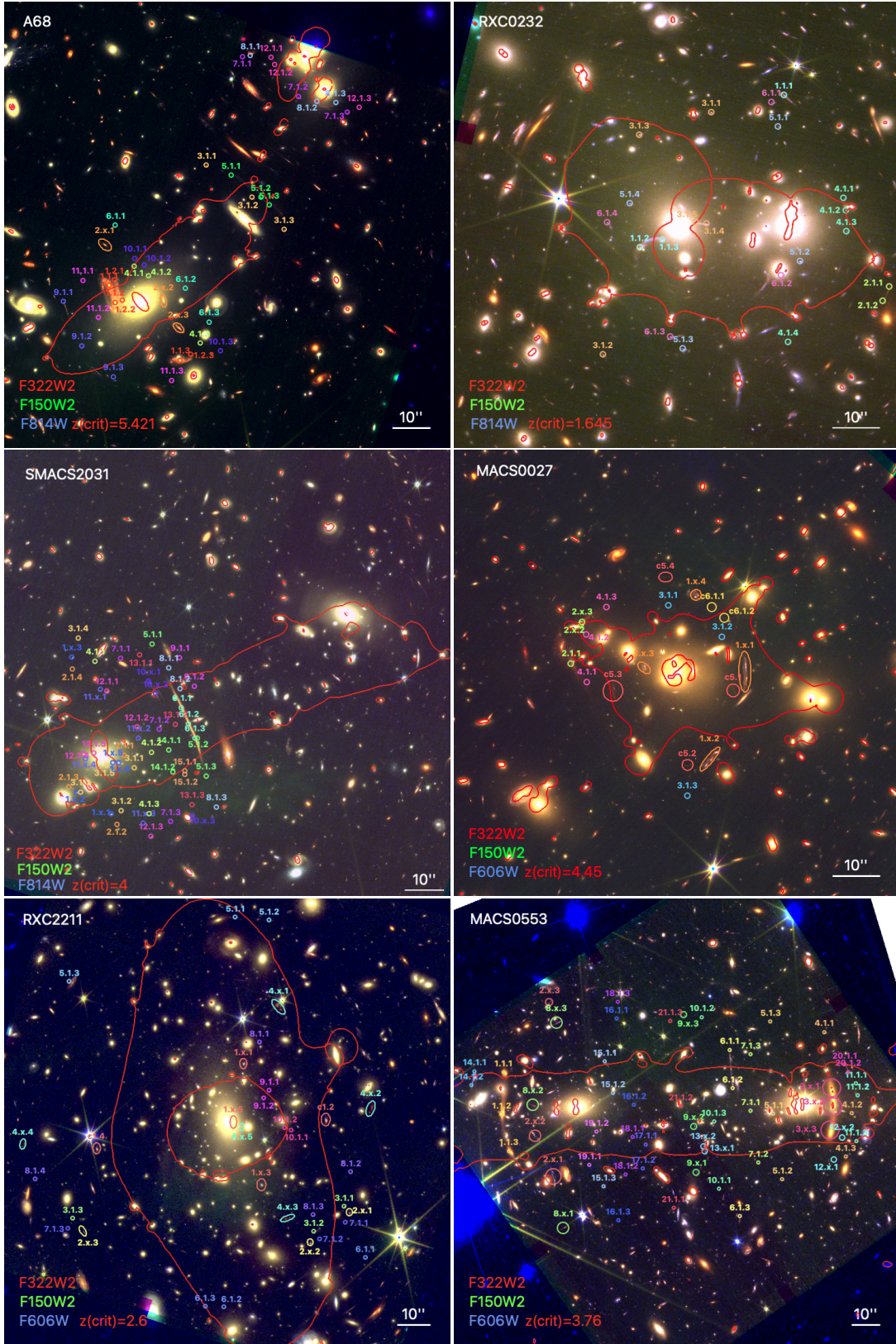


Figure 1. False-color images of all clusters modeled in this paper. All images are oriented with north up and east to the left. The color composites are rendered from the two SLICE JWST NIRCcam bands and one of the available archival HST bands in the blue channel, as listed in the bottom left of each panel. We overplot the best-fit critical curves for a source at the redshift listed in each panel. Lens models constructed with `Lenstool` have their critical curves plotted in red, while lens models constructed with `WSLAP+` have their critical curves plotted in white. Sets of multiple images of lensed sources are color-coded and labeled. To reduce clutter, we label crowded individual clumps as “[Source#].x.[Image#],” where “x” refers to the clumps. Where applicable, candidate lensed source galaxies are labeled using the letter “c”—e.g., “c1.1.1” indicates a candidate lensed source galaxy that is not included in the optimization of the lens model. Two lensed source galaxies in PSZ1 G091.83+26.11 are outside the field of view but are included in the model. See Table 8 for a complete list of all the images and clumps for the lensed source galaxies in each cluster.

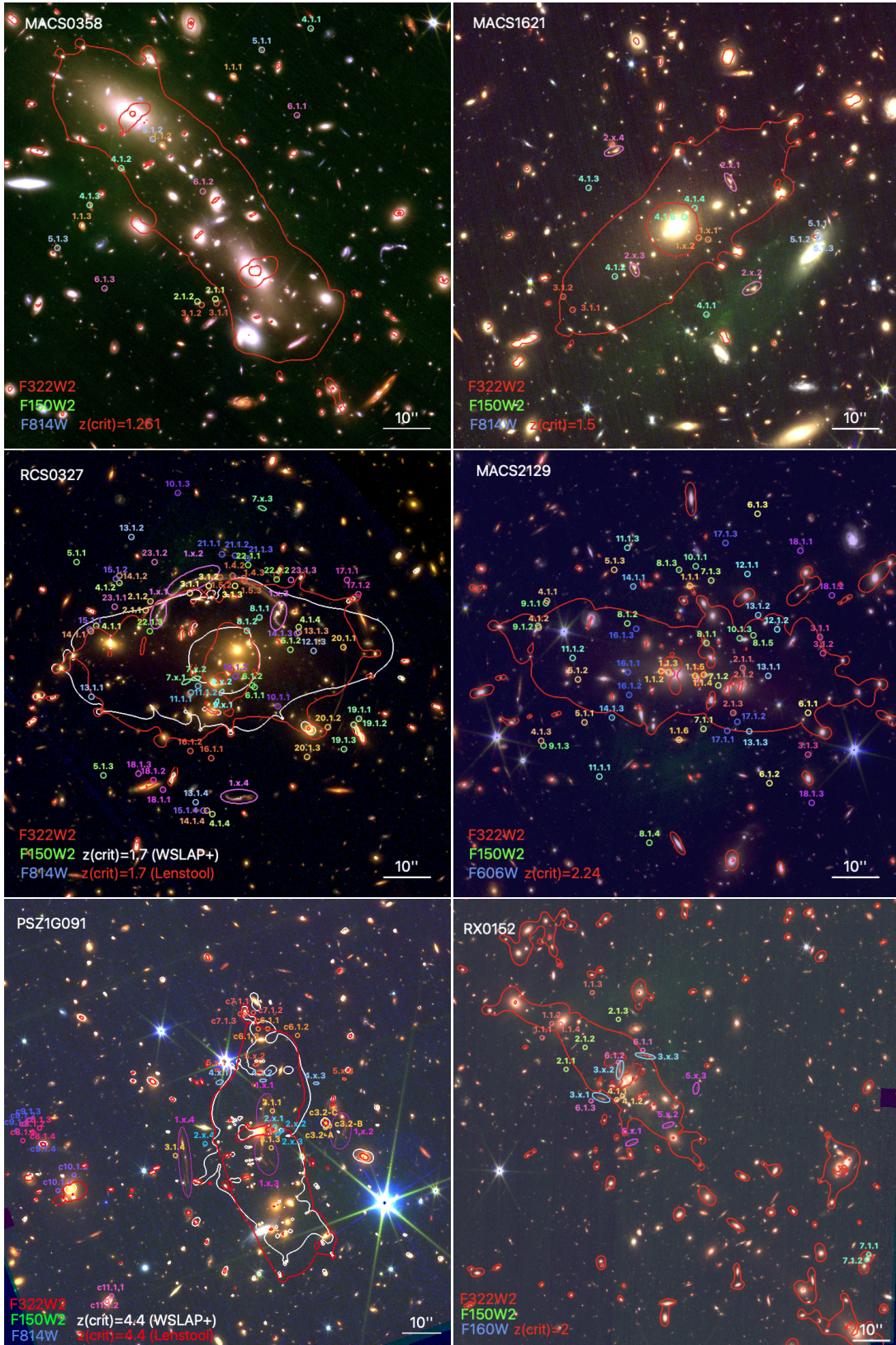


Figure 1. (Continued.)

images and 26 lensing constraints), where 2 source galaxies have spectroscopic redshifts and 5 redshifts are optimized within the model. A total of 115 cluster-member galaxies are fitted with a scaling relation based on a reference luminosity L^*

for the BCG of the cluster ($F814W = 18.23$). The model uses five potentials to describe the mass of the cluster. The final model has an rms of 0.43, and the masses enclosed within 200 kpc and 500 kpc are $\sim 1.85 \times 10^{14} M_\odot$ and $\sim 4.51 \times 10^{14} M_\odot$,

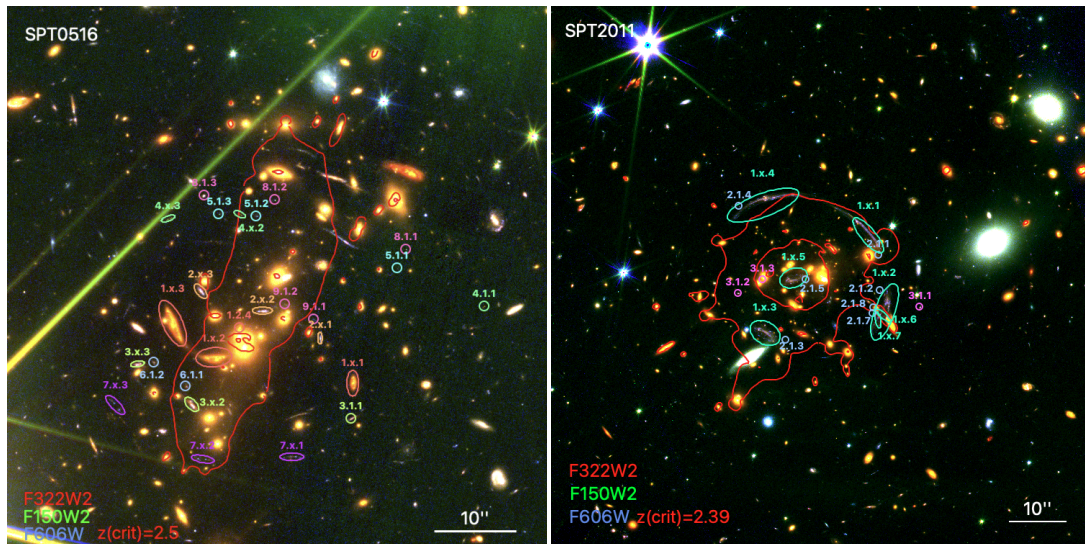


Figure 1. (Continued.)

respectively. We provide a detailed description of the cluster modeling in the following paragraph.

RXC0232 was observed as part of the RELICS cluster program (D. Coe et al. 2019) and displays a bimodal light distribution, with two BCGs (BCG_A and BCG_B) separated by 24'' along the east–west direction. Both the X-rays and radio contours are centered on BCG_A in the east (R. Kale et al. 2019). We report six lensed source galaxies around these two BCGs (two radial multiple images), one of them being at a spectroscopic redshift $z_{\text{spec}} = 1.645$ (R. Mainali 2019). We report one lensed source galaxy at a spectroscopic redshift $z_{\text{spec}} = 1.467$ (R. Mainali 2019), located farther east, just outside the JWST field of view but observed thanks to the HST imaging. It is located around a group of three galaxies. The mass model includes two large-scale DM halos coincident with each BCG. The two BCGs are also optimized individually. A group-scale DM halo is included as well, to include the eastern galaxy group. The central peak of the X-ray imaging is aligned with the center of the mass peak of the cluster (see Table 3 for the X-ray observation details and Figure 3 for the X-ray contours in cyan and projected mass contours in black). The model optimizes the fits for the redshifts of five lensed source galaxies. The best-fit optimization of the redshift for Source #2 is $5.76^{+0.15}_{-0.86}$, while the other four sources have optimized redshifts under $z \sim 3$.

3.4.3. SMACS J2031.8–4036

SMACS J2031.8–4036 (SMACS2031), located at $z = 0.3416$, is optimized with a total of 15 lensed source galaxies (53 multiple images and 67 lensing constraints), where 13 source galaxies have spectroscopic redshifts and 2 redshifts are optimized within the model. A total of 165 cluster-member galaxies are fitted with a scaling relation based on a reference luminosity L^* for the BCG of the cluster ($F814W = 18.74$). The model uses three potentials to describe the mass of the cluster. The final model has an rms of 0''.40, and the masses enclosed within 200 kpc and 500 kpc are $\sim 1.38 \times 10^{14} M_{\odot}$ and $\sim 4.47 \times 10^{14} M_{\odot}$, respectively. We provide a detailed description of the cluster modeling in the following paragraphs.

The SLICE model of SMACS2031 is based on (and updates) the model presented in J. Richard et al. (2021) as part of the MUSE Cluster Atlas—a project targeting massive galaxy clusters with a combination of MUSE spectroscopy and HST imaging. Based on the HST data, SMACS2031 appears to be undergoing a major merger, with two distinct BCGs separated by 72''. The apparent merger axis is oriented at a position angle of 60° west of north. As a Cluster Atlas member, SMACS2031 has significant spectroscopic coverage, though only over its eastern half, as the western portion was not targeted by the survey. The J. Richard et al. (2021) model identified 13 multiply imaged sources (consisting of 46 multiple images); however, due to the relatively shallow HST data, several of these lensed source galaxies are not detected in imaging but only as emission-line features in MUSE. In contrast, SLICE JWST imaging reveals clear continuum emission (in both F150W2 and F332W2) for all 13 sources, improving the centroiding precision of each image by up to $\sim 0''.5$. The improved resolution of JWST also reveals complex morphologies in many of the lensed source galaxies, with Sources #1, #10, and #11 each having identifiable clumps in their continuum appearances, allowing us to use each of these clumps as a distinct model constraint.

In addition to confirming and updating the positions of existing lensed source galaxies and their associated clumps, we also identify two new, faint, arc-like objects (which we label as Sources #14 and #15) in the eastern half of the cluster. Although we also detect several long extended arc structures around the western half of SMACS2031, these arcs have a distinctly smooth appearance, with no obvious counterimages, making it difficult to know if they are merging pairs or simply distorted single-image galaxies. Therefore, at present, we do not include any of the western arcs as constraints, but this can be revisited with deeper imaging and/or spectroscopic follow-up.

Using these constraints, we construct a new lens model that includes three cluster- and galaxy-scale mass halos in the model (see Table 7)—two to represent the cluster-scale halos of the eastern and western components of SMACS2031, and a third galaxy-scale halo to account for the eastern BCG. Our model is then complemented with 165 smaller-scale halos to

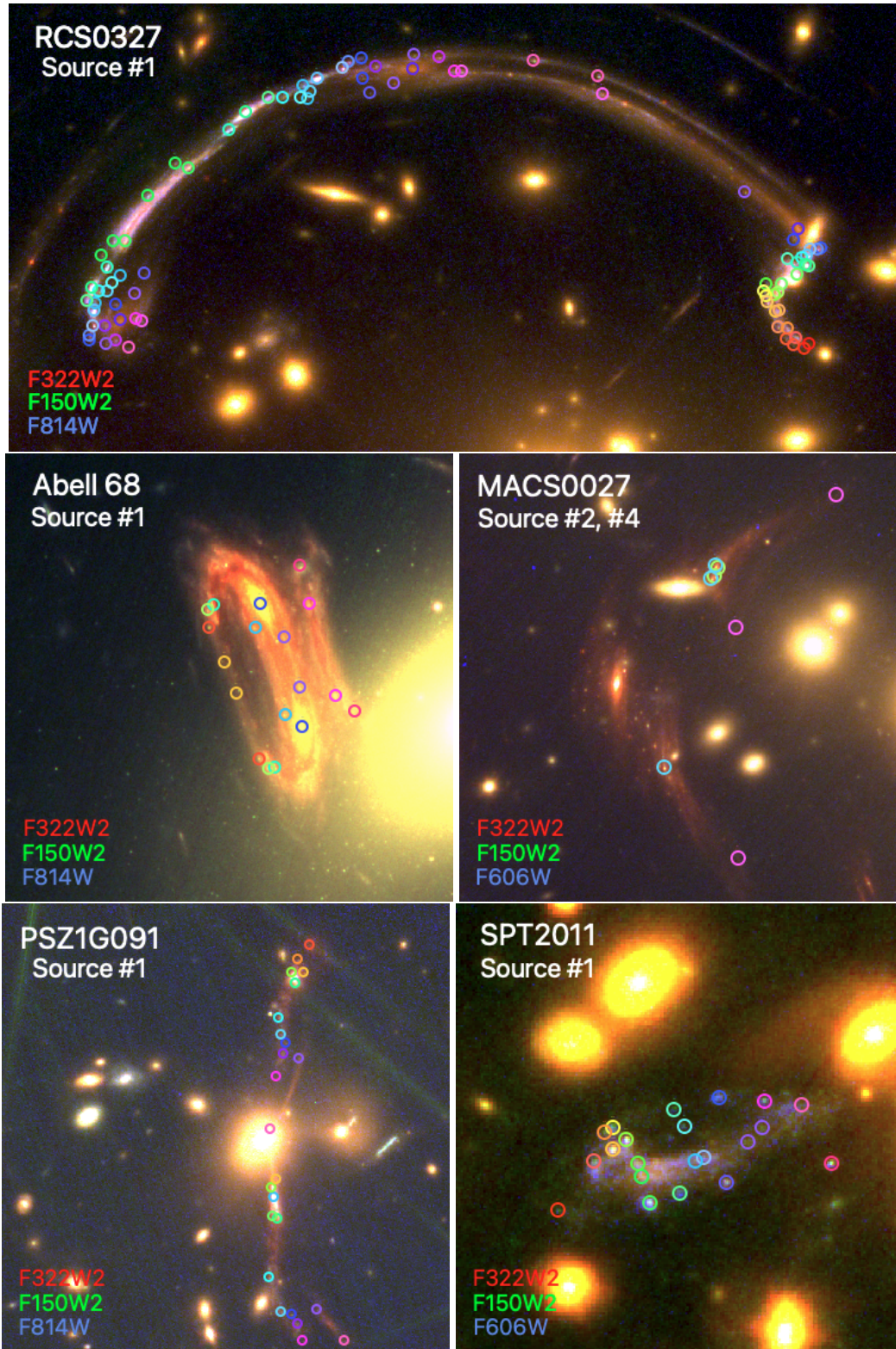


Figure 2. Snapshots of five lensed images from the SLICE program, including the primary tangential arc from Source #1 in RCS 0327 (top), Source #1 in A68 (middle left), Sources #2 and #4 in MACS0027 (middle right), Source #1 in PSZ1G091 (bottom left), and the radial arc from Source #1 in SPT2011 (bottom right). The constraints identified in the process of constructing the lens models are color-coded but are not labeled for visual clarity. Some constraints shown in this figure include candidate clumps that were not used in the construction of the final lens model presented in this paper. The complete constraint information is provided in Table 8. The large number of identified emission knots (clumps) in these lensed galaxies is possible due to the high-resolution infrared imaging capabilities of JWST. Each additional constraint imposes more precise limits on the modeled mass distributions of these clusters, increasing the potential for lens modeling to explore the fundamental properties of clusters.

Table 6
Cluster Mass Table ($10^{14} M_{\odot}$ with 68% Confidence Interval Uncertainty)

(1) Cluster	(2) M (<200 kpc)	(3) M (<500 kpc)	(4) R_E (arcsec) $z = 2$	(5) R_E (arcsec) $z = 9$
A68	$1.60^{+0.07}_{-0.26}$	$4.90^{+0.37}_{-0.81}$	$16.38^{+0.38}_{-0.19}$	$19.72^{+0.43}_{-0.48}$
RXC J0232.2–4420	$1.85^{+0.05}_{-0.04}$	$4.51^{+0.21}_{-0.21}$	$25.23^{+0.38}_{-0.75}$	$29.53^{+0.41}_{-0.99}$
SMACS J2031.8–4036	$1.38^{+0.02}_{-0.01}$	$4.47^{+0.21}_{-0.10}$	$21.70^{+0.23}_{-0.86}$	$28.12^{+0.10}_{-0.48}$
MACS J0027.8+2616	$1.73^{+0.07}_{-0.18}$	$5.09^{+0.37}_{-0.84}$	$10.90^{+1.21}_{-1.08}$	$18.65^{+0.54}_{-2.44}$
RXC J2211.7–0349	$2.81^{+0.02}_{-0.01}$	$7.04^{+0.11}_{-0.08}$	$43.98^{+0.61}_{-0.55}$	$53.35^{+0.98}_{-0.91}$
MACS J0553.4–3342	$1.84^{+0.03}_{-0.01}$	$6.15^{+0.03}_{-0.04}$	$32.33^{+0.09}_{-0.10}$	$41.98^{+0.11}_{-0.06}$
MACS J0358.8–2955	$2.15^{+0.14}_{-0.03}$	$5.99^{+1.38}_{-0.11}$	$16.14^{+6.96}_{-2.21}$	$32.78^{+1.62}_{-0.86}$
MACS J1621.4+3810	$1.62^{+0.07}_{-0.06}$	$3.91^{+0.26}_{-0.29}$	$21.59^{+0.44}_{-0.69}$	$27.32^{+0.01}_{-1.40}$
RCS2 032727–132623	$1.91^{+0.28}_{-0.29}$	$5.14^{+0.68}_{-0.82}$	$23.60^{+0.05}_{-0.25}$	$31.86^{+0.20}_{-0.31}$
MACS J2129.4–0741	$1.84^{+0.01}_{-0.03}$	$5.32^{+0.10}_{-0.19}$	$20.80^{+0.41}_{-0.00}$	$29.77^{+0.71}_{-0.00}$
PSZ1 G091.83+26.11	$1.89^{+0.02}_{-0.00}$	$7.61^{+0.21}_{-0.12}$	$4.64^{+0.00}_{-0.37}$	$24.82^{+0.19}_{-0.31}$
RX J0152.7–1357	$1.14^{+0.13}_{-0.10}$	$3.44^{+0.40}_{-0.42}$	$11.15^{+1.75}_{-0.90}$	$17.16^{+5.35}_{-1.44}$
SPT-CL J0516–5755	$1.74^{+0.08}_{-0.04}$	$5.10^{+0.42}_{-0.18}$	$7.23^{+0.35}_{-2.05}$	$21.51^{+0.77}_{-2.57}$
SPT-CL J2011–5228	$2.51^{+0.22}_{-0.00}$	$7.73^{+1.75}_{-0.00}$	$8.94^{+0.04}_{-1.06}$	$33.48^{+0.47}_{-3.08}$

Note. Summary of mass estimates from all SL models. Columns (2) and (3): the masses enclosed within 200 kpc and within 500 kpc, respectively. Columns (3) and (4): measurements of the cluster’s Einstein radius R_E at two different redshifts. For A68, the measurement of R_E is limited to the major cluster component, to ensure consistency between the two redshift measurements. The mass estimates are calculated starting from the reference coordinates listed in Column (2) of Table 7. All uncertainties are calculated relative to the best-fit model with an asymmetric 68% confidence level.

account for cluster-member galaxies. We specifically model the eastern BCG separately from other galaxies (see Section 3.1), because it lies close to individual lensed galaxies and could bias the fit.

After optimizing the model, we find a best fit with an rms of $0''.40$. The best-fit position of the eastern large-scale cluster halo is nearly colinear with the BCG, while the western halo is offset by $\sim 12''$ to the south (similar to the results of the J. Richard et al. 2021 model). However, the JWST imaging of the eastern BCG reveals that the galaxy has a significant diffuse/shell-like appearance, suggesting that it has recently been disrupted and possibly offering clues as to the nature of the cluster halo offset. The lack of constraints around the western BCG makes it difficult to obtain a proper centroid, which may also account for this offset. The model optimizes the redshifts of two lensed source galaxies, #14 and #15. The best-fit optimization of Source #15 is $6.89^{+0.08}_{-0.20}$, while Source #14 is under $z \sim 2$.

3.4.4. MACS J0027.8+2616

MACS J0027.8+2616 (MACS0027), located at $z = 0.365$, is optimized with a total of 4 lensed source galaxies (19 multiple images and 31 lensing constraints), where 2 source galaxies have spectroscopic redshifts and 2 redshifts are optimized within the model. A total of 170 cluster-member galaxies are fitted with a scaling relation based on a reference luminosity L^* for the BCG of the cluster ($F606W = 19.39$). The model uses one potential to describe the mass of the cluster. The final model has an rms of $0''.48$, and the masses enclosed within 200 kpc and 500 kpc are $\sim 1.73 \times 10^{14} M_{\odot}$ and $\sim 5.09 \times 10^{14} M_{\odot}$, respectively. We provide a detailed description of the cluster modeling in the following paragraphs.

This model is the first published lens model for MACS0027. The cluster was first reported in A. Repp & H. Ebeling (2018) as part of the HST SNAPshot surveys (PID: 12166, PI: Ebeling). We identify four lensed source galaxies, of which two have spectroscopic redshifts from MUSE. Source #1 consists of four multiple images arranged in an Einstein Cross configuration, with a spectroscopic redshift measurement of $z_{\text{spec}} = 3.127$. MUSE also reveals a total of five images with a spectroscopic redshift of $z_{\text{spec}} = 4.45$. Inspection of the JWST imaging shows that three of these images share the same color and morphology and are spatially arranged in a configuration consistent with expectations from lensing. We label these three images as Source #3. The other two sources at this redshift do not share the morphology or colors of Source #3, but according to the best-fit lens model, they may be counter-images of each other. We thus label these two sources as candidate Source #7, though we do not use it in the lens model. The five MUSE sources are likely associated with two different galaxies at the same redshift, separated by ~ 30 kpc in the source plane. We discuss these sources further in Section 4.4.

Sources #1 and #2 have a large amount of substructure that is only visible in the JWST imaging, and we use these substructure components as additional constraints in the model. We visually identify a radial arc near the BCG but do not associate it with any source, due to the difficulty in securing a reliable spectroscopic redshift for it. We also identify two candidate lensed source galaxies, #5 and #6, as shown in Figure 1. For our final model, we only include Sources #1, #2, #3, and #4, while keeping Sources #5, #6, and #7 as candidates. We note that apart from these lensed source galaxies, there are several arcs found in JWST imaging that have no obvious counterimages at the depth of the available data.

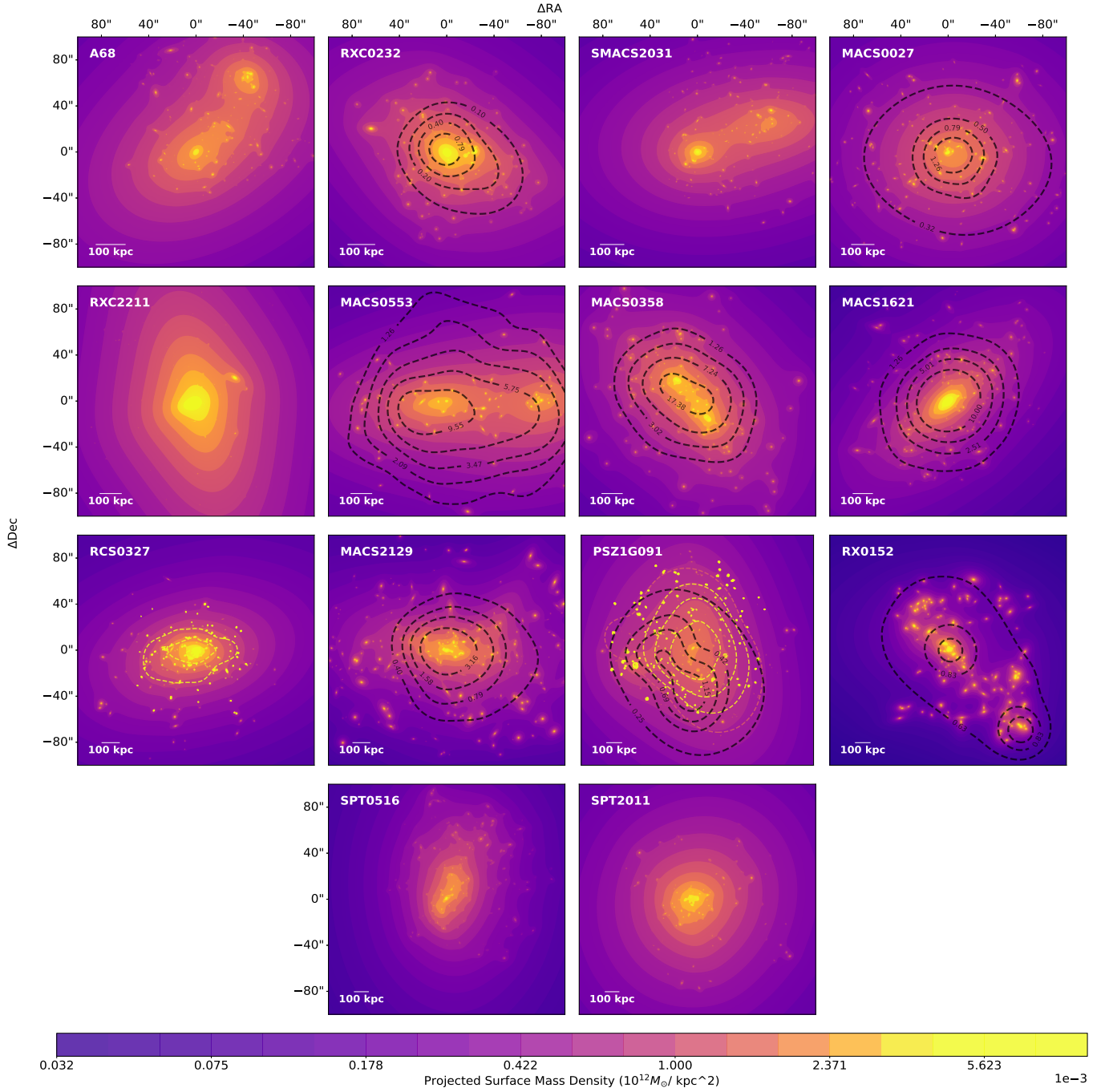


Figure 3. The total projected surface mass density of each cluster is measured within a $200'' \times 200''$ box centered on the reference coordinates for each lens model made with *Lenstool*, which are listed in Column (2) of Table 7. The *Lenstool* mass density map is shown as the logarithmically spaced contours between $10^8 M_\odot$ and $10^{11} M_\odot$, which are spaced according to the scale given in the color bar. The mass contours across the grids used in the two *WSLAP+* models are shown as the dashed lines and are colored according to the same scale as the *Lenstool* maps. Chandra X-ray observations are available for 8 of the 14 clusters. For the purposes of presentation, we smooth the X-ray map with the *csmooth* routine, using adaptive smoothing to 2.5σ significance. We convolve the smoothed X-ray map with a Gaussian of a standard deviation of 5 pixels and plot logarithmically spaced contours with black dashed lines over the projected mass map, with the contour levels given explicitly in the plot. A uniform scale length of 100 kpc is shown in the bottom left corner of each plot.

The central peak of the X-ray imaging is generally aligned with the center of the mass peak of the cluster (see Table 3 for the X-ray observation details and Figure 3 for the X-ray contours in cyan and projected mass contours in black). The model optimizes the fits for the redshifts of two lensed source galaxies. The best-fit optimization of the redshift for Source #2 varies, depending on the substructure clump used to perform the fit, where the first clump, #2.1, has an optimized model redshift of $5.91^{+0.01}_{-0.55}$, while the second clump, #2.2, has

an optimized redshift of $5.17^{+0.00}_{-2.37}$. The second source, Source #4, has an optimized redshift of $4.68^{+0.19}_{-0.35}$.

3.4.5. RXC J2211.7–0349

RXC J2211.7–0349 (RXC2211), located at $z = 0.397$, is optimized with a total of 10 lensed source galaxies (32 multiple images and 45 lensing constraints), where 1 source galaxy has a spectroscopic redshift and the remaining 9

redshifts are optimized within the model. A total of 197 cluster-member galaxies are fitted with a scaling relation based on a reference luminosity L^* for the BCG of the cluster (F814W = 19.20). The model uses five potentials to describe the mass of the cluster. The final model has an rms of $0''.57$, and the masses enclosed within 200 kpc and 500 kpc are $\sim 2.81 \times 10^{14} M_\odot$ and $\sim 7.04 \times 10^{14} M_\odot$, respectively. We provide a detailed description of the cluster modeling in the following paragraphs.

We update the lens model of RXC2211 that was first presented in C. Cerny et al. (2018), based on HST observations from RELICS (D. Coe et al. 2019). The original model consisted of three different lensed source galaxies, oriented mainly around the BCG of the cluster. The SLICE JWST imaging allows us to add seven new lensed source galaxies to this model. The substructure in all 10 sources of this model is clearly resolved, which allows us to use the clumps within five source galaxies as additional constraints in the model.

Sources #1, #2, and #3 correspond to the identifications in C. Cerny et al. (2018). Sources #4, #5, #6, #7, #8, #9, and #10 are new identifications that are only visible in the JWST imaging. We use the spectroscopic redshift measurement of $z_{\text{spec}} = 1.501$ from C. Cerny et al. (2018) for Source #1 and allow the model to optimize the redshifts of the other constraints. All optimized sources have redshifts under $z \sim 4$. Sources #9 and #10, which have an optimized model redshift of $z \sim 2$, are located very close to the critical curve, providing a tight constraint on its location. We also identify a candidate lensed galaxy, Source #11, in the southwest part of the cluster, though we do not include it in the final model, as its predicted configuration yields additional counterimages that cannot be reliably identified in the JWST imaging. Source #4 is a very dusty red galaxy that is bright in the JWST imaging.

The new constraints give definition to the elongated, angularly warped, projected mass distribution, which is slightly tilted toward the west at both the north and south ends. The complexity of the underlying mass distribution is reflected by the need for two large cluster-scale DM halos at the center of the cluster to accurately reproduce the positions of the lensed source galaxies and clumps. An additional two galaxy-scale cluster-member halos are also placed near the second- and seventh-brightest galaxies in the cluster core, to successfully reproduce the multiple images. Halo 3 adds a significant clump of mass to the west part of the cluster, indicating the presence of possible DM substructure. Further improvements to this model rely on the acquisition of more spectroscopic redshifts, especially for the new lensed source galaxies identified with JWST.

3.4.6. MACS J0553.4–3342

MACS J0553.4–3342 (MACS0553), located at $z = 0.412$, is optimized with a total of 21 lensed source galaxies (57 multiple images and 102 lensing constraints), where 4 source galaxies have a spectroscopic redshift and the remaining 17 redshifts are optimized within the model. A total of 197 cluster-member galaxies are fitted with a scaling relation based on a reference luminosity L^* for the BCG of the cluster (F814W = 19.47). The model uses two potentials to describe the mass of the cluster. The final model has an rms of $0''.66$, and the masses enclosed within 200 kpc and 500 kpc are $\sim 1.84 \times 10^{14} M_\odot$ and $\sim 6.15 \times 10^{14} M_\odot$, respectively. We

provide a detailed description of the cluster modeling in the following paragraphs.

We update the lens model that was originally presented in H. Ebeling et al. (2017) and use the HST observations from RELICS (D. Coe et al. 2019). The original model consisted of 10 different lensed source galaxies covering two main subclusters. The SLICE JWST imaging allows us to add 11 new lensed source galaxies to this model. The substructure in six sources of this model is clearly resolved, which allows us to use a total of 102 clumps in the 21 sources as constraints in the model.

Sources #1 through #10 correspond to the identifications in H. Ebeling et al. (2017). Sources #11 through #21 are new identifications that are only fully confirmed using the JWST imaging. All sources are comprised of three-image folds. We use the spectroscopic redshift measurements of Sources #1 and #5 and make use of additional VLT/MUSE observations from the Kaleidoscope survey (PID: 0104.A-0801, PI: Edge) to confirm the Lyman- α emission from Sources #5, #10, and #13. We let the model optimize the redshifts of the other sources.

The new constraints confirm the very elongated and strongly bimodal mass distribution of the previous model presented in H. Ebeling et al. (2017) and do not require additional complexity. The central peak of the X-ray imaging is aligned with the western peak of the mass distribution, which contains a larger fraction of mass than the eastern portion of the cluster (see Table 3 for the X-ray observation details and Figure 3 for the X-ray contours in cyan and projected mass contours in black). The model optimizes the fits for the redshifts of 17 sources. Source #6 has an optimized redshift of $4.31^{+0.00}_{-0.16}$, Source #8 has a redshift of $5.79^{+0.02}_{-0.24}$, Source #12 has a redshift of $7.25^{+0.00}_{-0.52}$, Source #16 has a redshift of $4.66^{+0.00}_{-0.20}$, and the remaining sources are under $z \sim 4$.

3.4.7. MACS J0358.8–2955

MACS J0358.8–2955 (MACS0358), located at $z = 0.425$, is optimized with a total of 6 lensed source galaxies (16 images and 16 lensing constraints), where 3 source galaxies have a spectroscopic redshift and the remaining 3 redshifts are optimized within the model. A total of 256 cluster-member galaxies are fitted with a scaling relation based on a reference luminosity L^* for the BCG of the cluster (F814W = 19.32). Only the velocity dispersion for the scaling relation is optimized in the model; the cut radius is fixed to 30 kpc, to allow the model to produce a consistent physical result. The model uses two potentials to describe the mass of the cluster. The final model has an rms of $0''.21$, and the masses enclosed within 200 kpc and 500 kpc are $\sim 2.15 \times 10^{14} M_\odot$ and $\sim 5.99 \times 10^{14} M_\odot$, respectively. We provide a detailed description of the cluster modeling in the following paragraph.

MACS0358, a RELICS (D. Coe et al. 2019) cluster, displays a bimodal light distribution elongated in the northeast/southwest direction. A BCG is dominating the northeast light clump, whereas the southwest one is dominated by two galaxies with comparable magnitudes. The cluster's 3D geometry and merger history have been investigated by L.-Y. Hsu et al. (2013), suggesting a complex merger of at least three subclusters. These authors constructed a mass model using three lensed source galaxies. We add three new sources, for a total of six lensed source galaxies, and adopt the spectroscopic redshift measurement for the three sources from

L.-Y. Hsu et al. (2013). The mass model is comprised of two large-scale DM halos associated with each light concentration, on top of which we add 256 cluster members. The best-fit mass model has an rms of $0''.21$ and our results are in agreement with the former model proposed by L.-Y. Hsu et al. (2013).

The peak of the X-ray imaging is located slightly south of the northernmost peak of the mass model (see Table 3 for the X-ray observation details and Figure 3 for the X-ray contours in cyan and projected mass contours in black). The model optimizes the redshifts of three lensed source galaxies, all of which are under $z \sim 3$.

3.4.8. MACS J1621.4+3810

MACS J1621.4+3810 (MACS1621), located at $z = 0.4631$, is optimized with a total of 5 lensed source galaxies (16 multiple images and 22 lensing constraints). None of the source galaxies have a spectroscopic redshift at this time. One source (using two clumps) is fixed to its photometric redshift, and the remaining four source redshifts are optimized within the model. A total of 150 cluster-member galaxies are fitted with a scaling relation based on a reference luminosity L^* for the BCG of the cluster ($F814W = 19.58$). The model uses three potentials to describe the mass of the cluster. The final model has an rms of $0''.26$, and the masses enclosed within 200 kpc and 500 kpc are $\sim 1.62 \times 10^{14} M_\odot$ and $\sim 3.91 \times 10^{14} M_\odot$, respectively. We provide a detailed description of the cluster modeling in the following paragraphs.

We present a first lens model of the cluster MACS1621, whose discovery was initially reported in A. Repp & H. Ebeling (2018). We identified five lensed source galaxies in this field. Sources #1 and #2 are resolved in the SLICE JWST imaging, with several clumps identified (Figure 1). The model uses two clumps as constraints for each of these two source galaxies. We could not find any public spectroscopic record of the lensed source galaxies in this cluster. We thus rely on a photometric redshift measurement for the brightest image, Source #2, estimated at $z = 1.5^{+0.3}_{-0.2}$ using all available HST bands (ACS/F606W, ACS/F814W, WFC3IR/F110W, and WFC3IR/F140W), to anchor the model and break mass-redshift degeneracies.

Using the aperture photometric apparent magnitudes (and Gaussian estimated uncertainties) from the arc/clump of interest in the available HST and JWST filters, we conduct a Bayesian statistical inference to estimate photometric redshifts. We use the stellar population synthesis modeling package Prospector (B. D. Johnson et al. 2021) to simultaneously infer the physical properties of the lensed galaxy along with its redshift. For our fiducial model, we use a parametric star formation history—delayed- τ —model and fit the stellar metallicity, dust attenuation (D. Calzetti et al. 2000), and total mass formed in the galaxy (with TopHat priors) as nuisance parameters (see G. Khullar et al. 2022 for details on the nominal fitting and modeling prescription used here).

We also note that the bluest photometry samples the $\text{Ly}\alpha/\text{Ly}\beta$ emission region, and hence we fit an additional free parameter to marginalize the contribution of the intergalactic medium absorption and Lyman-series flux. The expectation from this process was that the Lyman and Balmer breaks in galaxy/clump spectral energy distributions (SEDs) would allow us to put limits on the redshifts while simultaneously aiding the lens models. Equally importantly, with limited photometry for these sources, it is critical to simultaneously fit

multiple galaxy parameters to respect the age-metallicity-dust degeneracy and the potential for the existence of multiple stellar populations (including emission-line-producing stellar regions).

All other source redshifts are set as free parameters in the model. Although still limited by the lack of spectroscopic redshift constraints, the overall simple geometry of the cluster gives us enough confidence in our ability to accurately describe its shape. This assumption is supported by the overlap of the X-ray imaging peak with the projected surface mass density peak of the cluster (see Table 3 for the X-ray observation details and Figure 3 for the X-ray contours in cyan and projected mass contours in black). The model includes one cluster-scale potential, and the BCG is optimized separately. The BCG potential position is fixed to the center of the BCG, and its shape is free to vary. A third galaxy-scale potential at the cluster redshift is included, to account for a foreground galaxy, in proximity of Source #5. The optimized redshifts for Sources #1–#4 are all below $z \sim 4$.

3.4.9. RCS2 0327–1326

We present two lens models for RCS2 0327–1326 (RCS 0327), located at $z = 0.564$, using two different algorithms: Lenstool and WSLAP+. The Lenstool model is optimized with a total of 23 lensed source galaxies (61 multiple images and 184 SL constraints), where 6 source galaxies have spectroscopic redshifts and the remaining 17 are optimized within the model. The WSLAP+ model is optimized using only the 6 sources with a spectroscopic redshift (16 multiple images and 137 SL constraints). Both models are constructed using the same catalog of 132 cluster-member galaxies.

The field hosts a bright, highly magnified, $\sim 38''$ giant arc of a $z = 1.701$ galaxy that has been studied extensively (K. Sharon et al. 2012; E. Wuyts et al. 2014; R. Bordoloi et al. 2016; S. Lopez et al. 2018). The giant arc in the north of the field is composed of three partial images that merge at two critical curve crossings and has a full counterimage in the south. A fifth demagnified image was detected by K. Sharon et al. (2012) $0''.6$ north of the BCG.

Lenstool Model. We improve upon the HST+MUSE-based model that was used in S. Lopez et al. (2018) and later work. That model is based on and improves the K. Sharon et al. (2012) model, by adding constraints from two lensed sources and three spectroscopic redshifts from MUSE to the previous model of K. Sharon et al. (2012). The Lenstool model is optimized in the source plane, due to the large number of constraints. The SLICE JWST imaging reveals or confirms 19 new lensed sources, including six new radial arcs to add to the one formerly known (K. Sharon et al. 2012). In addition, we identify and map 42 clumps in the multiple images of the giant arc. We adopt MUSE spectroscopic redshifts from S. Lopez et al. (2018) for Source #7 ($S7a/S7b$ in K. Sharon et al. 2012) at $z_{\text{spec}} = 2.82624$, for Source #4 at $z_{\text{spec}} = 2.73$, and for Source #5 at $z_{\text{spec}} = 5.2$. We discover a new radial arc in the MUSE data, labeled as Source #6, with a bright $\text{Ly}\alpha$ emission line and CIII placing this arc at $z_{\text{spec}} = 3.518$. A faint counterpart appears in the JWST imaging at the same location; the counterimage is predicted to be outside the MUSE field of view. We use all the lensed source galaxies and clumps in Table 8 as constraints in the lens model. More arc candidates are visible in the data, and we

leave their confirmation and possible use for the further refining of the lens model to future work.

The *Lenstool* model optimizes seven DM halos, including two DM cluster-scale halos at the cluster core, one of which is constrained to within $2''$ of the BCG; three galaxy-scale halos—two cluster members within the west end of the giant arc and one south of the giant arc—are allowed to be solved for separately from the scaling relations, as they are likely contributing a local shear effect to either end of the giant arc. Another small halo is positioned at the location of a small group of galaxies. Finally, a halo in the east is necessary in order to reproduce the faint arc (“A” in K. Sharon et al. 2012). The 132 cluster-member galaxies are fitted with a scaling relation based on a reference luminosity L^* for the BCG of the cluster ($F814W = 20.17$). The best-fit rms is $0''.77$. Due to the large number of constraints along the giant arc, and the equal weights assigned to all the constraints, the model is dominated by the constraints of the giant arc and is thus more tuned to producing accurate results in its vicinity, which could be at the expense of other regions in the field of view. The masses enclosed within 200 kpc and 500 kpc are $\sim 1.91 \times 10^{14} M_\odot$ and $\sim 5.14 \times 10^{14} M_\odot$, respectively.

WSLAP+ Model. The large number of clumps available for Source #1 enables the use of free-form methods such as WSLAP+, which require a large number of constraints to build functional models (see Section 3.2). The WSLAP+ model is derived from the lensed galaxies in the *Lenstool* model described above that have a spectroscopic redshift; any constraints in the *Lenstool* model that do not have this measurement are not included in the WSLAP+ model. The model contains $536 + 1 + 2 \times 51$ free parameters. Of these, 536 of them correspond to the Gaussian functions that are distributed on a multiresolution grid (derived iteratively, starting from a regular grid of 20×20 Gaussians). One free parameter accounts for a renormalization factor to the mass of the member galaxies. The mass of these galaxies traces the observed light in the F150W2 filter, and it is assumed as a fiducial mass that is later optimized by WSLAP+. Finally, the last 2×51 free parameters correspond to the x and y positions in the source plane of the clumps in Source #1 and the other lensed galaxies used as constraints. The final solution is obtained after optimizing 200,000 steps (≈ 5 minutes on a laptop), once convergence is achieved. The model contains $\sim 2.02 \times 10^{14} M_\odot$ within 200 kpc from the center and $\sim 5.34 \times 10^{14} M_\odot$ within 500 kpc from the center.

The *Lenstool* and WSLAP+ models, which are constructed using a subset of the same constraints, result in similar overall mass distributions, particularly within the SL region confined by the tangential critical curve. The difference between the models for both enclosed mass measurements is less than $\sim 4\%$. Nevertheless, minor differences between their resulting critical curves are observed (Figure 1). The discrepancy is smaller in regions that are well constrained in both models, e.g., the critical curve crossing of the giant arc of Source #1, which has numerous clumps, and near other arcs with spectroscopic redshift. Notably, while the east and west regions are relatively well constrained in the *Lenstool* model, the lack of spectroscopic redshifts leaves these regions relatively underconstrained for WSLAP+. A deep comparison between these two algorithms is beyond the scope of this paper and will be left to future work.

3.4.10. MACS J2129.4–0741

MACS J2129.4–0741 (MACS2129), located at $z = 0.589$, is optimized with a total of 17 lensed source galaxies (53 multiple images and 53 lensing constraints), where 13 source galaxies have a spectroscopic redshift confirmation (A. Zitrin et al. 2015; G. B. Caminha et al. 2019; M. Jauzac et al. 2021) and the remaining 4 source redshifts are optimized within the model. The mass model includes two cluster-scale potentials to describe the overall mass distribution of the cluster. A total of 293 cluster-member galaxies are fitted with a scaling relation optimizing two parameters. The reference luminosity L^* used in this relation is associated with the BCG of the cluster ($F814W = 17.94$). Five cluster galaxies are also modeled independently, due to their proximity to multiple images (all details can be found in M. Jauzac et al. 2021). Newly identified multiple images do not require the independent modeling of other cluster members. Our mass model is optimized using the *Lenstool* software (E. Jullo et al. 2007). The best-fit rms is $0''.79$. The masses enclosed within 200 kpc and 500 kpc are $\sim 1.84 \times 10^{14} M_\odot$ and $\sim 5.32 \times 10^{14} M_\odot$, respectively. We provide a detailed description of the cluster modeling in the following paragraph.

The model presented in this work is based on the model presented in M. Jauzac et al. (2021) and includes three newly identified lensed source galaxies from the SLICE JWST imaging (Sources #16, #17, and #18). This elongated cluster presents one dominant elliptical cluster-scale potential. In addition, we relax the BCG potential and four other galaxy potentials near lensed source galaxies in this central region. One more group-scale potential in the northwest region of the cluster is added, matching the light distribution of an overdensity of bright cluster galaxies with diffuse emission. This component is interpreted as an infalling group, even if the X-ray imaging does not show a gaseous counterpart at the position of the galaxy group (see Table 3 for the X-ray observation details, and Figure 3 for the X-ray contours in cyan and projected mass contours in black). Furthermore, we note that the gas peak in the X-ray distribution coincides with the main lensing mass peak, which corresponds to the location of the BCG. This updated mass model is in excellent agreement with the model it is based on, with the rms of the SLICE best-fit mass model at $0''.79$, in comparison to $0''.80$ for the M. Jauzac et al. (2021) best-fit model rms. The final model is optimizing the redshifts of Sources #5, #16, #17, and #18. Source #18 has a best-fit optimized redshift of $5.53^{+0.47}_{-0.19}$. The other sources have optimized redshifts below 1.7.

3.4.11. PSZ1 G091.83+26.11

We construct a preliminary lens model of PSZ1 G091.83+26.11 (PSZ1G09), located at $z = 0.822$, using both *Lenstool* and WSLAP+. The *Lenstool* model is optimized with a total of 5 lensed source galaxies (19 multiple images and 89 SL constraints). The WSLAP+ model is optimized with a total of 2 sources (9 multiple images and 71 SL constraints). An additional 7 candidate lensed source galaxies or galaxy–galaxy lensing instances are identified within the field of view but are not used in either model. There are no spectroscopic redshifts available for the lensed galaxies in this field at the time of writing. Both models are constructed using the same 217 cluster-member galaxies.

This is one of the most massive clusters known at $z > 0.8$ (Planck Collaboration et al. 2016) and hence deserves special attention. Clusters at this redshift are in an active phase of formation and often in a nonrelaxed state. PSZ1G09 shows a bimodal structure both in SZ maps (Planck Collaboration et al. 2016; E. Artis et al. 2022) as well as in the X-rays (E. Artis et al. 2022), thus suggesting an active merger. This interpretation is supported by radio observations that show prominent radio shock emission on the east side of the cluster (G. Di Gennaro et al. 2023). To date, no lens model is available in the literature. The JWST observations show a very large galaxy imaged into four counterimages (Source #1). This galaxy has two components: a blue and compact nucleus, which is already clearly visible in earlier observations with HST, and a very red extended tail, which is barely detectable in previous HST observations but is very prominent in F322W2 and possibly harboring copious amounts of dust. These types of blue–red pairs have been observed multiple times with JWST, often corresponding to interacting galaxies at $z > 3$ (J. M. Diego et al. 2023a). Combining HST and JWST photometry, we derive photometric redshifts (as outlined in Section 3.4.8) for all four images of Source #1, finding the redshifts of the two most reliable images to be 4.39 and 4.44. We adopt a redshift of $z_{\text{phot}} = 4.4$ for this source. In the new JWST data, we identify 10 additional lensed source candidates. For Source #2, composed of two radial arcs and a tangential arc, we derive a photometric redshift of $z_{\text{phot}} = 2.8$. All the remaining sources lack reliable photometric redshift estimates, since they are too faint to be detected in HST observations. Only the sources with redshift estimates can be used as constraints in the WSLAP+ algorithm.

To provide sufficient constraining power in the east, the WSLAP+ model assumes a redshift $z \sim 3$ for a third source, Source #8. The Lenstool model can use sources without a redshift estimate as constraints, by including the redshift as a free parameter to be solved by the model. The Lenstool model uses the secure arcs as constraints. We describe the two models below.

WSLAP+ Model. We model PSZ1G09 with the hybrid algorithm WSLAP+. We divide the member galaxies into two layers, with the BCG in Layer 1 and all the remaining members in Layer 2. The smooth component is modeled by a combination of Gaussian functions. A first model is derived on a grid of 20×20 points, with a Gaussian centered on each grid point. This solution is used to construct a new grid for the Gaussian centers, where more Gaussians (with smaller FWHMs) are placed in the regions with more mass. The new grid lowers the number of Gaussians (from 400 to 267) and increases the resolution near the regions of higher density. The number of free parameters in the model is then $267 + 2 + 2 \times 11 = 291$ (267 Gaussians, 2 layers, and the positions in the source plane of 11 lensed galaxies). The bimodal structure of this cluster is evident in both the X-ray imaging and the projected surface mass density map. The X-ray peak is located around the middle of the two mass peaks, lending further evidence to the cluster’s status as an active merger (see Table 3 for the X-ray observation details and Figure 3 for the X-ray contours in cyan and projected mass contours in black). The model has an rms of $1''.06$. The masses enclosed within 200 kpc and 500 kpc are $\sim 1.80 \times 10^{14} M_{\odot}$ and $\sim 6.30 \times 10^{14} M_{\odot}$, respectively.

We compute a second WSLAP+ model to explore a secondary mass distribution in the east, using the candidate Source #8 as a constraint with an assumed redshift of $z \sim 3$. From this model, the masses enclosed within 200 kpc and 500 kpc are $\sim 1.84 \times 10^{14} M_{\odot}$ and $\sim 7.05 \times 10^{14} M_{\odot}$, respectively.

Lenstool Model. The Lenstool model of PSZ1G09 uses the same constraints as the WSLAP+ model for Sources #1 and #2. Since Lenstool can include sources without photometric redshifts as constraints with free redshift parameters, we are able to use Source #3 to constrain the cluster center and Sources #4 and #5 to constrain the north part of the cluster core. We used an iterative modeling approach, starting with a lens plane composed of red-sequence-selected cluster-member galaxies and a single cluster-scale halo with broad priors. As expected from the arc geometry of the images of Source #1, a single halo model resulted in a poor solution. We iteratively added cluster-scale halos, increasing the model complexity, until no significant improvement was recorded. The best-fit model converged on three cluster-scale halos: two near the main SL core and one east of the main SL core. The slope and normalization parameters of the east halo were allowed to vary, but its position was fixed to the location of the BCG, $\sim 50''$ east of the main SL core, at R.A., decl. = [277.816360, 62.245004], and we assumed a circular mass distribution. The arc candidates near this halo were not used as constraints in the Lenstool model. We additionally freed some of the parameters of the two galaxies near the radial arcs of Source #2, to increase the model flexibility at the center (see Table 7). The 218 cluster-member galaxies are fitted with a scaling relation based on a reference luminosity L^* for the BCG of the cluster (F110W = 20.25). The best-fit model has an image-plane rms of $0''.47$. The masses enclosed within 200 kpc and 500 kpc are $\sim 1.89 \times 10^{14} M_{\odot}$ and $\sim 7.61 \times 10^{14} M_{\odot}$, respectively. This model uses five sources as SL constraints: Source #1 at $z_{\text{phot}} = 4.4$, with four images, each with 18 clumps; Source #2 at $z_{\text{phot}} = 2.8$, with five images; Sources #4 (two clumps, best-fit optimized redshift below $z \sim 4$) and #5 (three clumps, best-fit optimized redshift of $4.66^{+0.03}_{-0.17}$), with three images each; and Source #3, which has three secure images (best-fit optimized redshift of $4.47^{+0.00}_{-0.17}$). The fourth image of Source #3 is left as a candidate and not used as constraint, since there is more than one possible arc near the location predicted by the lens model from the other three images. Acquiring a reliable redshift measurement (i.e., a spectroscopic measurement) for this source would likely allow the model to identify the correct counterimage from the three possible candidate images.

Figure 1 shows the critical curves of the WSLAP+ model (white) and the Lenstool model (black) for a source at $z = 4.4$. Although using very different approaches, the two models yield similar critical curves, with the main discrepancies occurring in regions with less constraints. An examination of the mass measurements between the two modeling methods shows that the WSLAP+ model created with the same constraints as Lenstool measures a mass that is $\sim 5\%$ lower than the Lenstool model within 200 kpc and $\sim 19\%$ lower within 500 kpc. This difference originates from the lack of reliable constraints in the eastern half of the cluster. The Lenstool model chooses to place a parametric halo fixed to the BCG of this portion of the cluster, while the WSLAP+ model created with the same constraints as Lenstool cannot constrain a mass halo in this region and thus does not include

one. The second WSLAP+ model, which is created with different constraints than the Lenstool model, elects to place a free-form mass halo around the locations of candidate Sources #8 and #9. The agreement between this second model and the Lenstool model at 500 kpc is better, with only a $\sim 9\%$ difference between the two models. This comparison highlights the importance of the eastern mass component of this cluster in constraining the model. The acquisition of at least one spectroscopic redshift will enable both modeling methods to explore the parameter space in this region more rigorously.

3.4.12. RX J0152.7–1357

RX J0152.7–1357 (RX0152), located at $z = 0.8269$, is optimized with a total of 7 lensed source galaxies (20 multiple images and 26 lensing constraints), where 1 source galaxy has a spectroscopic redshift and the remaining 8 source redshifts are optimized within the model. A total of 131 cluster-member galaxies are fitted with a scaling relation based on a reference luminosity L^* for the BCG of the cluster ($F160W = 20.64$). The model uses one cluster-scale potential to describe the mass of the cluster. The final model has an rms of $0''.45$, and the masses enclosed within 200 kpc and 500 kpc are $\sim 1.14 \times 10^{14} M_\odot$ and $\sim 3.44 \times 10^{14} M_\odot$, respectively. We provide a detailed description of the cluster modeling in the following paragraphs.

In this work, we present a new mass model of RX0152 based on the SLICE JWST imaging. This cluster presents three overdensities of galaxies, highlighting a dominant cluster-scale halo and two group-scale halos in the southwest and west of the cluster. These three structures are apparent in the X-ray emission, as highlighted by the contours of the X-ray surface brightness in Figure 3. These structures have already been reported by a previous lensing analysis presented in A. Acebron et al. (2019).

Thanks to the new JWST imaging, we identify one new lensed source galaxy located near a cluster-member overdensity, southwest of the cluster. The images of this source are barely visible in the reddest band of the RELICS imaging (i.e., WFC3/F160W), but it appears clearly in the JWST/F322W2 band as a galaxy-scale lensing feature, where only a part of the galaxy disk is multiply imaged. The color and the apparent size of the singly lensed body of the galaxy likely highlight a dusty galaxy at $z \gtrsim 2$. We confirm morphologically the six multiply imaged galaxies used as constraints in A. Acebron et al. (2019). We could secure more accurate positions of the multiple images thanks to the star-forming regions clearly appearing in the JWST imaging. Two of the lensed galaxies show more than one clump; in total, we therefore have nine lensed source galaxies as lensing constraints for our mass model.

Our Lenstool model includes 131 halos, to account for the cluster members that we identified with a red-sequence fitting based on the HST imaging in the ACS/F625W and WFC3/F160W bands. Based on this selection, we measure their position, position angle, and ellipticity based on the JWST/F322W2 band. In addition, we add one cluster-scale halo to represent the smooth DM component of the main cluster. We try to add another halo in the southwest, to account for the galaxy group mentioned earlier, but the lack of lensing constraints in this region leads to an unrealistic mass of this component. Unfortunately, only half of the structure is visible

in JWST imaging, limiting our ability to identify new multiply imaged candidates.

Our model is similar to the Lenstool model presented in A. Acebron et al. (2019) in its parameterization, its one cluster-scale DM halo, and its cluster galaxy-scale components. However, we are not modeling any galaxy outside the cluster-member relation. Indeed, in A. Acebron et al. (2019), they model one cluster galaxy individually, due to its proximity to the images of Source #1. Using the same sources as A. Acebron et al. (2019), our best-fit model has an rms of $0''.47$ —a slightly lower value than the rms of $0''.52$ reported by A. Acebron et al. (2019). When including the newly identified lensed source galaxy presented earlier, our best-fit mass model has an rms of $0''.45$. Source #6 has a best-fit optimized redshift of $4.39^{+0.43}_{-0.46}$; Source #7 is optimized to $4.35^{+0.44}_{-0.47}$; Source #11 is optimized to $4.45^{+0.00}_{-2.58}$; and all other optimized redshifts are below $z \sim 3$.

3.4.13. SPT-CL J0516–5755

SPT-CL J0516–5755 (SPT0516), located at $z = 0.9656$, is optimized with a total of 10 lensed source galaxies (25 multiple images and 53 lensing constraints), where the model is anchored using a photometric redshift estimate for 1 source galaxy and the remaining 9 sources are optimized within the model. A total of 247 cluster-member galaxies are fitted with a scaling relation based on a reference luminosity L^* for the BCG of the cluster ($F150W2 = 19.30$). The model uses three potentials to describe the mass of the cluster. The final model has an rms of $0''.21$, and the masses enclosed within 200 kpc and 500 kpc are $\sim 1.74 \times 10^{14} M_\odot$ and $\sim 5.10 \times 10^{14} M_\odot$, respectively. We provide a detailed description of the cluster modeling in the following paragraphs.

We present the first SL model of SPT0516. Archival HST data exist only in F606W for this field. We select cluster-member galaxies by their color in ACS/F606W–NIRCam/F150W2 and magnitudes as measured from the NIRCam/F150W2 band. We identify 10 lensed sources with high confidence to be used as lensing constraints. The elongated projected mass distribution results in naked cusp lensing configurations for virtually all the lensed sources, with three images of each source. We only identify a central fourth image for Source #1, near a cluster member at the cluster core. The most prominent source in the SLICE JWST imaging is entirely absent from the HST/F606W data—a red dusty galaxy with distinct morphology and obvious dust lane. Interestingly, the eastern image of this galaxy features an emission clump that is missing from the other images. We discuss this candidate transient in Section 3.4.14.

Unfortunately, no spectroscopic redshifts have been measured for lensed galaxies in this field. An attempt to obtain spectroscopy in this field in 2024 October (soon after the JWST observations, and prompted by the discovery of the candidate transient; see Section 3.4.14) failed due to weather conditions. We were awarded time on the Magellan telescope in 2025A (U. of Michigan allocation, PI: Sharon) to obtain spectroscopic redshifts of multiple images in this field, and we will revisit the lens model once spectroscopic redshifts are secured.

To compute the model presented here, we anchor the model at the photometric redshift of Source #1 and leave the redshifts of all the other sources as free parameters in the model. We then test the results of the model against the

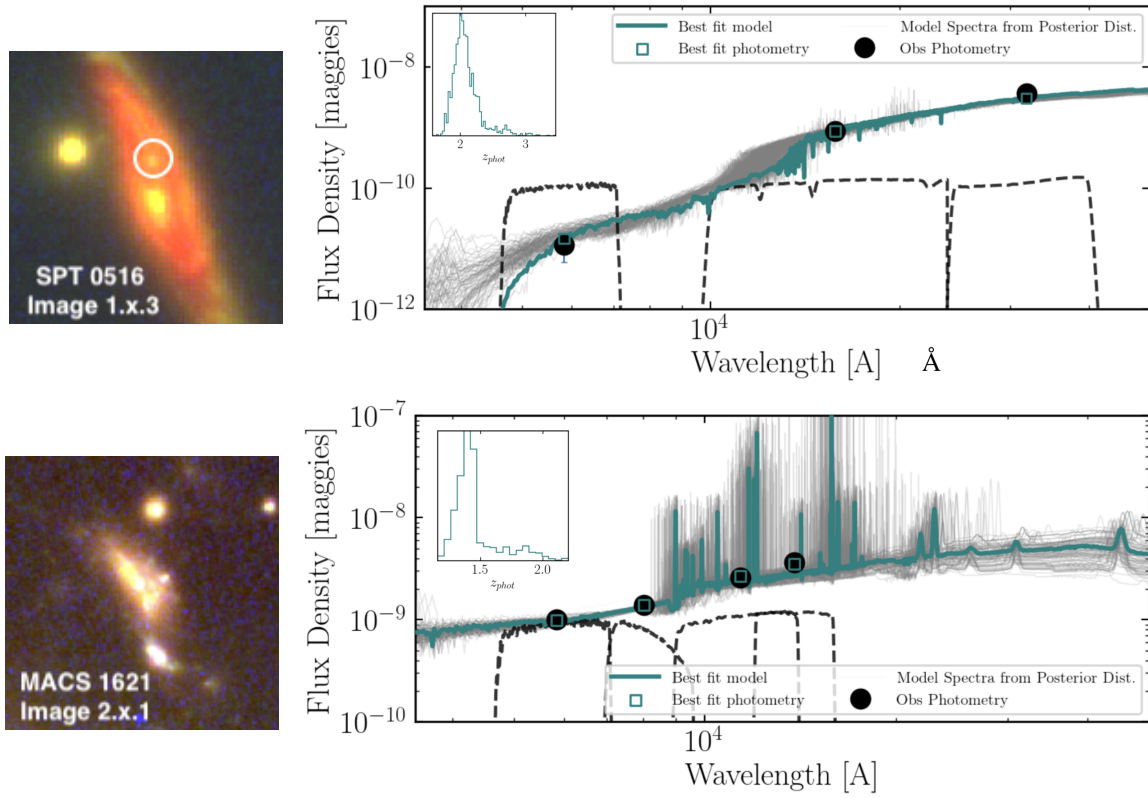


Figure 4. Top: SED analysis of Image #10.1 in SPT-CL J0516–5755, shown in the postage stamp on the left. The candidate transient is circled in white. The photometry is measured in ACS/F606W, NIRCcam/F150W2, and NIRCcam/F322W2. The best-fit redshift is consistent with $z_{\text{phot}} = 2.0^{+0.7}_{-0.4}$, as can be seen in the inset. Bottom: SED analysis of Source #2 in MACS J1621.4+3810, shown in the postage stamp on the left. The photometry is measured in ACS/F606W, ACS/F814W, WFC3IR/F110W, and WFC3IR/F140W. The estimated redshift measurement is set at $z_{\text{phot}} = 1.5^{+0.3}_{-0.2}$.

photometric redshifts of other sources. Photometric redshifts were estimated using *Prospector* (see Section 3.4.8), to fit the photometry of Image #10.1, $F606W = 27.36 \pm 0.44$ (consistent with no detection), $F150W2 = 22.65 \pm 0.02$, and $F322W2 = 21.08 \pm 0.01$. Figure 4 shows the fit results. The redshift posterior distribution of Source #1 is consistent with $z_{\text{phot}} = 2.0^{+0.7}_{-0.4}$. Sources #2 and #3 have broader posterior distributions, favoring redshifts $2 \lesssim z \lesssim 4$. We produce two models, one assuming that Source #1 is at $z = 2.0$ and one assuming $z = 2.5$. Both models produce satisfactory results in terms of reproducing the lensing observables and low rms. However, the model that assumes $z_{\text{src1}} = 2.0$ predicts redshifts for Sources #2 and #3 that are inconsistent with the photo- z estimates. We therefore adopt the $z_{\text{src1}} = 2.5$ model moving forward, and we report the model parameters and lensing outputs from this model in Table 7.

The SLICE JWST and single-band HST imaging allow us to identify and map substructures in more than half of the sources, multiplexing the number of lens model constraints. As shown in Figure 3, the overall shape of the projected mass distribution is elongated in the northwest/southeast direction. Our final best-fit mass model has an rms of $0''.21$. Source #4 has an optimized redshift of $5.32^{+0.08}_{-0.41}$ for Clump 1 and $5.51^{+0.00}_{-0.86}$ for Clump 2. The rest of the optimized redshifts for the sources in this cluster are below $z \sim 4$.

3.4.14. Candidate Transient in SPT-CL J0516–5755

The most prominent lensed source galaxy in this field is Source #1, lensed into a set of three full images of a red dusty

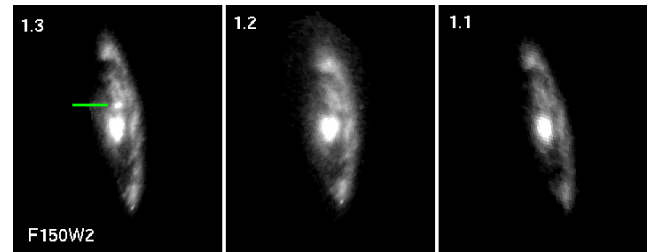


Figure 5. Source projection of the three multiple images of Source #1 in SPT0516, produced by ray tracing the NIRCcam/F150W2 image through the best-fit lens model. The green line in the left panel points to the candidate transient, which appears in Image #1.3 of the source and is missing from the two counterimages. The host galaxy is assumed to be at $z_{\text{phot}} = 2.5$. Spectroscopic confirmation is pending. The host galaxy is not visible in the ACS/F606W band, likely due to obscuration by dust. The model predicts that if it is indeed a transient, it will reappear in Image #1.2 ~ 530 days after its first appearance in Image #1.3.

galaxy appearing south of the BCG and a fourth partial image clearly seen in the light of a cluster-member galaxy $1''.8$ northeast of the BCG. We show the reconstructed source projection of the three images in Figure 5. Interestingly, in Image #1.3, we identify a point-like emission clump that does not appear in any of the other images. Owing to the low distortion, good resolution, and clear symmetry between the three full images, the identification is unambiguous. The candidate could possibly be a lensed supernova (SN) at $z \sim 2$, adopting the photometric redshift of its host galaxy. The lens model predicts the time delay between the multiple images of the lensed source. If this is indeed a transient and not a

foreground interloper, the model predicts that this is the second image to appear; the first one occurred in Image #1.1 (the western image), ~ 4000 days prior, and the next appearance will be in Image #1.2, in 560 days. The model is limited by the lack of spectroscopic redshifts; however, estimating the time delays with a model that anchors this source at $z = 2$ instead of $z = 2.5$ yields similar results, predicting that the first image occurred ~ 4300 days before the second (current) one and that the third image will appear 530 days after the second image. We therefore predict that a counterimage of the candidate transient event will be visible in Image #1.2 of the galaxy in the next 2 yr.

3.4.15. SPT-CL J2011–5228

SPT-CL J2011–5228 (SPT2011), located at $z = 1.064$, is optimized with a total of 3 lensed source galaxies (12 multiple images and 96 lensing constraints), where 1 source galaxy has a spectroscopic redshift and the remaining 2 sources are optimized within the model. A total of 112 cluster-member galaxies are fitted with a scaling relation based on a reference luminosity L^* for the BCG of the cluster (F125W = 20.63). The model uses five potentials to describe the mass of the cluster. The final model has an rms of $0''.33$, and the masses enclosed within 200 kpc and 500 kpc are $\sim 2.51 \times 10^{14} M_\odot$ and $\sim 7.73 \times 10^{14} M_\odot$, respectively. We provide a detailed description of the cluster modeling in the following paragraphs.

The SLICE JWST imaging for this cluster reveals an impressive amount of substructure in the main lensed source galaxy. These clumps appear across five main multiple images, including a radial arc. The resolution of JWST reveals this radial arc in precise detail, showing that it is an almost exactly mirrored counterpart of the southernmost arc. JWST also demonstrates that the southwest image is actually a merging pair that is intersected by the critical curve of the model, with a multiplicity of up to three within this image alone, depending on the location of the substructure clumps in the lensed galaxy. To construct a lens model for this cluster, we use the spectroscopic redshift measurement for the main lensed source galaxy from T. E. Collett et al. (2017). We reproduce the lens model from this paper and add 25 different clumps to the model. These clumps are only clearly resolved in JWST. To reproduce the positions of each of the clumps, a total of two cluster-scale DM halos are required in the *Lenstool* model, with one halo centered on the BCG and the second one located west of the cluster, near the merging pair. This extra halo also partially accounts for the shear effect produced by several large foreground galaxies, which was previously noted in T. E. Collett et al. (2017). A third DM halo is also added near the foreground galaxy by Image #1.x.3, to account for the shearing effect of this galaxy on this image. We also optimize the second-brightest cluster-member galaxy and the galaxy near the second image of the main source (Source #1), as these galaxies are likely contributing to the mass producing the lensing effect. Source #2 is spatially associated with Source #1 but has a different multiplicity than the rest of the substructure clumps within the lensed galaxy. We assign its redshift to be the same as the spec- z for Source #1, to reproduce the observed lensing constraints. Source #3 has an optimized model redshift below $z \sim 4$.

4. Results

The clusters presented in this paper represent the first effort at cluster mass modeling from the first few months of observations from the SLICE program and were not deliberately selected to be a representative subsample. Nevertheless, they span both a wide range of redshifts (from $z \sim 0.2$ to $z \sim 1$) and masses ($M_{500} \sim 2 \times 10^{14} M_\odot$ to $M_{500} \sim 12 \times 10^{14} M_\odot$), covering nearly the entire range of the parent sample. The lensing properties of the subsample are thus worth considering in aggregate. In this section, we discuss several of the key results from the SL models, including the projected surface mass density measurements, the alignment of the mass peaks with the Chandra X-ray observations, the identification of new constraints facilitated by inspection of the JWST images, and an estimate of the lensing strength of each cluster.

4.1. Mass

We compute the projected masses within 200 kpc and 500 kpc for each SL cluster, which we report in Table 6. We use the masses enclosed within these distances as our primary metrics, since it is difficult to use SL models to approximate quantities like M_{500} without drawing potentially nonphysical assumptions about the shape of the overall cluster mass distribution. SL only constrains the central cluster mass. This limitation can be seen in the projected mass surface density plots shown in Figure 3, where we plot contours of the mass within a uniform box that extends beyond 500 kpc for all clusters. Although we plot these contours across a large region, to show the general mass distribution of the cluster, the SL constraints of each cluster are limited to a region that is spatially smaller than 500 kpc from the BCG. This limitation means that the estimation of the cluster mass at larger radii carries a high level of uncertainty that we cannot restrict without the introduction of other modeling techniques (i.e., weak lensing). We thus restrict our mass measurements to 200 and 500 kpc (see Table 6 for the mass estimates) and leave any inspection of larger radii to future work. We additionally overplot the density contours from the Chandra X-ray observations listed in Table 3. These data are available for 8 of the 14 clusters. In most cases, the center of the X-ray peak aligns well with the center of the mass peak of the cluster, except for PSZ1G091, which displays a noticeable misalignment that is discussed in Section 3.4.11. We show these data together to emphasize the potential of the SLICE program to make use of multiwavelength observations when studying the physical and dynamical properties of the observed clusters.

4.2. New Constraints

The new JWST imaging facilitates the discovery of new SL features that could be used to constrain the lens models. These come in three flavors: (1) complete new systems of lensed source galaxies that were not previously identified; (2) the discovery of new counterimages of known lensed galaxies or the confirmation of suspected candidates; and (3) the identification and mapping of previously unresolved features and substructures within arcs, including space-resolution positioning of images previously only detected in MUSE data with no HST counterpart. The number of newly discovered features varies from field to field. While the JWST observations are uniform across the sample, the available archival data

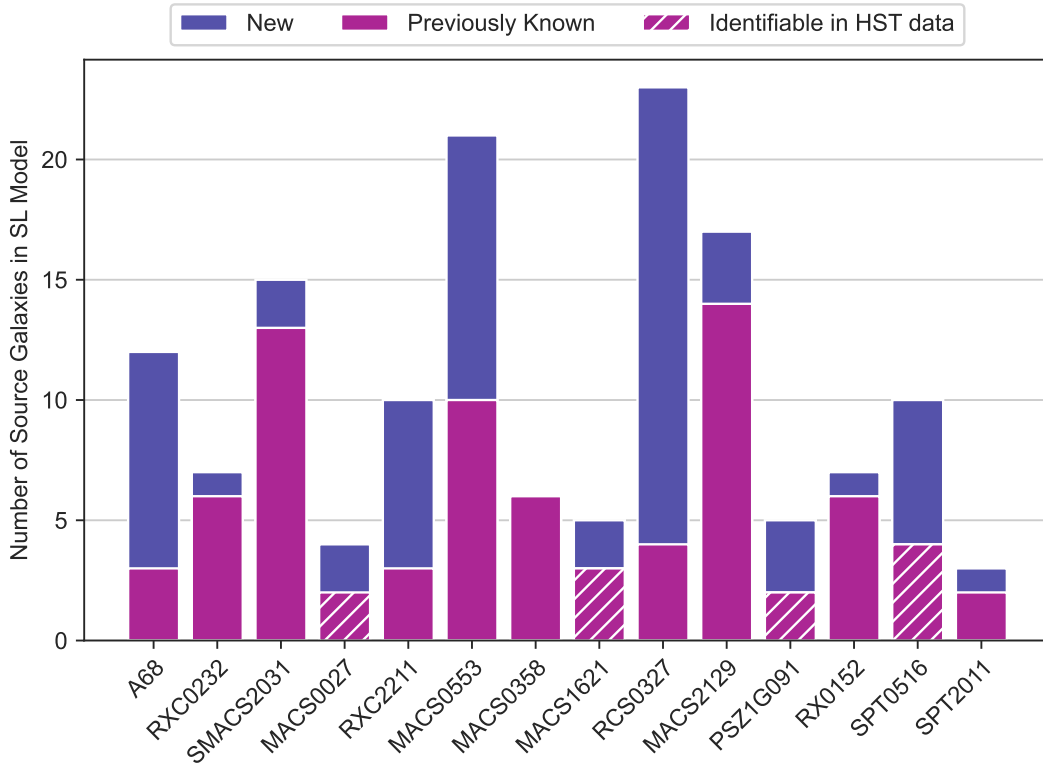


Figure 6. The number of sources used to construct the SL models in this paper is broken down to demonstrate the effect of JWST imaging on the identification and use of constraints in the modeling process; this number does not include candidate sources. The total number of sources in the paper is given by the size of the whole bar for each cluster. The bar is then subdivided into the magenta section, which represents lensed source galaxies that were previously identified in other publications for these clusters, and the purple section, which represents the number of new lensed source galaxies identified in the SLICE JWST images. Four clusters in this paper do not have published or public SL models available: MACS0027, MACS1621, PSZ1G091, and SPT0516. For these clusters, two of the authors independently inspected the available HST imaging to identify strongly lensed galaxies without the use of JWST. The numbers of sources identifiable in the HST data are shown in the hashed magenta section of each bar.

and literature range from as little as one frame of HST imaging (e.g., SPT-CL J0516–5755) and no previous lensing analysis through multiwavelength HST imaging and MUSE spectroscopy (e.g., clusters observed by treasury programs) and published lensing analysis for clusters that have previously been well studied. Newly discovered lensed source galaxies have images that are typically either too red or too faint, or both, to have been discovered without JWST (e.g., Source #1 in SPT0516). The identification of new clumps benefits from the high spatial resolution of NIRCcam. Adding clumps as constraints multiplies the number of constraints and adds leverage over the lensing potential, as it probes the relative spatial magnification in resolved arcs. An example of the plethora of clumps in some of the most highly extended arcs is shown in Figure 2. Table 8 lists the total number of sources, multiple images, and positional constraints (i.e., the sum of the multiple images of all the individual clumps) that were used for modeling each cluster. Figure 6 provides a visualization of the number of new and previously known lensed source galaxies. Where available, we determined the number of pre-JWST SL features from the literature or publicly available lens models on MAST. For clusters that do not have a public or published lens model, we assessed the pre-JWST identification through a visual inspection of the archival data by two of the authors, at least one of whom was not involved in computing the JWST-based model. We note that the numbers presented in Table 8 and Figure 6 only represent the features that were used to constrain the lens models. In many of our fields, there are additional candidate sources and images that were observed

but not used as constraints (see Section 3.4 for a cluster-by-cluster account).

New lensed source galaxies were discovered in most cluster fields. In some, the number of sources used to constrain the lens models has more than doubled (notably, RCS 0327, MACS0553, A68, and RXC2211). In addition, SPT2011, PSZ1G091, and RCS 0327 include dozens of constraints from clumps in giant arcs (see Table 5). While the clusters presented in this work are not a representative sample, they span the range of SLICE targets in both redshift and mass. These number counts highlight the added value of JWST imaging and validate our observing strategy for facilitating lensing analyses of the observed clusters. We expect that both the accuracy and precision of the lensing outputs would improve with increased numbers of lensing constraints (T. L. Johnson & K. Sharon 2016). In future work, we will conduct a thorough investigation of and comparison to expectations from simulations, by enforcing a systematic identification of arc candidates and a uniform use of the available clumps in lens models.

4.3. Lensing Strength

One of the most important applications of SL models is their use in studying the background Universe. This can be accomplished by computing the magnification of lensed sources out of the lens models. In the era of JWST, this is a particularly relevant quantity to be used to discover and characterize high-redshift galaxies. We examine this quantity

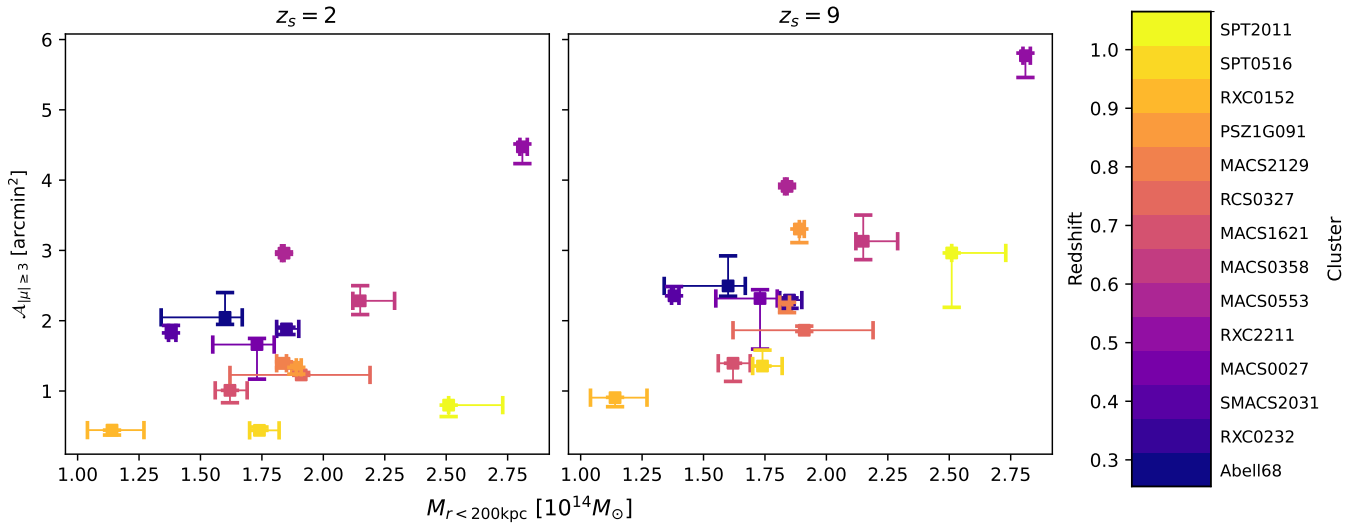


Figure 7. The lensing strength of each cluster—defined as the area in arcmin² at which a source has an absolute magnification greater than 3—is shown for a source at $z = 2$ in the left-hand plot and at $z = 9$ in the right-hand plot. It is plotted relative to the projected surface mass enclosed within 200 kpc. Each point is color-coded, to correspond to a specific cluster, where the names are given on the right-hand side of the color bar. The left-hand side of the color bar shows the approximate redshift of the clusters, where the range of redshifts within the color bar fully covers the upper and lower limits of the redshifts for the clusters.

for the 14 clusters in this paper following the method used by C. Fox et al. (2022), where we define the “lensing strength” $\mathcal{A}_{|\mu| \geq 3}$ of a cluster based on the size of the area in the image plane where a source at a redshift z_s is magnified by a factor $\mu \geq 3$. This threshold is chosen as a useful break point that describes a source that has been magnified enough for identification and study while still remaining spatially close to the SL constraints at the center of the cluster. Indeed, lower magnification factors farther away from the cluster may not be as reliable in SL models. Additionally, a source magnified by this factor can be included in studies of the high- z luminosity function (see, e.g., B. Salmon et al. 2018; H. Atek et al. 2023) but remain within an acceptable range of the SL area to have a reliable magnification measurement (see, e.g., the magnification map uncertainties in C. Cerny et al. 2018). We choose to measure the lensing strength for a source at $z_s = 2$, a common redshift for lensed galaxies used as constraints in SL models, and at $z_s = 9$, a common target redshift for high- z galaxy searches. This also eases comparison among clusters, as it minimizes the impact of the distance between the lens and the observer.

We compute the lensing strength of every cluster and plot this quantity relative to the mass enclosed within 200 kpc, as shown in Figure 7. Generally, all clusters see an increase in the lensing strength for a source at $z_s = 9$ relative to a source at $z_s = 2$. This is to be expected. PSZ1G091 is the most extreme example of this behavior, but we note that this jump in lensing area arises due to the addition of the cluster’s eastern mass clump at high redshift. The presence of this clump more than doubles the amplification area, as shown in the figure. However, this measurement is derived from a model without spectroscopic redshifts and should thus be treated as preliminary, until the lens model can be more precisely constrained. The sharp increase does seem to point to a potential trend, in that clusters at lower redshifts see only a minimal increase in lensing strength, while clusters at high redshifts experience a larger shift, potentially because a cluster at $z \gtrsim 0.9$ is more limited in its potential to magnify sources at $z \sim 2$. This trend can also be seen in the lensing strength histogram reported in Figure 8. This demonstrates that most of

the cluster lensing strength for amplifying sources at $z_s = 9$ is more evenly distributed, in comparison with the more concentrated area that amplifies a source at $z_s = 2$.

4.4. High-redshift Detections with SLICE

The detection of high-redshift overdensities in the backgrounds of galaxy clusters is of particular interest in clusters with SL, since background galaxies can appear brighter and bigger thanks to lensing effects. However, these apparent overdensities can simply be multiple images of a strong-lensed galaxy rather than a true overdensity. Since high-redshift overdensities can potentially be an indication of protoclusters of galaxies, careful lens modeling and spectroscopic identifications are necessary to distinguish lensed images from candidate protoclusters (W. Zheng et al. 2014; K. I. Caputi et al. 2021; N. Laporte et al. 2022; T. Morishita et al. 2023; G. Noirot et al. 2023).

In the field of MACS J0027.8+2616, a galaxy at redshift 4.45 was identified more than five times in the MUSE data cube. Of these detections, four are visible in the JWST imaging, but their geometric configuration does not resemble a lensed source. Our mass model of MACS0027 predicts that three of these detections are multiple images (shown as Source #30 in the model), while the other candidates do not show any signs of multiplicity. The available information does not allow us to conclusively determine if these are multiple images of the same galaxy or a potential protocluster candidate, but the detection of this high-redshift overdensity is compelling grounds for future follow-up observations. Several other clusters presented in this paper show similar overdensities of relatively high-redshift galaxies, demonstrating that the large area covered by the SLICE program is well suited to the identification of potential protocluster candidates. However, protocluster confirmation relies heavily on complementary observations (e.g., the targeted spectroscopic follow-up of specific sources or additional multiband imaging). We thus leave the broader discussion of protocluster discoveries from the SLICE sample to future work.

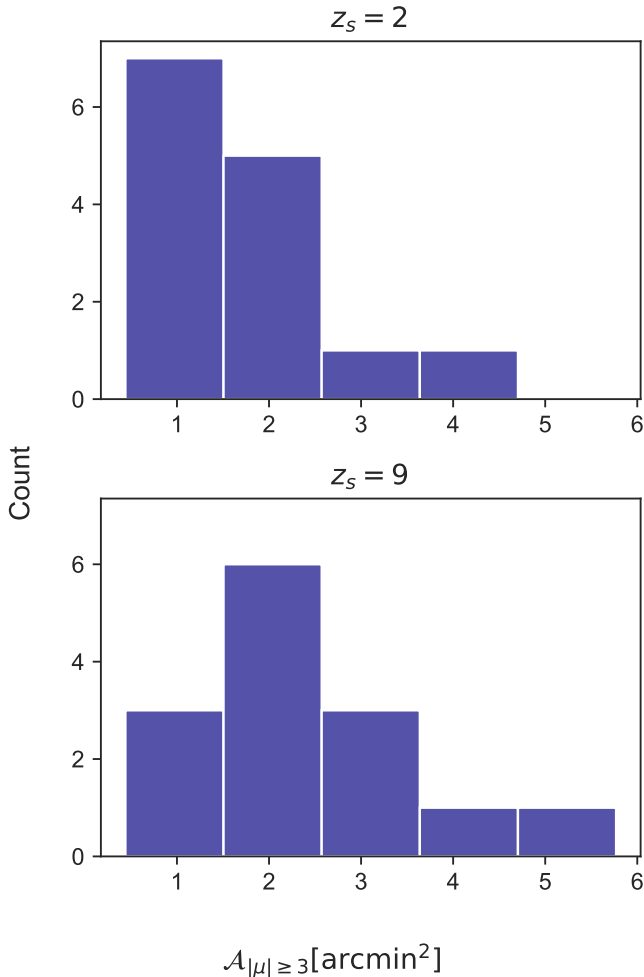


Figure 8. A histogram of the lensing strength for a source at $z = 2$ (top panel) and a source at $z = 9$ (bottom panel) for all clusters studied in the paper, divided into six equally spaced bins. The lensing strength increases for a source at $z_s = 9$ relative to a source at $z_s = 2$, and the distribution of the lensing strength at a higher redshift is also more uniform than for a source at $z_s = 2$.

At intermediate redshifts, beyond the cluster lenses, typically during the so-called cosmic noon ($z \sim 1-3$), SLICE provides exquisite spatially resolved imaging at parsec and dozens-of-parsec scales of magnified clumpy galaxies. Notably, the high sensitivity of NIRCcam reveals dusty arcs that are too faint to be detected in the HST WFC3/IR channel (e.g., in SPT0516) and that benefit from ongoing spectroscopy follow-up. SL provides the only way to access the internal physical scales that are important for characterizing the individual star-forming regions at these redshifts (typical clump sizes of $10-10^2$ pc and stellar masses of $\sim 10^5-10^9 M_\odot$; see A. Claeysens et al. 2023; J. R. Rigby et al. 2023). Despite significant advancements with JWST, the formation mechanisms and contributions of stellar clumps to galaxy mass buildup remain debated (e.g., L. Mowla et al. 2022; N. Lahén et al. 2024; A. Claeysens et al. 2025; J. Pfeffer et al. 2025). Current and upcoming mass modeling efforts will produce the necessary underlying lens models to support the investigation of spatially resolved properties of high-redshift galaxies.

Additionally, the imaging from the SLICE program has identified a promising lensed SN candidate in SPT0516, located in a dusty galaxy that is too faint to be observed in ACS/F606W but is revealed in NIRCcam/F150W and F322W.

Further investigation is needed to confirm the nature of this object, which could be a new target of choice for time-delay cosmography for precise measurements of H_0 , independent of distance ladder (e.g., P. L. Kelly et al. 2023; M. Pascale et al. 2025). Notably, only four lensed SNe have been confirmed to date, compared to about 300 lensed quasars (see, e.g., S. Birrer et al. 2024 for a review).

5. Discussion and Conclusions

The SLICE JWST program is designed to observe the coevolution of luminous matter and DM in galaxy clusters across cosmic time, spanning a period of 8 Gyr ($0.2 < z < 1.9$), for structures more massive than $M_{500} > 2 \times 10^{14} M_\odot$. This work features a randomly sampled selection of 14 SL clusters from this program that span a representative range of both redshift and mass, and presents the first results for the properties of these clusters from the collaboration’s SL modeling efforts. In nearly every cluster, the use of JWST imaging adds to the number of lensed sources used to build the SL model (see Figure 6). This increase can be as low as one additional lensed galaxy and as large as 15 additional lensed galaxies. It appears to be uncorrelated to cluster redshift or mass. JWST imaging is particularly useful for revealing red dusty galaxies, as well as very faint systems of multiple images, both of which are essentially invisible in HST imaging (P. G. Pérez-González et al. 2023). Of the 16 models presented in this paper for the 14 clusters studied, 4 describe clusters that have not been previously published in the literature: MACS0027, MACS1621, PSZ1G09, and SPT0516. The constraints used to create these models depend on JWST imaging to confirm counterimages of lensed galaxies that appear very faint in HST as well as to identify red and dusty galaxies that only appear with JWST.

The process used to construct the lens models presented in this paper was undertaken by multiple lens modelers, who were each asked to achieve the smallest possible rms value using any visible SL constraints in the field, as well as a satisfactory level of uncertainty, given the availability of constraints (e.g., spectroscopic redshifts). The main objective was to create a basic SL model for each cluster that could reproduce the observed JWST multiple-image constraints and constrain the clusters’ total mass distribution. The amount of lensed substructures used as constraints, the availability of the spectroscopic redshifts, and the reliability of the photometric redshifts varies from cluster to cluster. These models should thus be treated as preliminary results from the SLICE program and may be updated in future work. We provide candidate lensed source galaxies and substructure clumps for several of the clusters studied in this paper in Table 8. These candidates are not used in this paper, because they have a marginal effect on the derivation of the global mass and magnification results we discuss in Section 4; however, studies of questions like the magnification and source-plane reconstruction of lensed galaxies, substructure statistics, and the DM distributions of these clusters may benefit from their use. We thus include them here as a reference for future work.

In general, the use of SLICE JWST images improves the ability of the SL models to reproduce the observed constraints, as seen in the lower rms values reported for all models in this paper compared to previous literature. Although the difference in rms is sometimes quite small (0.01 for MACS J2129.4–0741, for instance), the inclusion of new lensed sources in

the model (three new sources in the aforementioned cluster) places tighter constraints on the global mass distribution and can thus be treated as an overall improvement. In the four clusters studied in this paper for which no lens models had previously been published, the specific contribution of JWST is to provide identifications of lensed source galaxies that are crucial to creating the SL model. For example, the inspection of archival imaging for these clusters yielded identifications for less than half the sources used in the final lens model presented in this paper, with the exception of MACS1621. Each of these clusters contains a red dusty galaxy that was used as a constraint in the model and that is crucial to resolving the shape of the overall mass distribution of the cluster.

Additionally, the ability of JWST to resolve complex morphology within the multiple images aids in the construction of the lens models. For instance, inspection of the HST imaging for SPT2011 seems to indicate that a single lensed image is produced in the southeast (Image #1.x.2 in Figure 1). However, examination of the SLICE JWST imaging reveals that this image is actually a merging pair, with a multiplicity of up to 3 spread across the intersecting critical curve, depending on the location of the substructure clumps in the lensed galaxy. The JWST imaging is also well suited to resolving images of radial arcs that may appear within a cluster’s lensing configuration. Radial arcs are a relatively uncommon SL feature that lie at or near the center of a cluster’s mass potential. That means they are often obscured by the light of the surrounding cluster-member galaxies and the BCG (M. Bartelmann 2010), making their identification reliant on spectroscopic follow-up. However, inspection of the “No. of Radial Arcs” column of Table 5 shows clearly that the wavelength range covered by the SLICE JWST imaging is able either to directly identify radial arcs through visual inspection or to lend compelling evidence to the presence of a radial arc—i.e., by revealing continuum emission separate from the BCG and cluster-member galaxies at the location of a predicted multiple image.

Beyond the cluster lenses, the SLICE program provides exquisite spatially resolved imaging of the clumpy interstellar medium (ISM) of high-redshift lensed galaxies. This is complemented by ongoing spectroscopic follow-up, as in the case of SPT0516, which will be observed on the Magellan telescope in 2025A (U. of Michigan allocation, PI: Sharon). Combined with other facilities in the submillimeter and mid-infrared—e.g., ALMA and MIRI (J. R. Rigby et al. 2025; H. Umehata et al. 2026)—SLICE has the potential to bring new constraints on the physical properties governing the star formation activity in high-redshift giant molecular clouds during cosmic noon and beyond, a key epoch for galaxy evolution (P. Madau & M. Dickinson 2014; J. R. Weaver et al. 2023; G. D. Lucia et al. 2025).

This paper presents early results from the first clusters observed in the SLICE JWST program. At the time of this paper’s release, the SLICE sample covers a total of 124 galaxy clusters, spread across a broad range of redshifts and masses. This wealth of data is designed to probe the coevolution of luminous matter and DM across cosmic time, by studying a variety of cluster properties, from DM and ISM distributions to globular cluster populations, protocluster discoveries, and studies of the background Universe. This paper thus marks the first step toward the future science that will be accomplished using the full SLICE JWST sample, including providing constraints on cluster mass distributions and identifying new lensed galaxies. Since observations are still ongoing, a complete

breakdown of the SLICE program—including a presentation of the whole observed cluster sample, together with statistical analyses of various cluster properties, such as lensed galaxy substructure counts—will be presented in the forthcoming survey paper (G. Mahler et al. 2026, in preparation). This paper will be released once observations have concluded.

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Facilities: JWST (NIRCam), HST (ACS, WFC3), VLT: Yepun (MUSE spectrograph).

Software: astropy (Astropy Collaboration et al. 2013), Source Extractor (E. Bertin & S. Arnouts 1996), Lenstool (E. Jullo et al. 2007), SAOImageDS9, Astrodrizzle, CIAO, Matlab, IDL, IRAF.

Appendix Appendix Information

Tables for the lens model parameters are provided in this appendix. Table 7 gives the best-fit and median lens model parameters, and Table 8 gives the coordinates and redshifts for all multiple images used in this work.

Table 7
Lens Model Best-fit and Median Parameters

Model Statistics	Object	Value	$\Delta\alpha$ (arcsec)	$\Delta\delta$ (arcsec)	ϵ	θ (deg)	r_{core} (arcsec)	r_{cut} (arcsec)	σ (km s ⁻¹)
Cluster	A68	DM H1	best	$0.46^{+1.57}_{-0.77}$	$-2.00^{+0.91}_{-0.81}$	$0.37^{+0.34}_{-0.00}$	$31.4^{+1.3}_{-1.1}$	$20.3^{+0.3}_{-4.0}$	961^{+5}_{-136}
R.A. (deg)	9.278516		med.	$0.74^{+1.29}_{-1.05}$	$-1.98^{+0.90}_{-0.82}$	$0.54^{+0.17}_{-0.13}$	$31.5^{+1.2}_{-1.2}$	$19.2^{+1.4}_{-2.9}$	883^{+84}_{-57}
Decl. (deg)	9.156716	BCG H2	best	[0.00]	[0.00]	$0.33^{+0.31}_{-0.00}$	$52.4^{+28.3}_{-0.6}$	$2.5^{+0.0}_{-1.5}$	340^{+18}_{-58}
χ^2_ν	1.34		med.	[0.00]	[0.00]	$0.52^{+0.13}_{-0.15}$	$66.2^{+14.6}_{-14.4}$	$1.6^{+0.5}_{-0.6}$	312^{+45}_{-31}
ν, N_{Free}	24, 32	DM H3	best	$-41.82^{+0.61}_{-1.03}$	$64.04^{+2.32}_{-0.09}$	$0.14^{+0.00}_{-0.13}$	$150.1^{+0.0}_{-72.0}$	$17.0^{+3.7}_{-1.9}$	52^{+68}_{-0}
sigpos	0''69		med.	$-42.14^{+0.93}_{-0.71}$	$65.20^{+1.16}_{-1.25}$	$0.03^{+0.07}_{-0.02}$	$116.6^{+27.1}_{-38.5}$	$17.3^{+3.4}_{-2.1}$	93^{+26}_{-23}
		Gal. H4	best	[27.37]	[22.09]	$0.42^{+0.01}_{-0.27}$	$23.6^{+27.9}_{-9.1}$	$13.0^{+7.6}_{-3.2}$	101^{+5}_{-19}
			med.	[27.37]	[22.09]	$0.30^{+0.12}_{-0.15}$	$30.3^{+21.2}_{-15.7}$	$15.5^{+5.0}_{-5.7}$	94^{+13}_{-11}
		L_* Gal.	best	...	...	...	...	[0.03]	11^{+1}_{-2}
			med.	...	...	...	...	[0.03]	10^{+2}_{-1}
Cluster	RXC0232	DM H1	best	$-0.19^{+0.78}_{-0.00}$	$-1.48^{+0.23}_{-0.29}$	$0.29^{+0.05}_{-0.00}$	$131.7^{+0.9}_{-3.0}$	$10.3^{+0.0}_{-2.0}$	815^{+6}_{-44}
R.A. (deg)	38.077317		med.	$0.21^{+0.39}_{-0.32}$	$-1.52^{+0.02}_{-0.25}$	$0.32^{+0.02}_{-0.03}$	$130.9^{+1.0}_{-2.1}$	$9.3^{+1.0}_{-1.0}$	793^{+29}_{-22}
Decl. (deg)	-44.346666	BCG _A H2	best	[0.00]	[0.00]	[0.11]	[-42.0]	[0.2]	339^{+3}_{-21}
χ^2_ν	2.55		med.	[0.00]	[0.00]	[0.11]	[-42.0]	[0.2]	332^{+10}_{-14}
ν, N_{Free}	12, 26	DM H3	best	$-21.56^{+0.39}_{-0.83}$	$-2.44^{+0.35}_{-0.01}$	$0.83^{+0.03}_{-0.08}$	$160.8^{+1.1}_{-0.9}$	$20.1^{+0.0}_{-5.5}$	600^{+3}_{-31}
sigpos	0''80		med.	$-21.62^{+0.45}_{-0.77}$	$-2.32^{+0.24}_{-0.13}$	$0.81^{+0.05}_{-0.06}$	$160.9^{+1.0}_{-1.0}$	$16.8^{+2.9}_{-2.2}$	588^{+15}_{-19}
		BCG _B H4	best	[23.89]	[0.07]	[0.28]	[22.4]	[0.1]	28^{+24}_{-5}
			med.	[23.89]	[0.07]	[0.28]	[22.4]	[0.1]	39^{+13}_{-17}
		DM H5	best	[-63.84]	[20.24]	$0.50^{+0.00}_{-0.34}$	$173.5^{+0.0}_{-162.8}$	[0.02]	10^{+31}_{-26}
			med.	[-63.84]	[20.24]	$0.33^{+0.13}_{-0.17}$	$152.7^{+19.5}_{-142.0}$	[0.02]	28^{+13}_{-16}
		L_* Gal.	best	...	...	...	...	[0.03]	29^{+5}_{-2}
			med.	...	...	...	...	[0.03]	30^{+3}_{-4}
Cluster	SMACS2031	DM H1	best	$-0.57^{+0.01}_{-0.12}$	$-0.46^{+0.07}_{-0.10}$	$0.27^{+0.03}_{-0.00}$	$4.6^{+2.2}_{-0.2}$	$6.7^{+0.1}_{-0.3}$	637^{+13}_{-12}
R.A. (deg)	307.971920		med.	$-0.63^{+0.06}_{-0.06}$	$-0.48^{+0.09}_{-0.08}$	$0.28^{+0.02}_{-0.01}$	$5.6^{+1.2}_{-1.2}$	$6.6^{+0.2}_{-0.2}$	637^{+13}_{-12}
Decl. (deg)	-40.625216	DM H2	best	$-61.40^{+0.00}_{-0.79}$	$24.19^{+0.53}_{-0.09}$	$0.56^{+0.03}_{-0.05}$	$7.7^{+0.9}_{-3.7}$	$22.2^{+2.2}_{-0.8}$	983^{+30}_{-2}
χ^2_ν	3.32		med.	$-61.82^{+0.42}_{-0.37}$	$24.40^{+0.32}_{-0.29}$	$0.55^{+0.04}_{-0.04}$	$6.5^{+2.1}_{-2.4}$	$22.9^{+1.4}_{-1.5}$	997^{+16}_{-17}
ν, N_{Free}	80, 18	Gal. H3	best	[0.07]	[-0.05]	[0.09]	[-0.4]	[0.1]	29^{+1}_{-13}
sigpos	0''44		med.	[0.07]	[-0.05]	[0.09]	[-0.4]	[0.1]	24^{+5}_{-9}
		L_* Gal.	best	...	...	...	...	[0.03]	5^{+6}_{-0}
			med.	...	...	...	...	[0.03]	6^{+5}_{-1}
Cluster	MACS0027	DM H1	best	$-3.83^{+0.33}_{-0.59}$	$-2.72^{+0.07}_{-0.41}$	$0.12^{+0.03}_{-0.01}$	$1.5^{+0.3}_{-0.8}$	$24.2^{+1.6}_{-2.7}$	1199^{+33}_{-76}
R.A. (deg)	6.9407970		med.	$-3.93^{+0.43}_{-0.49}$	$-2.85^{+0.20}_{-0.28}$	$0.13^{+0.02}_{-0.02}$	$1.2^{+0.5}_{-0.5}$	$23.7^{+2.1}_{-2.2}$	1181^{+51}_{-58}
Decl. (deg)	26.2740340	L_* Gal.	best	...	...	...	...	[0.03]	3^{+4}_{-1}
χ^2_ν	2.03		med.	...	...	...	...	[0.03]	3^{+3}_{-1}
ν, N_{Free}	33, 11	...	...	...	...	...	...	...	...
sigpos	0''56	...	...	...	...	...	...	...	...
Cluster	RXC2211	DM H1	best	$-1.51^{+0.00}_{-0.19}$	$-2.35^{+0.10}_{-0.27}$	$0.66^{+0.01}_{-0.01}$	$101.5^{+0.3}_{-0.0}$	$22.2^{+1.3}_{-1.6}$	1438^{+10}_{-14}
R.A. (deg)	332.941368		med.	$-1.62^{+0.09}_{-0.08}$	$-2.42^{+0.18}_{-0.19}$	$0.66^{+0.01}_{-0.01}$	$101.6^{+0.1}_{-0.2}$	$22.1^{+1.3}_{-1.5}$	1437^{+11}_{-13}
Decl. (deg)	-3.828952	DM H2	best	$4.60^{+0.74}_{-0.24}$	$-2.22^{+0.00}_{-0.31}$	$0.52^{+0.09}_{-0.07}$	$20.8^{+2.3}_{-0.4}$	$3.7^{+1.0}_{-1.4}$	184^{+0}_{-49}
χ^2_ν	5.20		med.	$4.84^{+0.49}_{-0.48}$	$-2.36^{+0.15}_{-0.16}$	$0.53^{+0.09}_{-0.07}$	$21.7^{+1.4}_{-1.3}$	$3.7^{+1.0}_{-1.4}$	629^{+48}_{-46}
ν, N_{Free}	31, 33	Gal. H3	best	[32.76]	[20.19]	[0.53]	[145.6]	$1.8^{+0.0}_{-1.2}$	7^{+2}_{-2}
sigpos	1''42		med.	[32.76]	[20.19]	[0.53]	[145.6]	$1.2^{+0.5}_{-0.7}$	6^{+3}_{-1}
		Gal. H4	best	[33.09]	[-28.09]	[0.23]	[30.2]	[0.08]	11^{+6}_{-4}
			med.	[33.09]	[-28.09]	[0.23]	[30.2]	[0.08]	13^{+4}_{-5}
		Gal. H5	best	[42.57]	[10.53]	[0.18]	[56.3]	[0.03]	7^{+10}_{-2}
			med.	[42.57]	[10.53]	[0.18]	[56.3]	[0.03]	11^{+6}_{-5}
		L_* Gal.	best	...	...	...	...	[0.03]	11^{+0}_{-9}
			med.	...	...	...	...	[0.03]	5^{+5}_{-3}
Cluster	MACS0553	DM H1	best	$7.21^{+0.01}_{-0.32}$	$-2.08^{+0.02}_{-0.06}$	$0.62^{+0.01}_{-0.00}$	$4.3^{+0.1}_{-0.1}$	$15.7^{+0.0}_{-0.2}$	1095^{+3}_{-3}
R.A. (deg)	88.357356		med.	$7.05^{+0.16}_{-0.16}$	$-2.10^{+0.04}_{-0.04}$	$0.62^{+0.01}_{-0.01}$	$4.3^{+0.1}_{-0.1}$	$15.7^{+0.1}_{-0.1}$	1094^{+3}_{-3}
Decl. (deg)	-33.707789	DM H2	best	$-83.44^{+0.12}_{-0.32}$	$-1.23^{+0.08}_{-0.07}$	$0.26^{+0.00}_{-0.01}$	$20.3^{+0.7}_{-0.4}$	$18.9^{+0.5}_{-0.2}$	950^{+8}_{-2}
χ^2_ν	14.08		med.	$-83.52^{+0.20}_{-0.24}$	$-1.22^{+0.07}_{-0.07}$	$0.25^{+0.01}_{-0.01}$	$20.5^{+0.4}_{-0.7}$	$19.0^{+0.4}_{-0.3}$	953^{+5}_{-5}
ν, N_{Free}	80, 46	L_* Gal.	best	...	...	...	...	[0.03]	6^{+0}_{-0}
sigpos	0''85		med.	...	...	...	...	[0.03]	5^{+0}_{-0}

Table 7
(Continued)

Model Statistics		Object	Value	$\Delta\alpha$ (arcsec)	$\Delta\delta$ (arcsec)	ϵ	θ (deg)	r_{core} (arcsec)	r_{cut} (arcsec)	σ (km s ⁻¹)
Cluster	MACS0358	DM H1	best	$-9.21^{+4.67}_{-0.97}$	$-15.27^{+7.51}_{-0.92}$	$0.31^{+0.18}_{-0.13}$	$127.4^{+0.6}_{-39.1}$	$8.6^{+13.2}_{-0.0}$	[261]	826^{+187}_{-64}
R.A. (deg)	59.719446		med.	$-7.97^{+3.43}_{-2.21}$	$-12.83^{+5.07}_{-3.37}$	$0.31^{+0.18}_{-0.13}$	$119.7^{+8.3}_{-31.5}$	$13.7^{+8.1}_{-3.8}$	[261]	858^{+154}_{-96}
Decl. (deg)	-29.930547	DM H2	best	$16.55^{+2.03}_{-1.14}$	$16.24^{+0.60}_{-1.79}$	$0.40^{+0.25}_{-0.05}$	$144.2^{+6.9}_{-5.1}$	$10.2^{+5.3}_{-1.4}$	[261]	874^{+78}_{-150}
χ^2_ν	1.90		med.	$16.92^{+1.65}_{-1.52}$	$15.85^{+0.99}_{-1.41}$	$0.48^{+0.16}_{-0.13}$	$143.2^{+7.9}_{-4.1}$	$12.3^{+3.3}_{-3.4}$	[261]	877^{+75}_{-153}
ν , N_{Free}	4, 16	L_* Gal.	best	...	...	...	...	[0.03]	[5]	131^{+62}_{-0}
sigpos	0''45		med.	...	...	...	...	[0.03]	[5]	171^{+22}_{-27}
para	MACS1621	DM H1	best	$1.05^{+0.23}_{-0.90}$	$-1.09^{+0.82}_{-0.22}$	$0.62^{+0.15}_{-0.05}$	$42.2^{+1.1}_{-0.4}$	$6.9^{+0.4}_{-2.8}$	[247]	954^{+3}_{-34}
R.A. (deg)	245.353136		med.	$0.77^{+0.23}_{-0.63}$	$-0.86^{+0.01}_{-0.45}$	$0.72^{+0.04}_{-0.05}$	$42.6^{+0.8}_{-0.7}$	$5.1^{+1.3}_{-1.1}$	[247]	939^{+17}_{-19}
Decl. (deg)	38.169125	Gal. H2	best	[0.03]	[0.00]	$0.20^{+0.23}_{-0.11}$	$50.2^{+5.2}_{-15.4}$	$1.3^{+0.2}_{-0.8}$	[19]	349^{+112}_{-171}
χ^2_ν	0.59		med.	[0.03]	[0.00]	$0.27^{+0.17}_{-0.18}$	$44.6^{+10.8}_{-9.7}$	$1.1^{+0.4}_{-0.6}$	[19]	358^{+103}_{-181}
ν , N_{Free}	10, 20	Gal. H3	best	[28.77]	[-5.68]	$0.20^{+0.65}_{-0.04}$	[47.3]	$1.7^{+0.2}_{-1.4}$	[47]	28^{+118}_{-2}
sigpos	0''47		med.	[28.77]	[-5.68]	$0.51^{+0.33}_{-0.36}$	[47.3]	$0.9^{+0.6}_{-0.6}$	[47]	79^{+66}_{-54}
		L_* Gal.	best	...	...	...	...	[0.02]	13^{+3}_{-4}	188^{+13}_{-16}
			med.	...	...	...	...	[0.02]	13^{+3}_{-4}	189^{+12}_{-17}
Cluster	RCS 0327	DM H1	best	$3.80^{+0.42}_{-0.04}$	$-4.09^{+0.01}_{-0.15}$	$0.47^{+0.00}_{-0.02}$	$14.6^{+1.1}_{-0.0}$	$11.0^{+0.8}_{-0.0}$	[224]	1031^{+9}_{-1}
R.A. (deg)	51.863234		med.	$4.00^{+0.23}_{-0.24}$	$-4.17^{+0.01}_{-0.08}$	$0.46^{+0.00}_{-0.00}$	$15.4^{+0.2}_{-0.3}$	$11.6^{+0.2}_{-0.3}$	[224]	1035^{+4}_{-4}
Decl. (deg)	-13.439644	DM H2	best	$-0.32^{+0.24}_{-0.00}$	$0.25^{+0.00}_{-0.19}$	$0.72^{+0.00}_{-0.03}$	$167.4^{+0.5}_{-0.7}$	$4.1^{+0.3}_{-0.8}$	22^{+5}_{-0}	616^{+23}_{-10}
χ^2_ν	3.90		med.	$-0.12^{+0.04}_{-0.06}$	$0.12^{+0.05}_{-0.05}$	$0.71^{+0.01}_{-0.02}$	$167.4^{+0.6}_{-0.6}$	$3.7^{+0.7}_{-0.4}$	24^{+3}_{-2}	616^{+22}_{-10}
ν , N_{Free}	183, 49	Gal. H3	best	[9.34]	[9.27]	[0.54]	[63.3]	[0.01]	[2]	61^{+23}_{-4}
sigpos	0''87		med.	[9.34]	[9.27]	[0.54]	[63.3]	[0.01]	[2]	69^{+15}_{-12}
		Gal. H4	best	$20.53^{+1.05}_{-0.00}$	$3.89^{+0.00}_{-1.05}$	$0.70^{+0.00}_{-0.01}$	$53.6^{+1.0}_{-3.2}$	$3.3^{+0.0}_{-1.0}$	147^{+39}_{-32}	245^{+0}_{-38}
			med.	$21.28^{+0.31}_{-0.45}$	$3.28^{+0.49}_{-0.43}$	$0.69^{+0.01}_{-0.01}$	$52.7^{+1.8}_{-2.3}$	$2.7^{+0.4}_{-0.4}$	144^{+43}_{-29}	219^{+13}_{-12}
		Gal. H5	best	[-0.80]	[11.24]	[0.34]	[7.7]	$0.2^{+0.3}_{-0.1}$	4^{+0}_{-2}	235^{+40}_{-0}
			med.	[-0.80]	[11.24]	[0.34]	[7.7]	$0.2^{+0.2}_{-0.1}$	3^{+0}_{-0}	256^{+18}_{-13}
		Gal. H6	best	[-10.79]	[3.95]	[0.00]	[0.0]	$3.6^{+0.0}_{-2.3}$	9^{+30}_{-0}	154^{+0}_{-50}
			med.	[-10.79]	[3.95]	[0.00]	[0.0]	$2.1^{+0.8}_{-0.8}$	30^{+9}_{-11}	125^{+26}_{-21}
		Gal. H7	best	[8.61]	[7.56]	[0.22]	[163.44]	$0.1^{+0.0}_{-0.0}$	2^{+0}_{-1}	127^{+21}_{-0}
			med.	[8.61]	[7.56]	[0.22]	[163.44]	$0.1^{+0.0}_{-0.0}$	1^{+0}_{-0}	137^{+11}_{-9}
		L_* Gal.	best	...	...	...	...	[0.02]	3^{+0}_{-0}	229^{+0}_{-16}
			med.	...	...	...	...	[0.02]	3^{+0}_{-0}	220^{+7}_{-8}
Cluster	MACS2129	DM H1	best	$0.95^{+0.63}_{-0.22}$	$0.28^{+0.00}_{-0.62}$	$0.63^{+0.03}_{-0.00}$	$170.6^{+0.1}_{-1.3}$	$15.2^{+0.4}_{-0.8}$	[146]	1111^{+15}_{-14}
R.A. (deg)	322.358780		med.	$1.17^{+0.42}_{-0.43}$	$-0.06^{+0.25}_{-0.28}$	$0.64^{+0.02}_{-0.02}$	$170.0^{+0.7}_{-0.7}$	$14.9^{+0.7}_{-0.6}$	[146]	1112^{+14}_{-15}
Decl. (deg)	-7.690996	BCG H2	best	[-0.07]	[-0.21]	[0.32]	[5.3]	[0.0]	7^{+0}_{-5}	295^{+49}_{-4}
χ^2_ν	2.99		med.	[-0.07]	[-0.21]	[0.32]	[5.3]	[0.0]	3^{+2}_{-1}	313^{+31}_{-21}
ν , N_{Free}	44, 28	Gal. H3	best	[-2.93]	[0.81]	[0.44]	[70.0]	[0.1]	1^{+8}_{-0}	212^{+27}_{-44}
sigpos	1''02		med.	[-2.93]	[0.81]	[0.44]	[70.0]	[0.1]	6^{+3}_{-4}	199^{+40}_{-31}
		Gal. H4	best	[4.53]	[-1.28]	[0.27]	[-31.6]	[0.1]	5^{+2}_{-0}	177^{+28}_{-10}
			med.	[4.53]	[-1.28]	[0.27]	[-31.6]	[0.1]	7^{+0}_{-1}	184^{+21}_{-18}
		Gal. H5	best	[14.42]	[7.24]	[0.47]	[4.6]	[0.1]	1^{+4}_{-0}	337^{+0}_{-74}
			med.	[14.42]	[7.24]	[0.47]	[4.6]	[0.1]	3^{+2}_{-1}	282^{+34}_{-20}
		DM H6	best	$-42.36^{+0.12}_{-2.29}$	$20.36^{+1.21}_{-1.02}$	$0.80^{+0.00}_{-0.30}$	$61.9^{+4.4}_{-6.0}$	$18.1^{+0.0}_{-7.8}$	[75]	565^{+6}_{-70}
			med.	$-43.11^{+0.87}_{-1.53}$	$20.56^{+1.01}_{-1.22}$	$0.65^{+0.13}_{-0.16}$	$61.3^{+5.0}_{-5.4}$	$13.4^{+4.3}_{-3.1}$	[75]	538^{+33}_{-43}
		Gal. H7	best	[5.92]	[6.84]	[0.39]	[88.5]	[0.1]	10^{+3}_{-1}	227^{+17}_{-5}
			med.	[5.92]	[6.84]	[0.39]	[88.5]	[0.1]	11^{+2}_{-2}	234^{+10}_{-12}
		L_* Gal.	best	...	...	...	...	[0.02]	11^{+1}_{-1}	253^{+0}_{-20}
			med.	...	...	...	...	[0.02]	12^{+0}_{-1}	242^{+9}_{-10}
Cluster	PSZ1G091	DM H1	best	$-6.08^{+1.06}_{-0.33}$	$14.85^{+0.01}_{-1.43}$	$0.54^{+0.02}_{-0.04}$	$95.6^{+1.7}_{-2.3}$	$24.1^{+0.6}_{-1.6}$	[192]	982^{+50}_{-7}
R.A. (deg)	277.787803		med.	$-5.76^{+0.74}_{-0.65}$	$14.42^{+0.44}_{-1.00}$	$0.53^{+0.04}_{-0.03}$	$95.3^{+2.0}_{-2.0}$	$23.6^{+1.1}_{-1.1}$	[192]	1005^{+28}_{-30}
Decl. (deg)	62.249099	BCG H2	best	[0.00]	[0.00]	$0.50^{+0.00}_{-0.04}$	$45.1^{+11.9}_{-1.9}$	$0.2^{+0.0}_{-0.0}$	8^{+0}_{-2}	248^{+16}_{-0}
χ^2_ν	2.35		med.	[0.00]	[0.00]	$0.49^{+0.01}_{-0.02}$	$51.1^{+5.9}_{-7.9}$	$0.3^{+0.0}_{-0.0}$	7^{+1}_{-1}	256^{+8}_{-7}
ν , N_{Free}	92, 32	DM H3	best	[-47.87]	[14.74]	[0.00]	[0.0]	$11.0^{+1.9}_{-1.8}$	[192]	600^{+16}_{-52}
sigpos	0''55		med.	[-47.87]	[14.74]	[0.00]	[0.0]	$10.8^{+2.1}_{-1.6}$	[192]	582^{+34}_{-34}
		DM H4	best	$0.07^{+0.79}_{-1.10}$	$-12.55^{+0.51}_{-1.26}$	$0.50^{+0.05}_{-0.01}$	$125.7^{+5.5}_{-1.5}$	$19.2^{+0.0}_{-2.3}$	[192]	894^{+0}_{-67}
			med.	$0.00^{+0.86}_{-1.04}$	$-12.99^{+0.95}_{-0.83}$	$0.52^{+0.03}_{-0.03}$	$127.5^{+3.7}_{-3.4}$	$17.8^{+1.2}_{-1.0}$	[192]	858^{+32}_{-31}

Table 7
(Continued)

Model Statistics		Object	Value	$\Delta\alpha$ (arcsec)	$\Delta\delta$ (arcsec)	ϵ	θ (deg)	r_{core} (arcsec)	r_{cut} (arcsec)	σ (km s ⁻¹)
		Gal. H5	best	[3.49]	[0.42]	$0.30^{+0.00}_{-0.02}$	$46.7^{+4.4}_{-9.8}$	$0.1^{+0.0}_{-0.0}$	1^{+0}_{-0}	147^{+21}_{-0}
			med.	[3.49]	[0.42]	$0.29^{+0.01}_{-0.02}$	$44.1^{+7.0}_{-7.2}$	$0.1^{+0.0}_{-0.0}$	1^{+0}_{-0}	159^{+9}_{-9}
		L_* Gal.	best	...	...	...	...	[0.02]	2^{+0}_{-1}	150^{+12}_{-11}
			med.	...	...	...	...	[0.02]	2^{+0}_{-0}	150^{+13}_{-10}
Cluster	RX0152	DM H1	best	$4.77^{+1.06}_{-1.99}$	$7.62^{+0.35}_{-2.08}$	$0.49^{+0.21}_{-0.06}$	$-18.9^{+11.2}_{-21.0}$	$6.6^{+4.0}_{-5.4}$	[197]	538^{+147}_{-109}
R.A. (deg)	28.182939		med.	$4.18^{+1.65}_{-1.40}$	$6.73^{+1.25}_{-1.18}$	$0.59^{+0.11}_{-0.16}$	$-26.1^{+18.3}_{-13.8}$	$3.6^{+7.0}_{-2.6}$	[197]	514^{+171}_{-49}
Decl. (deg)	-13.955495	L_* Gal.	best	...	...	...	...	[0.02]	18^{+1}_{-2}	356^{+18}_{-85}
χ^2_ν	0.59		med.	...	...	...	...	[0.02]	18^{+1}_{-2}	351^{+24}_{-37}
ν, N_{Free}	18, 16	...	...	...	...	...	...	...	...	...
sigpos	0.63	...	...	...	...	...	...	...	...	...
Cluster	SPT0516	DM H1	best	$-5.37^{+0.38}_{-0.22}$	$12.47^{+0.97}_{-0.52}$	$0.39^{+0.03}_{-0.06}$	$89.6^{+2.8}_{-2.7}$	$12.3^{+1.4}_{-0.7}$	[183]	929^{+28}_{-79}
R.A. (deg)	79.246251		med.	$-5.28^{+0.29}_{-0.31}$	$12.68^{+0.76}_{-0.73}$	$0.38^{+0.04}_{-0.05}$	$89.5^{+2.9}_{-2.6}$	$12.6^{+1.1}_{-1.0}$	[183]	908^{+49}_{-58}
Decl. (deg)	-57.918573	DM H2	best	$5.77^{+0.24}_{-0.39}$	$-8.01^{+0.65}_{-0.80}$	$0.55^{+0.09}_{-0.10}$	$109.4^{+9.0}_{-3.4}$	$5.2^{+0.7}_{-1.3}$	31^{+49}_{-0}	443^{+11}_{-60}
χ^2_ν	0.87		med.	$5.72^{+0.29}_{-0.34}$	$-8.05^{+0.70}_{-0.76}$	$0.54^{+0.11}_{-0.09}$	$110.9^{+7.5}_{-4.8}$	$4.7^{+1.2}_{-0.9}$	58^{+22}_{-18}	416^{+38}_{-33}
ν, N_{Free}	30, 38	Gal. H3	best	$0.98^{+0.26}_{-0.56}$	$0.17^{+0.18}_{-0.22}$	$0.85^{+0.00}_{-0.29}$	$42.3^{+1.5}_{-18.2}$	$0.0^{+0.1}_{-0.0}$	23^{+14}_{-0}	204^{+2}_{-43}
sigpos	0.34		med.	$0.82^{+0.43}_{-0.40}$	$0.14^{+0.20}_{-0.19}$	$0.74^{+0.11}_{-0.18}$	$36.3^{+7.5}_{-12.2}$	$0.1^{+0.0}_{-0.0}$	31^{+7}_{-6}	184^{+22}_{-23}
		L_* Gal.	best	...	...	...	...	[0.02]	9^{+1}_{-0}	54^{+3}_{-4}
			med.	...	...	...	...	[0.02]	14^{+6}_{-5}	53^{+4}_{-4}
Cluster	SPT2011	DM H1	best	$-2.94^{+1.58}_{-3.71}$	$-3.11^{+0.82}_{-4.27}$	$0.21^{+0.09}_{-0.00}$	$63.4^{+4.6}_{-3.8}$	$26.2^{+4.2}_{-5.0}$	[246]	1078^{+10}_{-248}
R.A. (deg)	302.781449		med.	$-3.97^{+2.61}_{-2.68}$	$-4.43^{+2.14}_{-2.95}$	$0.25^{+0.05}_{-0.03}$	$64.4^{+3.6}_{-4.7}$	$25.7^{+4.7}_{-4.6}$	[246]	984^{+104}_{-154}
Decl. (deg)	-52.471004	DM H2	best	$4.97^{+0.00}_{-0.29}$	$1.53^{+0.67}_{-0.16}$	$0.01^{+0.05}_{-0.00}$	$41.7^{+17.3}_{-9.3}$	$9.1^{+0.7}_{-0.9}$	184^{+0}_{-21}	888^{+55}_{-34}
χ^2_ν	1.09		med.	$4.89^{+0.08}_{-0.21}$	$1.76^{+0.44}_{-0.39}$	$0.03^{+0.03}_{-0.02}$	$45.5^{+13.5}_{-13.1}$	$8.9^{+0.9}_{-0.7}$	177^{+5}_{-14}	898^{+44}_{-45}
ν, N_{Free}	109, 31	DM H3	best	[8.37]	[3.63]	$0.56^{+0.19}_{-0.07}$	$10.9^{+22.5}_{-5.8}$	$0.0^{+0.4}_{-0.0}$	43^{+13}_{-1}	179^{+32}_{-0}
sigpos	0.38		med.	[8.37]	[3.63]	$0.62^{+0.12}_{-0.14}$	$13.3^{+20.1}_{-8.2}$	$0.2^{+0.2}_{-0.1}$	49^{+7}_{-8}	198^{+13}_{-13}
		Gal. H4	best	[-12.71]	[-14.24]	$0.70^{+0.06}_{-0.11}$	$118.6^{+1.3}_{-4.5}$	$16.0^{+3.6}_{-0.8}$	32^{+11}_{-5}	540^{+105}_{-0}
			med.	[-12.71]	[-14.24]	$0.68^{+0.08}_{-0.09}$	$116.8^{+3.1}_{-2.7}$	$17.3^{+2.3}_{-2.2}$	34^{+10}_{-6}	601^{+45}_{-49}
		Gal. H5	best	$-0.01^{+1.06}_{-1.01}$	$0.00^{+0.91}_{-1.11}$	[0.00]	[0.0]	$8.7^{+1.4}_{-3.1}$	57^{+0}_{-33}	123^{+89}_{-11}
			med.	$0.11^{+0.94}_{-1.13}$	$-0.22^{+1.13}_{-0.88}$	[0.00]	[0.0]	$7.2^{+2.9}_{-1.6}$	45^{+11}_{-22}	143^{+70}_{-30}
		L_* Gal.	best	...	...	...	...	[0.02]	6^{+3}_{-0}	156^{+15}_{-0}
			med.	...	...	...	...	[0.02]	7^{+2}_{-2}	164^{+7}_{-7}

Note. Parameters for the best-fit and median results of all clusters modeled with *lenstool*. The first two columns of the table are labeled “Model Statistics” and provide the following information: the cluster name; the R.A. and decl. of the coordinates for the BCG, given in degrees; the best-fit reduced χ^2 ; the number of degrees of freedom and the number of free parameters (ν, N_{Free}); and “sigpos,” which represents the positional uncertainty for the multiple images that could be used to generate a model with a χ^2 equal to 1. The remaining columns give the values for the best-fit model and the median model, which are distinguished by keyword in the “Value” column as “best” and “med.” respectively. $\Delta\alpha$ and $\Delta\delta$ are defined in relation to the BCG of the clusters. The position angles are measured north of west, and the ellipticity ϵ is defined as $(a^2 - b^2)/(a^2 + b^2)$. The error bars correspond to the 68% confidence level. Nonoptimized values are indicated by brackets. The cluster names are abbreviated in this table for readability. The designations for the individual potentials associated with a cluster-scale DM halo (DM), the BCG, or a galaxy-scale mass halo (Gal.) are abbreviated as H1, H2, etc. The properties of the reference galaxy used to scale the cluster-member mass parameters are given in the row designated “ L_* Gal.” The decimal precision in each column is chosen for readability; exact values for these parameters can be retrieved from the model files hosted on the Strong Lensing Cluster Atlas Data Base.

Table 8
List of Multiple Images

ID	R.A. (J2000)	Decl. (J2000)	z	z_{spec}	References	Notes
A68						
1.1.1	9.2808328	9.1578944	1.600		J. Richard et al. (2007)	
1.1.2	9.2803979	9.1566506				
1.1.3	9.2755277	9.1524037				
1.2.1	9.2804222	9.1582902				
1.2.2	9.2798639	9.1568091				
1.2.3	9.2747681	9.1528177				
2.1.1	9.2811551	9.1609147	1.583		J. Richard et al. (2007)	
2.1.2	9.2768184	9.1568752				
2.1.3	9.2756267	9.1547914				
2.2.1	9.2812803	9.1610266				
2.2.2	9.2767501	9.1566571				
2.2.3	9.2758399	9.1550114				
3.1.1	9.2735876	9.1667299	5.421		J. Richard et al. (2007)	
3.1.2	9.2702008	9.1643861				
3.1.3	9.2678101	9.1620116				
4.1.1	9.2789663	9.1593152	$1.42^{+0.00}_{-0.09}$			
4.1.2	9.2778949	9.1586256				
4.1.3	9.2740603	9.1536464				
5.1.1	9.2717546	9.1659809	2.689		J. Richard et al. (2007)	
5.1.2	9.2695335	9.1643621				
5.1.3	9.2688970	9.1638078				
6.1.1	9.2803624	9.1623110	$2.37^{+0.30}_{-0.12}$			
6.1.2	9.2751285	9.1576863				
6.1.3	9.2733581	9.1552036				
7.1.1	9.2708859	9.1746921	$5.75^{+0.17}_{-0.45}$			
7.1.2	9.2667435	9.1717768				
7.1.3	9.2630784	9.1706364				
8.1.1	9.2703232	9.1747891	$2.82^{+0.31}_{-0.06}$			
8.1.2	9.2652996	9.1714227				
8.1.3	9.2639542	9.1713205				
9.1.1	9.2842303	9.1567185	$3.16^{+0.13}_{-0.73}$			
9.1.2	9.2828687	9.1534580				
9.1.3	9.2805242	9.1511926				
10.1.1	9.2788946	9.1598966	$2.27^{+0.28}_{-0.11}$			
10.1.2	9.2782120	9.1594081				
10.1.3	9.2725146	9.1530888				
11.1.1	9.2827857	9.1582672	3.135		J. Richard et al. (2007)	
11.1.2	9.2816335	9.1555403				
11.1.3	9.2761537	9.1509177				
12.1.1	9.2687562	9.1746462	$5.24^{+0.49}_{-0.38}$			
12.1.2	9.2685146	9.1741565				
12.1.3	9.2621883	9.1709687				
RXC J0232.2–4420						
1.1.1	38.068580	−44.339061	$1.53^{+0.02}_{-0.08}$			
1.1.2	38.078533	−44.347577				
1.1.3	38.080421	−44.348048				
2.1.1	38.059882	−44.350331	$5.76^{+0.15}_{-0.86}$			
2.1.2	38.060422	−44.351186				
3.1.1	38.074925	−44.346648	$2.75^{+0.14}_{-0.25}$			
3.1.2	38.075806	−44.346568				
3.1.3	38.083445	−44.354338				

Table 8
(Continued)

ID	R.A. (J2000)	Decl. (J2000)	z	z_{spec}	References	Notes
3.1.4	38.080452	−44.341404				
3.1.5	38.074558	−44.340086				
4.1.1	38.063653	−44.345115	1.42 ^{+0.00} _{−0.07}			
4.1.2	38.063474	−44.345851				
4.1.3	38.063408	−44.347079				
4.1.4	38.068204	−44.353601				
5.1.1	38.069032	−44.340911	1.645		R. Mainali (2019)	
5.1.2	38.067245	−44.348830				
5.1.3	38.076868	−44.353985				
5.1.4	38.081248	−44.345429				
6.1.1	38.069596	−44.339507	1.81 ^{+0.09} _{−0.03}			
6.1.2	38.068818	−44.349680				
6.1.3	38.077894	−44.353268				
6.1.4	38.083099	−44.346552				
7.1.1	38.102283	−44.340004	1.467		R. Mainali (2019)	
7.1.2	38.101758	−44.341137				
7.1.3	38.102921	−44.341632				
7.1.4	38.102983	−44.341092				
SMACS J2031.8−4036						
1.1.1	307.971089	−40.629378	3.5077		J. Richard et al. (2021)	
1.1.2	307.974309	−40.627775				
1.1.3	307.974707	−40.618324				
1.1.4	307.970435	−40.625669				
1.1.5	307.970817	−40.625661				
1.2.1	307.971060	−40.629320				
1.2.2	307.974247	−40.627788				
1.2.3	307.974684	−40.618266				
1.2.4	307.970276	−40.625706				
1.2.5	307.970896	−40.625687				
1.3.1	307.970985	−40.629285				
1.3.2	307.974192	−40.627783				
1.3.3	307.974649	−40.618224				
1.3.4	307.970129	−40.625728				
1.3.5	307.971004	−40.625697				
2.1.1	307.969785	−40.625190	3.5077		J. Richard et al. (2021)	
2.1.2	307.970456	−40.630080				
2.1.3	307.974965	−40.627433				
2.1.4	307.974611	−40.619106				
3.1.1	307.968870	−40.626091	5.6231		J. Richard et al. (2021)	
3.1.2	307.971415	−40.625912				
3.1.3	307.970076	−40.629100				
3.1.4	307.973875	−40.627797				
3.1.5	307.974076	−40.616935				
4.1.1	307.967266	−40.624978	3.3400		J. Richard et al. (2021)	
4.1.2	307.967502	−40.629310				
4.1.3	307.972504	−40.618556				
5.1.1	307.962191	−40.626671	3.7230		J. Richard et al. (2021)	
5.1.2	307.962981	−40.624008				
5.1.3	307.967191	−40.617338				
6.1.1	307.964474	−40.621845	1.4249		J. Richard et al. (2021)	
6.1.2	307.963829	−40.622961				
6.1.3	307.963235	−40.623975				
7.1.1	307.970140	−40.618343	5.2397		J. Richard et al. (2021)	
7.1.2	307.966525	−40.623373				
7.1.3	307.965493	−40.629880				

Table 8
(Continued)

ID	R.A. (J2000)	Decl. (J2000)	z	z_{spec} References	Notes
8.1.1	307.965651	−40.619021	5.6128	J. Richard et al. (2021)	
8.1.2	307.964631	−40.620507			
8.1.3	307.961211	−40.628841			
9.1.1	307.963306	−40.620319	6.4085	J. Richard et al. (2021)	
9.1.2	307.964655	−40.618320			
10.1.1	307.967560	−40.619973	3.8561	J. Richard et al. (2021)	
10.1.2	307.966840	−40.620941			
10.1.3	307.963441	−40.629438			
10.2.1	307.967467	−40.620069			
10.2.2	307.966874	−40.620820			
10.2.3	307.963445	−40.629449			
11.1.1	307.967944	−40.629967	2.2556	J. Richard et al. (2021)	
11.1.2	307.968403	−40.623989			
11.1.3	307.971923	−40.620533			
11.1.4	307.973291	−40.625414			
11.2.1	307.968026	−40.629999			
11.2.2	307.968470	−40.623994			
11.2.3	307.972006	−40.620555			
11.2.4	307.973504	−40.625448			
12.1.1	307.973569	−40.625071	3.4140	J. Richard et al. (2021)	
12.1.2	307.972630	−40.625049			
12.1.3	307.968618	−40.623199			
12.1.4	307.971400	−40.620672			
12.1.5	307.967336	−40.630901			
13.1.1	307.968342	−40.618096	4.7300	J. Richard et al. (2021)	
13.1.2	307.965065	−40.623021			
13.1.3	307.963477	−40.628684			
14.1.1	307.965657	−40.624813	$1.60^{+0.03}_{-0.04}$		
14.1.2	307.965245	−40.626385			
15.1.1	307.964186	−40.626310	$6.89^{+0.08}_{-0.20}$		
15.1.2	307.964164	−40.626570			
MACS J0027.8+2616					
1.1.1	6.936236	26.274556	3.1267	This work, MUSE	
1.1.2	6.938848	26.268583			
1.1.3	6.942843	26.274449			
1.1.4	6.939522	26.278502			
1.2.1	6.936217	26.274369			
1.2.2	6.938797	26.268650			
1.2.3	6.942850	26.274421			
1.2.4	6.939509	26.278536			
1.3.1	6.936158	26.273721			
1.3.2	6.938467	26.268934			
1.3.3	6.942782	26.274284			
1.3.4	6.939322	26.278602			
1.4.1	6.936253	26.274864			
1.4.2	6.938879	26.268495			
1.4.3	6.942814	26.274491			
1.4.4	6.939490	26.278434			
1.5.1	6.936227	26.273358			
1.5.2	6.938406	26.269068			
1.5.3	6.942842	26.274233			
1.5.4	6.939418	26.278711			
2.1.1	6.947640	26.274558	$5.91^{+0.01}_{-0.55}$		
2.1.2	6.946998	26.276859			
2.1.3	6.946939	26.277012			
2.2.2	6.946946	26.276888	$5.17^{+0.00}_{-2.37}$		

Table 8
(Continued)

ID	R.A. (J2000)	Decl. (J2000)	z	z_{spec}	References	Notes
2.2.3	6.946902	26.276983				
3.1.1	6.941260	26.277969	4.45		This work, MUSE	
3.1.2	6.937722	26.276142				
3.1.3	6.940009	26.266777				
4.1.1	6.946621	26.273450	$4.68^{+0.19}_{-0.35}$			
4.1.2	6.946658	26.276252				
4.1.3	6.945298	26.277877				
c5.1.1	6.937108	26.273139	...			
c5.1.2	6.940155	26.268576				
c5.1.3	6.944855	26.272580				
c5.1.4	6.941673	26.279653				
c5.2.1	6.937048	26.273066				
c5.2.2	6.940033	26.268586				
c5.2.3	6.944899	26.272698				
c5.2.4	6.941504	26.279663				
c5.3.1	6.936962	26.272928				
c5.3.2	6.939858	26.268637				
c5.3.3	6.944925	26.272887				
c5.3.4	6.941269	26.279685				
c6.1.1	6.938385	26.277879	...			
c6.1.2	6.937572	26.277232				
RXC J2211.7–0349						
1.1.1	332.939988	−3.824111	1.051		C. Cerny et al. (2018)	
1.1.2	332.933020	−3.828870				
1.1.3	332.938466	−3.834306				
1.1.4	332.952310	−3.831273				
1.1.5	332.940787	−3.829024				
1.2.1	332.939878	−3.824069				
1.2.2	332.933097	−3.828766				
1.2.3	332.938458	−3.834198				
1.2.4	332.952372	−3.831187				
1.2.5	332.940817	−3.829081				
2.1.1	332.931052	−3.836624	$1.74^{+0.27}_{-0.00}$			
2.1.2	332.934371	−3.839186				
2.1.3	332.953426	−3.838235				
2.2.1	332.931118	−3.836431	$1.75^{+0.24}_{-0.00}$			
2.2.2	332.934346	−3.838963				
2.2.3	332.953637	−3.837944				
3.1.1	332.931464	−3.836102	$1.73^{+0.26}_{-0.00}$			
3.1.2	332.934020	−3.838213				
3.1.3	332.954336	−3.837149				
4.1.1	332.937135	−3.819198	$2.98^{+1.27}_{-0.00}$			
4.1.2	332.929179	−3.827742				
4.1.3	332.936399	−3.837133				
4.1.4	332.958469	−3.830820				
4.1.5	332.940120	−3.829443				
4.2.1	332.936857	−3.819544	$2.84^{+1.27}_{-0.00}$			
4.2.2	332.929373	−3.828174				
4.2.3	332.936125	−3.837047				
4.2.4	332.958598	−3.831044				
5.1.1	332.940664	−3.811824	$3.30^{+1.09}_{-0.00}$			
5.1.2	332.937780	−3.812058				
5.1.3	332.954644	−3.817226				
6.1.1	332.929703	−3.840415	$1.65^{+0.20}_{-0.01}$			
6.1.2	332.941603	−3.844585				

Table 8
(Continued)

ID	R.A. (J2000)	Decl. (J2000)	z	z_{spec}	References	Notes
6.1.3	332.943154	−3.844507				
7.1.1	332.931384	−3.837458	$1.99^{+0.44}_{-0.00}$			
7.1.2	332.933528	−3.838877				
7.1.3	332.954729	−3.837951				
8.1.1	332.938615	−3.822329	$2.24^{+0.61}_{-0.00}$			
8.1.2	332.930927	−3.833218				
8.1.3	332.934065	−3.836824				
8.1.4	332.957495	−3.833822				
9.1.1	332.937813	−3.826374	$1.57^{+0.71}_{-0.00}$			
9.1.2	332.938254	−3.827022				
10.1.1	332.935926	−3.829706	$1.82^{+0.62}_{-0.00}$			
10.1.2	332.936471	−3.829518				
MACS J0553.4−3342						
1.1.1	88.3658619	−33.7044559	1.14		H. Ebeling et al. (2017)	
1.1.2	88.3661029	−33.7085889				
1.1.3	88.3652219	−33.7121889				
2.1.1	88.3599266	−33.7154709	$3.00^{+0.09}_{-0.00}$			
2.1.2	88.3625462	−33.7103277				
2.1.3	88.3607222	−33.6978757				
2.2.1	88.3599012	−33.7152936	$3.04^{+0.04}_{-0.04}$			
2.2.2	88.3624310	−33.7104217				
2.2.3	88.3606585	−33.6978104				
2.3.1	88.3599197	−33.7150017	$2.97^{+0.07}_{-0.00}$			
2.3.2	88.3623173	−33.7105328				
2.3.3	88.3606075	−33.6977394				
2.4.1	88.3601530	−33.7144632	$2.94^{+0.06}_{-0.03}$			
2.4.2	88.3621588	−33.7107136				
2.4.3	88.3605699	−33.6976552				
2.5.1	88.3601866	−33.7141458	$3.18^{+0.00}_{-0.15}$			
2.5.2	88.3618676	−33.7109455				
2.6.1	88.3603537	−33.7138338	$2.95^{+0.15}_{-0.00}$			
2.6.2	88.3617713	−33.7111093				
2.7.1	88.3603793	−33.7137162	$3.05^{+0.06}_{-0.09}$			
2.7.2	88.3616833	−33.7112069				
3.1.1	88.3277452	−33.7051380	$1.23^{+0.02}_{-0.00}$			
3.1.2	88.3273078	−33.7082501				
3.1.3	88.3274485	−33.7092172				
3.2.1	88.3273359	−33.7058549	$1.22^{+0.02}_{-0.01}$			
3.2.2	88.3269949	−33.7076049				
3.2.3	88.3272749	−33.7099219				
3.3.1	88.3274380	−33.7065044	$1.35^{+0.02}_{-0.03}$			
3.3.2	88.3272339	−33.7074439				
3.4.1	88.3264641	−33.7069933	$1.24^{+0.03}_{-0.02}$			
3.4.2	88.3264287	−33.7073152				
4.1.1	88.3280579	−33.7005219	$2.93^{+0.04}_{-0.05}$			
4.1.2	88.3248109	−33.7084709				
4.1.3	88.3255309	−33.7127209				
5.1.1	88.3340669	−33.7085559	3.32		H. Ebeling et al. (2017), this work, MUSE	
5.1.2	88.3330039	−33.7149389				
5.1.3	88.3344089	−33.6995059				
6.1.1	88.3392369	−33.7022729	$4.31^{+0.00}_{-0.16}$			
6.1.2	88.3388759	−33.7060559				
6.1.3	88.3380129	−33.7185729				
7.1.1	88.3367519	−33.7082559	$1.79^{+0.01}_{-0.02}$			

Table 8
(Continued)

ID	R.A. (J2000)	Decl. (J2000)	z	z_{spec}	References	Notes
7.1.2	88.3358289	−33.7133229				
7.1.3	88.3367729	−33.7026899				
8.1.1	88.3586698	−33.7195898	$5.79^{+0.02}_{-0.24}$			
8.1.2	88.3623042	−33.7077196				
8.1.3	88.3593580	−33.6994796				
8.2.1	88.3588082	−33.7196386	$5.71^{+0.02}_{-0.25}$			
8.2.2	88.3624804	−33.7076777				
8.2.3	88.3596472	−33.6995774				
8.3.1	88.3591336	−33.7197891	$5.49^{+0.26}_{-0.00}$			
8.3.2	88.3628382	−33.7075288				
8.3.3	88.3602558	−33.6998207				
9.1.1	88.3430541	−33.7144931	$3.00^{+0.05}_{-0.04}$			
9.1.2	88.3434497	−33.7096088				
9.1.3	88.3445746	−33.6989433				
9.2.1	88.3430718	−33.7143918	$2.99^{+0.07}_{-0.02}$			
9.2.2	88.3434399	−33.7096902				
9.2.3	88.3445769	−33.6988883				
9.3.1	88.3431052	−33.7143295	$3.07^{+0.00}_{-0.10}$			
9.3.2	88.3434448	−33.7097594				
9.3.3	88.3446123	−33.6988157				
9.4.1	88.3432159	−33.7140456	$3.05^{+0.01}_{-0.09}$			
9.4.2	88.3434595	−33.7100280				
9.4.3	88.3446996	−33.6986979				
10.1.1	88.3404779	−33.7158719	3.76		This work, MUSE	
10.1.2	88.3424669	−33.6990669				
10.1.3	88.3410299	−33.7092889				
11.1.1	88.3243083	−33.7055700	$1.92^{+0.03}_{-0.03}$			
11.1.2	88.3241319	−33.7067226				
11.1.3	88.3242985	−33.7112264				
12.1.1	88.3270548	−33.7131277	$7.25^{+0.00}_{-0.52}$			
12.1.2	88.3259715	−33.7108159				
12.2.1	88.3269715	−33.7129618	$7.20^{+0.00}_{-0.48}$			
12.2.2	88.3260084	−33.7109352				
13.1.1	88.3421014	−33.7123960	3.35		This work, MUSE	
13.1.2	88.3423039	−33.7115470				
13.2.1	88.3420916	−33.7122700				
13.2.2	88.3422705	−33.7115781				
13.3.1	88.3421702	−33.7121866				
13.3.2	88.3423138	−33.7116370				
13.4.1	88.3422017	−33.7120132				
13.4.2	88.3422803	−33.7117351				
14.1.1	88.3692959	−33.7043710	$3.25^{+0.27}_{-0.00}$			
14.1.2	88.3696681	−33.7057263				
15.1.1	88.3539066	−33.7034301	$1.41^{+0.01}_{-0.01}$			
15.1.2	88.3529558	−33.7065014				
15.1.3	88.3540589	−33.7156379				
16.1.1	88.3525536	−33.6992058	$4.66^{+0.00}_{-0.20}$			
16.1.2	88.3505162	−33.7076583				
16.1.3	88.3523411	−33.7190047				
17.1.1	88.3491110	−33.7115478	$3.25^{+0.24}_{-0.00}$			
17.1.2	88.3494206	−33.7139235				
18.1.1	88.3506594	−33.7107982	$2.92^{+0.01}_{-0.06}$			
18.1.2	88.3514718	−33.7144854				
18.1.3	88.3524087	−33.6975770				

Table 8
(Continued)

ID	R.A. (J2000)	Decl. (J2000)	z	z_{spec}	References	Notes
19.1.1	88.3557794	−33.7135415	$1.72^{+0.03}_{-0.03}$			
19.1.2	88.3548819	−33.7103140				
20.1.1	88.3256409	−33.7036986	$3.12^{+0.00}_{-0.13}$			
20.1.2	88.3252609	−33.7044253				
21.1.1	88.3458228	−33.7177558	$3.86^{+0.00}_{-0.13}$			
21.1.2	88.3449273	−33.7077872				
21.1.3	88.3462092	−33.6994610				
MACS J0358.8−2955						
1.1.1	59.718226	−29.923243	1.261		L.-Y. Hsu et al. (2013)	
1.1.2	59.728497	−29.932040				
1.1.3	59.723055	−29.927323				
2.1.1	59.719442	−29.936392	3.07		L.-Y. Hsu et al. (2013)	
2.1.2	59.720636	−29.936522				
3.1.1	59.719362	−29.936607	3.07		L.-Y. Hsu et al. (2013)	
3.1.2	59.720356	−29.936713				
4.1.1	59.712972	−29.920461	$2.44^{+0.06}_{-0.24}$			
4.1.2	59.727946	−29.930851				
4.1.3	59.725841	−29.928688				
5.1.1	59.716309	−29.921720	$2.11^{+0.11}_{-0.08}$			
5.1.2	59.730130	−29.933371				
5.1.3	59.723680	−29.926972				
6.1.1	59.713908	−29.925562	$1.57^{+0.08}_{-0.02}$			
6.1.2	59.726937	−29.935757				
6.1.3	59.720272	−29.930026				
MACS J1621.4+3810						
1.1.1	245.350738	38.168288	$1.69^{+4.17}_{-0.00}$			
1.1.2	245.351432	38.168379				
1.2.1	245.350885	38.168356	$2.05^{+3.76}_{-0.00}$			
1.2.2	245.351300	38.168401				
2.1.1	245.356333	38.166685	[1.5]			$z_{\text{phot}} = 1.5^{+0.3}_{-0.2}$
2.1.2	245.357710	38.173532				
2.1.3	245.349166	38.171773				
2.1.4	245.347364	38.165408				
2.2.1	245.356242	38.166394				
2.2.2	245.358219	38.173424				
2.2.3	245.349084	38.171462				
2.2.4	245.347807	38.165342				
3.1.1	245.360845	38.164155	$1.44^{+0.00}_{-0.20}$			
3.1.2	245.361585	38.164907				
4.1.1	245.351723	38.170133	$1.31^{+0.05}_{-0.04}$			
4.1.2	245.352504	38.169623				
4.1.3	245.357693	38.166126				
4.1.4	245.359653	38.171317				
4.1.5	245.350847	38.163867				
5.1.1	245.342426	38.168324	$2.91^{+2.76}_{-0.48}$			
5.1.2	245.342408	38.168421				
5.1.3	245.342542	38.168707				
RCS2 032727−132623						
1.1	51.867801	−13.437960	1.701		K. Sharon et al. (2012)	(Aa) Giant arc
1.2	51.864738	−13.435399				(Ab)
1.3	51.860701	−13.437034				(Ac)

Table 8
(Continued)

ID	R.A. (J2000)	Decl. (J2000)	z	z_{spec}	References	Notes
1.4	51.862555	−13.448303				(Counterimage)
Clumps in the Giant Arcs						
1.01.3	51.860580	−13.438194				1–15: clumps appearing only in Images 3 and 4
1.01.4	51.863845	−13.448153				
1.02.3	51.860638	−13.438243				
1.02.4	51.863931	−13.448169				
1.03.3	51.860751	−13.438207				
1.03.4	51.863957	−13.448234				
1.04.3	51.860718	−13.438137				
1.04.4	51.863864	−13.448239				
1.05.3	51.860828	−13.438147				
1.05.4	51.863927	−13.448288				
1.06.3	51.860812	−13.438045				
1.06.4	51.863810	−13.448301				
1.07.3	51.860913	−13.438025				
1.07.4	51.863817	−13.448358				
1.08.3	51.860897	−13.437855				
1.08.4	51.863621	−13.448371				
1.09.3	51.860938	−13.437870				
1.09.4	51.863633	−13.448398				
1.10.3	51.861024	−13.437777				
1.10.4	51.863544	−13.448455				
1.11.3	51.861031	−13.437717				
1.11.4	51.863465	−13.448459				
1.12.3	51.861062	−13.437661				
1.12.4	51.863414	−13.448484				
1.13.3	51.860945	−13.437703				
1.13.4	51.863419	−13.448412				
1.14.3	51.860915	−13.437671				
1.14.4	51.863366	−13.448396				
1.15.3	51.861038	−13.437592				
1.15.4	51.863313	−13.448479				
1.16.3	51.860867	−13.437591				Bright core of the east galaxy
1.16.4	51.863216	−13.448378				Demagnified central image
1.16.5	51.863261	−13.439496				
1.16.6	51.860714	−13.437493				Added multiplicity in Image 3 due to lensing by cluster member 17–19: extremely magnified region, not resolved in Images 3 and 4
1.17.1	51.867867	−13.437154				
1.17.2	51.867510	−13.436689				
1.18.1	51.867995	−13.437295				20–42: regions appearing in all four images
1.18.2	51.867226	−13.436358				
1.19.1	51.867750	−13.437152				
1.19.2	51.867089	−13.436406				
1.20.1	51.868096	−13.437631				
1.20.2	51.866481	−13.435842				
1.20.3	51.860629	−13.437397				
1.20.4	51.863030	−13.448299				
1.21.1	51.868147	−13.437756				
1.21.2	51.866251	−13.435691				
1.21.3	51.860591	−13.437404				
1.22.1	51.867937	−13.437416				
1.22.2	51.866661	−13.436025				
1.22.3	51.860705	−13.437373				
1.22.4	51.863006	−13.448348				
1.23.3	51.860808	−13.437330				
1.23.4	51.862961	−13.448395				
1.24.1	51.868021	−13.437668				
1.24.2	51.866101	−13.435692				
1.24.3	51.860662	−13.437328				
1.24.4	51.862933	−13.448304				
1.25.1	51.867883	−13.437576				
1.25.2	51.865914	−13.435689				
1.26.1	51.867935	−13.437665				

Table 8
(Continued)

ID	R.A. (J2000)	Decl. (J2000)	z	z_{spec}	References	Notes
1.26.2	51.865814	−13.435631				
1.27.1	51.867799	−13.437507				
1.27.2	51.865839	−13.435704				
1.28.1	51.868061	−13.437781				
1.28.2	51.865881	−13.435573				
1.29.1	51.868073	−13.437862				
1.29.2	51.865739	−13.435504				
1.29.3	51.860607	−13.437296				
1.29.4	51.862875	−13.448266				
1.30.1	51.868080	−13.438011				
1.30.2	51.865472	−13.435394				
1.30.3	51.860578	−13.437239				
1.30.4	51.862793	−13.448231				
1.31.1	51.868121	−13.438107				
1.31.2	51.865410	−13.435331				
1.31.3	51.860495	−13.437240				
1.31.4	51.862782	−13.448193				
1.32.1	51.868116	−13.438156				
1.32.2	51.865268	−13.435287				
1.32.3	51.860459	−13.437220				
1.32.4	51.862747	−13.448176				
1.33.1	51.867846	−13.437799				
1.33.2	51.865265	−13.435503				
1.33.3	51.860750	−13.437136				
1.33.4	51.862675	−13.448327				
1.34.1	51.867540	−13.437481				
1.34.2	51.865180	−13.435649				
1.35.1	51.867953	−13.438014				
1.35.2	51.865119	−13.435373				
1.36.1	51.867646	−13.437689				
1.36.2	51.864929	−13.435546				
1.36.3	51.861259	−13.436656				
1.37.1	51.867793	−13.437957				Bright red core of the west galaxy
1.37.2	51.864731	−13.435403				
1.37.3	51.860701	−13.437034				
1.37.4	51.862555	−13.448303				
1.38.1	51.867951	−13.438194				
1.38.2	51.864721	−13.435261				
1.38.4	51.862551	−13.448193				
1.39.1	51.867850	−13.438161				
1.39.2	51.864457	−13.435286				
1.39.4	51.862474	−13.448229				
1.40.1	51.867639	−13.437946				
1.40.2	51.864299	−13.435427				
1.40.4	51.862422	−13.448343				
1.41.1	51.867575	−13.437964				
1.41.2	51.864227	−13.435429				
1.41.3	51.862751	−13.435661				
1.41.4	51.862343	−13.448359				
1.42.1	51.867703	−13.438238				
1.42.2	51.863469	−13.435318				
1.42.3	51.862794	−13.435476				
1.42.4	51.862303	−13.448218				
2.1.1	51.868737	−13.437357	1.701	...		(“A”) Part of Source 1
2.1.2	51.868428	−13.436829				
3.1.1	51.866074	−13.436360	1.701	...		Part of Source 1
3.1.2	51.864921	−13.435939				
3.1.3	51.863321	−13.435913				
4.1.1	51.871731	−13.438264	2.730	S. Lopez et al. (2018)		
4.1.2	51.870326	−13.435747				
4.1.3	51.859482	−13.438346				
4.1.4	51.864700	−13.449324				

Table 8
(Continued)

ID	R.A. (J2000)	Decl. (J2000)	z	z_{spec} References	Notes
5.1.1	51.872897	−13.434544	5.200	S. Lopez et al. (2018)	
5.1.2	51.859969	−13.439685			
5.1.3	51.871301	−13.447044			
6.1.1	51.861985	−13.441969	3.518	This work; MUSE	
6.1.2	51.862410	−13.441657			
7.1.1	51.866110	−13.441461	2.8262	S. Lopez et al. (2018)	(S7a) Radial arc
7.1.2	51.865888	−13.441378			(S7b)
7.1.3	51.861632	−13.431357			(S7c)
7.2.1	51.866409	−13.441617			
7.2.2	51.865540	−13.441324			
7.2.3	51.861772	−13.431314			
7.3.1	51.866212	−13.441498			
7.3.2	51.865803	−13.441350			
7.4.1	51.866465	−13.441638			
7.4.2	51.865482	−13.441307			
8.1.1	51.861898	−13.437829	$3.11^{+1.66}_{-0.57}$		Radial arc
8.1.2	51.862620	−13.438543			
9.1.1	51.864446	−13.442833	$3.41^{+0.72}_{-1.17}$		Radial arc
9.1.2	51.864118	−13.442215			
9.2.1	51.864374	−13.442661	$2.42^{+2.38}_{-0.17}$		
9.2.2	51.864187	−13.442344			
10.1.1	51.860746	−13.442996	$2.55^{+0.02}_{-0.08}$		Radial arc
10.1.2	51.863311	−13.441242			
10.1.3	51.866801	−13.430480			
11.1.1	51.865991	−13.442196	$2.90^{+2.21}_{-0.43}$		Radial arc
11.1.2	51.865548	−13.441816			
12.1.1	51.861857	−13.439301	$3.18^{+1.69}_{-0.93}$		Radial arc
12.1.2	51.8621273	−13.4393533			
13.1.1	51.872008	−13.442422	$3.35^{+0.06}_{-0.06}$		
13.1.2	51.869600	−13.433048			
13.3	51.858583	−13.439729			
13.1.4	51.865692	−13.448646			
14.1.1	51.872048	−13.438578	$2.66^{+0.03}_{-0.04}$		
14.1.2	51.870323	−13.435348			
14.1.3	51.859465	−13.438657			
14.1.4	51.865012	−13.449137			
15.1.1	51.872119	−13.438484	$2.67^{+0.01}_{-0.06}$		
15.1.2	51.870544	−13.435505			
15.1.3	51.859580	−13.438727			
15.1.4	51.865240	−13.449129			
16.1.1	51.864756	−13.446027	$3.19^{+0.06}_{-0.48}$		
16.1.2	51.866044	−13.445628			
17.1.1	51.856582	−13.435563	$2.76^{+1.85}_{-0.11}$		
17.1.2	51.855895	−13.436411			
18.1.1	51.867692	−13.447883	$3.94^{+0.08}_{-0.84}$		
18.1.2	51.868275	−13.447341			
18.1.3	51.869144	−13.446956			
19.1.1	51.855839	−13.443733	$3.05^{+0.05}_{-0.52}$		
19.1.2	51.856174	−13.444099			
19.1.3	51.856763	−13.445518			
20.1.1	51.856767	−13.439523	$1.86^{+0.00}_{-0.07}$		
20.1.2	51.857704	−13.444226			

Table 8
(Continued)

ID	R.A. (J2000)	Decl. (J2000)	z	z_{spec}	References	Notes
20.1.3	51.858988	−13.445986				
21.1.1	51.864125	−13.434071	4.24 ^{+0.00} _{−0.41}			
21.1.2	51.863315	−13.434155				
21.1.3	51.862592	−13.434310				
22.1.1	51.862524	−13.434692	2.28 ^{+0.00} _{−0.09}			
22.1.2	51.860819	−13.435560				
22.1.3	51.868483	−13.438578				
23.1.1	51.870614	−13.437170	4.36 ^{+0.00} _{−0.30}			
23.1.2	51.868167	−13.434515				
23.1.3	51.859952	−13.435585				
MACS J2129.4−0741						
1.1.1	322.357970	−7.685880	1.36		G. B. Caminha et al. (2019), M. Jauzac et al. (2021)	
1.1.2	322.359661	−7.690859				
1.1.3	322.359250	−7.690950				
1.1.4	322.357120	−7.691090				
1.1.5	322.357640	−7.691150				
1.1.6	322.358610	−7.694890				
2.1.1	322.354830	−7.690700	1.048		G. B. Caminha et al. (2019), M. Jauzac et al. (2021)	
2.1.2	322.354770	−7.691600				
2.1.3	322.355380	−7.693320				
3.1.1	322.350220	−7.688860	2.24		G. B. Caminha et al. (2019), M. Jauzac et al. (2021)	
3.1.2	322.350040	−7.689820				
3.1.3	322.350950	−7.695770				
4.1.1	322.366420	−7.686740	2.24		G. B. Caminha et al. (2019), M. Jauzac et al. (2021)	
4.1.2	322.366930	−7.688310				
4.1.3	322.366790	−7.694970				
5.1.1	322.364220	−7.693870	1.73 ^{+0.03} _{−0.04}			
5.1.2	322.364600	−7.691370				
5.1.3	322.362430	−7.684930				
6.1.1	322.350940	−7.693330	6.85		G. B. Caminha et al. (2019), M. Jauzac et al. (2021)	
6.1.2	322.353240	−7.697440				
6.1.3	322.353940	−7.681640				
7.1.1	322.357140	−7.694250	1.357		G. B. Caminha et al. (2019), M. Jauzac et al. (2021)	
7.1.2	322.356250	−7.691720				
7.1.3	322.356700	−7.685540				
8.1.1	322.356980	−7.689240	4.410		G. B. Caminha et al. (2019), M. Jauzac et al. (2021)	
8.1.2	322.361670	−7.688080				
8.1.3	322.358600	−7.684910				
8.1.4	322.360350	−7.700940				
8.1.5	322.354186	−7.688763				
9.1.1	322.366510	−7.686890	2.24		G. B. Caminha et al. (2019), M. Jauzac et al. (2021)	
9.1.2	322.366950	−7.688200				
9.1.3	322.366660	−7.695250				
10.1.1	322.357618	−7.684709	4.41		G. B. Caminha et al. (2019), M. Jauzac et al. (2021)	
10.1.3	322.354988	−7.688960				
11.1.1	322.363338	−7.697070	3.1081		G. B. Caminha et al. (2019), M. Jauzac et al. (2021)	
11.1.2	322.364905	−7.690096				
11.1.3	322.361673	−7.683623				
12.1.1	322.354550	−7.685180	3.897		G. B. Caminha et al. (2019), M. Jauzac et al. (2021)	
12.1.2	322.352780	−7.688412				
13.1.1	322.353304	−7.691134	1.3585		G. B. Caminha et al. (2019), M. Jauzac et al. (2021)	
13.1.2	322.353912	−7.687584				

Table 8
(Continued)

ID	R.A. (J2000)	Decl. (J2000)	z	z_{spec}	References	Notes
13.1.3	322.354428	−7.694413				
14.1.1	322.361311	−7.685896	1.451		G. B. Caminha et al. (2019), M. Jauzac et al. (2021)	
14.1.3	322.362594	−7.693603				
16.1.1	322.361637	−7.690945	1.08 ^{+0.00} _{−0.02}			
16.1.2	322.361559	−7.692262				
16.1.3	322.361128	−7.688382				
17.1.1	322.355734	−7.694368	1.95 ^{+0.04} _{−0.04}			
17.1.2	322.355149	−7.693848				
17.1.3	322.355853	−7.683335				
18.1.1	322.3513795	−7.6837914	5.53 ^{+0.47} _{−0.19}			
18.1.2	322.3495315	−7.6864161				
18.1.3	322.3507339	−7.6986070				
PSZ1 G091.83+26.11						
1.1.1	277.7869620	62.2510888	[4.4]			$z_{\text{phot}} = 4.4 \pm 0.21$
1.1.2	277.7752863	62.2501733				
1.1.3	277.7874961	62.2483920				
1.1.4	277.7994872	62.2482763				
1.2.1	277.7869786	62.2511314				
1.2.2	277.7752793	62.2502210				
1.2.3	277.7875272	62.2485160				
1.2.4	277.7994884	62.2483722				
1.3.2	277.7753932	62.2501785				
1.3.3	277.7874750	62.2484214				
1.3.4	277.7995271	62.2482937				
1.4.3	277.7874305	62.2482261				
1.4.4	277.7994924	62.2481162				
1.5.1	277.7866780	62.2511427				
1.5.2	277.7757413	62.2502249				
1.5.3	277.7874197	62.2486210				
1.5.4	277.7997173	62.2483896				
1.6.1	277.7868386	62.2513011				
1.6.2	277.7755426	62.2503851				
1.6.4	277.7996035	62.2487011				
1.7.1	277.7864894	62.2514413				
1.7.2	277.7759003	62.2505153				
1.7.4	277.7998018	62.2489277				
1.8.1	277.7865464	62.2514870				
1.8.2	277.7758083	62.2505735				
1.8.4	277.7997376	62.2490416				
1.9.1	277.7865464	62.2515431				
1.9.2	277.7757215	62.2506414				
1.9.4	277.7997091	62.2491390				
1.10.3	277.7874720	62.2478191				
1.10.4	277.7992313	62.2476938				
1.11.1	277.7873344	62.2506898				
1.11.2	277.7746473	62.2496752				
1.11.3	277.7876023	62.2475400				
1.11.4	277.7989422	62.2471154				
1.12.1	277.7873426	62.2506048				
1.12.2	277.7746267	62.2495807				
1.12.3	277.7875963	62.2474256				
1.12.4	277.7988844	62.2468949				
1.13.2	277.7748009	62.2493628				
1.13.3	277.7873677	62.2470452				
1.13.4	277.7988420	62.2464807				
1.14.2	277.7748632	62.2493136				
1.14.3	277.7872827	62.2470057				
1.14.4	277.7988295	62.2463978				
1.15.1	277.7871609	62.2502841				

Table 8
(Continued)

ID	R.A. (J2000)	Decl. (J2000)	z	z_{spec}	References	Notes
1.15.2	277.7752217	62.2491330				
1.15.3	277.7870082	62.2469761				
1.15.4	277.7989111	62.2462362				
1.16.1	277.7874079	62.2500616				
1.16.2	277.7750115	62.2488523				
1.16.3	277.7869465	62.2467345				
1.16.4	277.7985826	62.2455983				
1.17.1	277.7870989	62.2496455				
1.17.2	277.7762758	62.2485726				
1.17.3	277.7860480	62.2468622				
1.17.4	277.7990335	62.2453401				
1.18.2	277.7763622	62.2481439				
1.18.3	277.7856997	62.2466629				
1.18.4	277.7987771	62.2446211				
2.1.1	277.7854050	62.2493730	[2.8]			$z_{\text{phot}} = 2.8 \pm 0.1$
2.1.2	277.7843175	62.2491381				
2.1.3	277.7847487	62.2489539				
2.1.4	277.7959287	62.2481713				
2.1.5	277.7854979	62.2493044				
2.2.2	277.7842379	62.2491010				
2.2.3	277.7847361	62.2489129				
2.3.1	277.7854799	62.2494749				
2.3.2	277.7839669	62.2492076				
2.3.3	277.7851582	62.2488151				
2.3.4	277.7957981	62.2482003				
3.1.1	277.7857140	62.2505085	$4.47^{+0.00}_{-0.17}$			
c3.1.2a	277.7776959	62.2493322				
c3.1.2b	277.7770779	62.2494257				
c3.1.2 c	277.7778193	62.2498238				
3.1.3	277.7859491	62.2478811				
3.1.4	277.8004209	62.2473581				
4.1.1	277.7936034	62.2525418	$3.44^{+0.01}_{-0.11}$			
4.1.2	277.7874089	62.2526513				
4.1.3	277.7789478	62.2524631				
4.2.1	277.7937844	62.2525446	$3.45^{+0.00}_{-0.12}$			
4.2.2	277.7872413	62.2526708				
4.2.3	277.7791224	62.2524891				
4.3.1	277.7940137	62.2524772	$3.40^{+0.03}_{-0.10}$			
4.3.2	277.7869577	62.2526539				
4.3.3	277.7793528	62.2524485				
5.1.1	277.7943034	62.2533904	$4.66^{+0.03}_{-0.17}$			
5.1.2	277.7882075	62.2538140				
5.1.3	277.7750379	62.2527944				
5.2.1	277.7940439	62.2533904	$4.65^{+0.10}_{-0.08}$			
5.2.2	277.7883483	62.2537906				
5.2.3	277.7747966	62.2527522				
c6.1.1	277.7864548	62.2563030	...			
c6.1.2	277.7819559	62.2558484				
c6.1.3	277.7879239	62.2563098				
c7.1.1	277.7900394	62.2572796	...			
c7.1.2	277.7886401	62.2574043				
c7.1.3	277.7906497	62.2573414				
c8.1.1	277.8235233	62.2483831	...			
c8.1.2	277.8220189	62.2489751				
c8.1.3	277.8210136	62.2492630				
c8.1.4	277.8203899	62.2481170				
c9.1.1	277.8244726	62.2490875	...			

Table 8
(Continued)

ID	R.A. (J2000)	Decl. (J2000)	z	z_{spec}	References	Notes
c9.1.2	277.8233781	62.2495567				
c9.1.3	277.8225815	62.2498573				
c9.1.4	277.8204873	62.2480822				
c10.1.1	277.8182071	62.2448778	...			
c10.1.2	277.8157900	62.2459444				
c11.1.1	277.8100988	62.2374333	...			
c11.1.2	277.8107708	62.2370336				
c12.1.1	277.8029047	62.2671327	...			
c12.1.2	277.8025794	62.2672977				
RX J0152.7–1357						
1.1.1	28.189076	−13.952246	3.93		A. Acebron et al. (2019)	
1.1.2	28.188361	−13.951203				
1.1.3	28.185287	−13.948941				
1.1.4	28.187669	−13.951236				
2.1.1	28.187278	−13.954577	$2.91^{+0.58}_{-0.34}$			
2.1.2	28.185848	−13.952977				
2.1.3	28.183338	−13.950919				
3.1.1	28.184894	−13.956606	$1.66^{+0.11}_{-0.13}$			
3.1.2	28.183271	−13.954315				
3.1.3	28.181590	−13.953478				
3.2.1	28.184576	−13.956697				
3.2.2	28.183286	−13.954600				
3.2.3	28.181065	−13.953554				
4.1.1	28.183443	−13.956815	$1.69^{+0.09}_{-0.15}$			
4.1.2	28.182984	−13.956555				
5.1.1	28.182444	−13.959993	$2.62^{+0.24}_{-0.66}$			
5.1.2	28.179475	−13.958578				
5.1.3	28.177450	−13.956018				
5.2.1	28.182206	−13.959883				
5.2.2	28.179661	−13.958668				
5.2.3	28.177385	−13.955889				
6.1.1	28.181477	−13.953185	$4.39^{+0.43}_{-0.46}$			
6.1.2	28.183328	−13.954069				
6.1.3	28.185407	−13.956885				
7.1.1	28.164320	−13.968186	$4.35^{+0.44}_{-0.47}$			
7.1.2	28.164454	−13.968568				
SPT-CL J0516–5755						
1.1.1	79.239337	−57.919780	[2.5]			$z_{\text{phot}} = 2.0^{+0.7}_{-0.4}$
1.1.2	79.247988	−57.918978				
1.1.3	79.250781	−57.917842				
1.2.1	79.239299	−57.919948				
1.2.2	79.248751	−57.918934				
1.2.3	79.250289	−57.918338				
1.3.1	79.239342	−57.919604				
1.3.2	79.247563	−57.918914				
1.3.3	79.251129	−57.917350				
1.3.4	79.246525	−57.917927				
2.1.1	79.248980	−57.916689	$2.01^{+0.04}_{-0.00}$			
2.1.2	79.245068	−57.917352				
2.1.3	79.241400	−57.918282				
2.2.1	79.249042	−57.916612	$2.00^{+0.05}_{-0.00}$			
2.2.2	79.244889	−57.917333				
2.2.3	79.241380	−57.918202				

Table 8
(Continued)

ID	R.A. (J2000)	Decl. (J2000)	z	z_{spec}	References	Notes
2.3.1	79.248876	−57.916787	$1.99^{+0.05}_{-0.00}$			
2.3.2	79.245349	−57.917370				
2.3.3	79.241403	−57.918386				
2.4.1	79.248892	−57.916762	$2.02^{+0.03}_{-0.01}$			
2.4.2	79.245289	−57.917363				
2.4.3	79.241397	−57.918359				
3.1.1	79.239419	−57.921004	$2.98^{+0.04}_{-0.04}$			
3.1.2	79.249568	−57.920537				
3.1.3	79.253018	−57.919178				
3.2.2	79.249666	−57.920404	$2.83^{+0.21}_{-0.00}$			
3.2.3	79.252866	−57.919118				
3.3.2	79.249485	−57.920617	$2.87^{+0.17}_{-0.02}$			
3.3.3	79.253124	−57.919186				
4.1.1	79.250914	−57.914233	$5.32^{+0.08}_{-0.41}$			
4.1.2	79.246614	−57.914073				
4.1.3	79.230979	−57.917197				
4.2.1	79.251128	−57.914267	$5.51^{+0.00}_{-0.86}$			
4.2.2	79.246450	−57.914113				
5.1.1	79.247830	−57.914088	$2.55^{+0.02}_{-0.06}$			
5.1.2	79.245443	−57.914160				
5.1.3	79.236501	−57.915932				
6.1.2	79.249938	−57.919894	$2.86^{+0.05}_{-0.15}$			
6.1.3	79.251974	−57.919098				
7.1.1	79.243724	−57.922309	$3.19^{+0.07}_{-0.07}$			
7.1.2	79.248277	−57.922418				
7.1.3	79.254805	−57.920349				
7.2.1	79.242988	−57.922267	$3.19^{+0.06}_{-0.07}$			
7.2.2	79.248711	−57.922363				
7.2.3	79.254528	−57.920457				
7.3.1	79.242716	−57.922319	$3.14^{+0.08}_{-0.05}$			
7.3.2	79.249178	−57.922340				
7.3.3	79.254200	−57.920678				
8.1.1	79.248756	−57.913471	$2.75^{+0.03}_{-0.06}$			
8.1.2	79.244291	−57.913620				
8.1.3	79.235946	−57.915279				
c9.1.2	79.239817	−57.915020	...			
c9.1.3	79.239712	−57.915060				
c9.1.1	79.250913	−57.913842				
c9.2.2	79.240678	−57.914713				
c9.2.3	79.239344	−57.915166				
10.1.2	79.243620	−57.917139	$2.01^{+0.12}_{-0.00}$			
10.1.3	79.241795	−57.917649				
SPT-CL J2011−5228						
1.1.1	302.778750	−52.468514	2.39		T. E. Collett et al. (2017)	
1.1.2	302.777304	−52.473801				
1.1.3	302.786413	−52.473878				
1.1.4	302.788056	−52.468085				
1.1.5	302.783401	−52.470918				
1.2.1	302.778605	−52.468359				
1.2.2	302.776123	−52.472561				
1.2.3	302.786457	−52.473619				
1.2.4	302.785920	−52.467308				
1.2.5	302.784020	−52.471090				
1.3.1	302.776720	−52.469639				
1.3.2	302.776185	−52.471744				

Table 8
(Continued)

ID	R.A. (J2000)	Decl. (J2000)	z	z_{spec}	References	Notes
1.3.3	302.785524	−52.473703				
1.3.4	302.786017	−52.467120				
1.3.5	302.783865	−52.471347				
1.4.2	302.776110	−52.472685				
1.4.3	302.786757	−52.473530				
1.4.4	302.785390	−52.467269				
1.4.5	302.784113	−52.471039				
1.4.6	302.776430	−52.472941				
1.4.7	302.776819	−52.473485				
1.5.1	302.776974	−52.469463				
1.5.2	302.776145	−52.472136				
1.5.3	302.785922	−52.473689				
1.5.5	302.783920	−52.471241				
1.6.2	302.776341	−52.472333				
1.6.3	302.785582	−52.473885				
1.6.4	302.787028	−52.467465				
1.6.5	302.783560	−52.471175				
1.7.2	302.776045	−52.472627				
1.7.3	302.786759	−52.473505				
1.7.4	302.784679	−52.467175				
1.7.5	302.784164	−52.471059				
1.7.6	302.776532	−52.473056				
1.7.7	302.776725	−52.473362				
1.9.1	302.776805	−52.469752				
1.9.2	302.776376	−52.471894				
1.9.3	302.785055	−52.473923				
1.9.4	302.787054	−52.467369				
1.9.5	302.783347	−52.471265				
1.10.1	302.777721	−52.469223				
1.10.2	302.777413	−52.473786				
1.10.3	302.786022	−52.474016				
1.10.4	302.788336	−52.468186				
1.10.5	302.783094	−52.470933				
1.12.2	302.776112	−52.472286				
1.12.3	302.786123	−52.473657				
1.12.5	302.783945	−52.471186				
1.13.2	302.776257	−52.471842				
1.13.3	302.785323	−52.473810				
1.13.4	302.786546	−52.467242				
1.13.5	302.783662	−52.471306				
1.14.2	302.775857	−52.471818				
1.14.3	302.786208	−52.473365				
1.14.5	302.784478	−52.471378				
1.15.1	302.778616	−52.468309				
1.15.2	302.776045	−52.472465				
1.15.3	302.786459	−52.473569				
1.15.4	302.785220	−52.467181				
1.15.5	302.784111	−52.471128				
1.16.2	302.775965	−52.472341				
1.16.3	302.786454	−52.473511				
1.16.5	302.784240	−52.471178				
1.17.2	302.775978	−52.472261				
1.17.3	302.786349	−52.473529				
1.18.6	302.776841	−52.472824				
1.18.7	302.776973	−52.472923				
1.19.6	302.776741	−52.472864				
1.19.7	302.776867	−52.472969				
1.20.6	302.776563	−52.472916				
1.20.7	302.776817	−52.473189				
1.21.1	302.778809	−52.468405				
1.21.2	302.777113	−52.473539				
1.21.3	302.786508	−52.473760				
1.21.5	302.783702	−52.470964				

Table 8
(Continued)

ID	R.A. (J2000)	Decl. (J2000)	z	z_{spec} References	Notes
1.22.1	302.777476	−52.469217			
1.22.2	302.777029	−52.473390			
1.22.3	302.786208	−52.473807			
1.22.5	302.783634	−52.471033			
1.23.2	302.776326	−52.472367			
1.23.3	302.785456	−52.473916			
1.23.5	302.783502	−52.471160			
1.24.2	302.777457	−52.473627			
1.24.3	302.785626	−52.474100			
1.24.5	302.782845	−52.470949			
1.25.2	302.777236	−52.473334			
1.25.3	302.785376	−52.474010			
1.25.5	302.783207	−52.471100			
1.26.2	302.777336	−52.473516			
1.26.3	302.785389	−52.474069			
1.26.5	302.783106	−52.471040			
2.1.1	302.776724	−52.471719	2.39	T. E. Collett et al. (2017)	
2.1.2	302.784262	−52.474137			
2.1.3	302.787970	−52.467604			
2.1.4	302.782647	−52.471186			
2.1.5	302.777305	−52.472830			
2.1.6	302.777261	−52.472535			
3.1	302.773559	−52.472525	$2.59^{+0.04}_{-0.01}$		
3.2	302.788050	−52.471836			
3.3	302.786087	−52.471206			

Note. Properties of the multiple images identified in each cluster. The image ID for each multiple image is labeled such that the first number corresponds to the lensed source, the second number corresponds to a specific substructure clump in the image, and the third number corresponds to the image (e.g., #Source.#Clump.#Image). The R.A. and decl. are provided for each image in degrees, where the coordinate frame is aligned to the JWST WCS. The redshift and associated reference (s) for the multiple images in each cluster are also listed, where the redshift corresponds to a spectroscopic measurement, in which case it does not include error bars, a model redshift estimate, in which case error bars are provided, or a fixed model redshift, which is denoted by brackets. Candidate lensing sources are denoted with the letter “c,” such that “c1.1.1” indicates candidate Source #1, Image #1, Clump #1.

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