11560 - Cl0016+1609: the first (and the last) massive cluster of galaxies at z>0.5

Cycle: 17, Proposal Category: GO

(Availability Mode: SUPPORTED)

INVESTIGATORS

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VISITS

Visit	*Targets used in Visit*	*Configurations used in Visit*	*Orbits Used*	*Last Orbit Planner Run*	*OP Current with Visit?*
01	(1) MACSJ0018.5+1626	ACS/WFC	4	28-Jul-2009 21:04:42.0	yes

4 Total Orbits Used

ABSTRACT

We propose two-filter (F555W, F814W) ACS observations of the core of Cl0016+1609, arguably the most famous massive cluster at z>0.5. The most-studied such system at all wavelengths from X-ray to radio, Cl0016+1609 has no useful multi-passband ACS images to date. Complementing the only existing ACS data (a 2x2 mosaic in the F606W passband and a snapshot of the core in the F775W passband), the observations proposed here will provide resolved color information on both lensed background objects and cluster galaxies, thereby allowing us to measure accurately the

cluster's dark-matter distribution on scales from tens to more than 500/h_50 kpc using both strong- and weak-gravitational lensing, and to study the color morphology of mergers and the star-formation history of galaxies in a high-density environment. Supported by an extensive groundbased imaging and spectroscopic campaign, as well as by deep Chandra X-ray observations, this observation completes our HST/ACS survey of the 12 most distant galaxy clusters detected in the MACS X-ray survey.

OBSERVING DESCRIPTION

PROPOSED OBSERVATIONS

We propose moderately deep ACS observations in two passbands (two orbits in each of F555W and F814W) of Cl0016+1609 to improve upon existing WFPC2 images that cover only about half the area, and complementing wide-field ACS imaging in the F606W filter (proposal ID 10635) which provides valuable morphological parameters but no color information as the F606W filter straddles the 4000A break at z=0.5. The proposed observation completes our HST/ACS survey of massive, X-ray selected clusters at $0.5<z<0.7$, a cornerstone of our comprehensive, quantitative, multi-waveband study of the properties of massive distant clusters. The depth of the proposed observations is dictated by the requirement for an accurate measurement of the gravitational shear field; resolved color information is critical for secure identifications of all faint, multiply imaged background objects and thus an unambiguously determined lens model, as well as for the proposed detailed study of the cluster galaxy population and its evolution.

With Cl0016+1609 being the perhaps best-studied distant cluster of all, and MACS now being recognized as the ultimate sample for studies of massive clusters at

intermediate redshift (0.3<z<0.7), we stress the heritage character of the observations proposed here which will prove useful to a wider community for a multitude of cluster-related studies.

SUPPORTING OBSERVATIONS

X-ray

All 12 MACS clusters at z>0.5 have been observed with ACIS-I, providing superb X-ray data for this best-defined sample of massive distant clusters ever (Fig.~5). All data are reduced, yielding gas-density and temperature maps all the way from the cluster core out to typically 1~Mpc.

Groundbased optical

The HST observations of all 12 systems are supported and complemented by observations with Subaru, Gemini, and Keck. Specifically, we have, for Cl0016+1609, obtained high-quality Keck/DEIMOS spectroscopy of 334 cluster/filament members as well as deep UBVRIz' band imaging with CFHT/MegaCam and Subaru/SuprimeCam (Fig.~6) to constrain the large-scale mass distribution beyond the ACS field of view via weak lensing, and to obtain global colours for galaxies in this region.

REAL TIME JUSTIFICATION

TECHNICAL JUSTIFICATION

Our primary goal is to map in detail the dark matter distribution in these clusters. The ACS field extends to a median radius of 120" or ~0.9 1/h50 Mpc at z=0.5-0.7. The high masses expected for these X-ray luminous systems predict typical shears of 20% at this radius. Our analysis of our Subaru imaging data (see Fig.~6) confirms that ground-based data can measure the radially averaged shear on these scales, but can not provide the high-resolution mass maps essential for comparing the dark matter and intracluster gas on ~100 kpc scales in the cluster cores.

We plan to follow the same observing strategy that proved highly successful in our HST/ACS observations for the remainder of the MACS z>0.5 sample in GO-09722, and thus request 2 orbits per filter using LOW-SKY (to reduce Earth-shine) which translates into a visibility of about 2500 sec for Cl0016+1609. We will dither between exposures to cover the gaps between the WFC chips and also to reduce the effects of flatfield and hot pixel errors. We shall adopt the approach taken by the COSMOS team (Leauthaud et al. 2007, Rhodes et al. 2007, Massey et al. 2007) for a comprehensive analysis of the observed shear field.

The F814W observations will probe the restframe morphology of the cluster members longward of 4000A. Blueward of 4000A we complement these with observations in F555W to study the internal color structure of the cluster members and, importantly, to use color and morphological information to confirm the identity of multiply imaged background sources in the crowded cluster core. To achieve the latter we require photometry to 20% precision at the limit of our arclet catalog, I=25.5, or V=26.5 using the typical color at this depth.

For a 5-sigma detection of V=26.5 in F555W within a 1" aperture, this requires 5600 s and hence 2 orbits (again based on LOW-SKY).

LOW-SKY REQUIREMENT

A weak-lensing analysis of the gravitational shear field induced by the mass of the target cluster requires high-precision measurements of the ellipticity of faint background galaxies across the full field of view. Earth glow would drastically reduce our sensitivity by raising the limiting magnitude, and thus lowering the number of background galaxies for which accurate shape measurements can be obtained.

Visit

Proposal 11560, Visit 01, implementation Wed Jul 29 01:04:48 GMT 2009

Diagnostic Status: No Diagnostics

Scientific Instruments: ACS/WFC

Special Requirements: (none)

Patterns

#	Primary Pattern		Secondary Pattern		Exposures
(1)	Pattern Type=LINE Purpose=DITHER Number Of Points=2 Point Spacing=3.011 Line Spacing=	Coordinate Frame=POS-TARG Pattern Orientation=85.28 Angle Between Sides= Center Pattern=true	Pattern Type=ACS-WFC-DITHER-LINE Purpose=DITHER Number Of Points=3 Point Spacing=0.138 Line Spacing=	Coordinate Frame=POS-TARG Pattern Orientation=32.99 Angle Between Sides= Center Pattern=true	(1), (2)

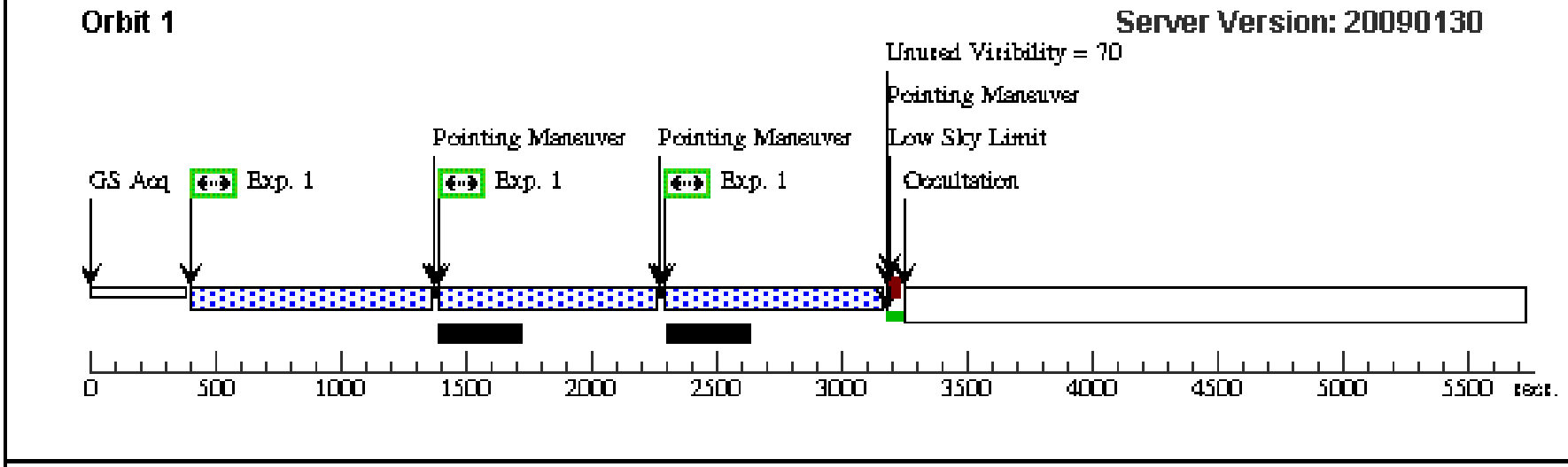
Fixed Targets

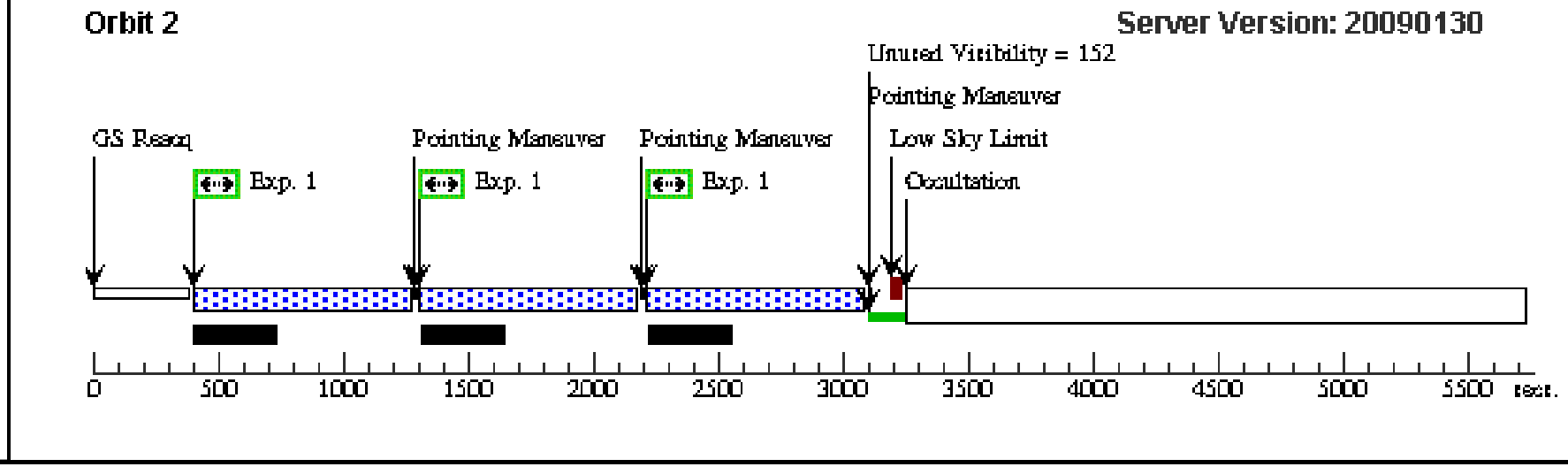
#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous
(1)	MACSJ0018.5+1626	RA: 00 18 33.2300 (4.6384583d) Dec: +16 26 10.60 (16.43628d) Equinox: J2000	Proper Motion RA: 0.0s/yr Proper Motion Dec: 0.0"/yr Epoch of Position:	V=18.0+/-0.0	Reference Frame: ICRS

Exposures

#	Label	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time/[Actual Dur.]	Orbit
1	0018-F555	(1) MACSJ0018.5+1626	ACS/WFC, ACCUM, WFC	F555W	CR-SPLIT=NO	LOW-SKY	Pattern 1, Exps 1-1 (1)	750.0 Secs	
								[==>(Pattern 1,1)]	
								[==>(Pattern 1,2)]	***[1]***
								[==>(Pattern 1,3)]	
								[==>(Pattern 2,1)]	
								[==>(Pattern 2,2)]	***[2]***
								[==>(Pattern 2,3)]	
2	0018-F814	(1) MACSJ0018.5+1626	ACS/WFC, ACCUM, WFC	F814W	CR-SPLIT=NO	LOW-SKY	Pattern 1, Exps 2-2 (1)	760.0 Secs	
								[==>(Pattern 1,1)]	
								[==>(Pattern 1,2)]	***[3]***
								[==>(Pattern 1,3)]	
								[==>(Pattern 2,1)]	
								[==>(Pattern 2,2)]	***[4]***
								[==>(Pattern 2,3)]	

Orbit Structure





Orbit Structure (continued)