Subaru Telescope
National Astronomical Observatory of Japan

Proposal ID	S07B-
Received	/ /

Application Form for Telescope Time

1. Title of Proposal

Subaru lensing survey of dark matter in supermassive galaxy clusters

2. Principal Investigator

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3. Scientific Category

☐ Solar System	☐ Normal Stars	☐ Extrasolar Planets	☐ Star and Planet Formation
☐ Compact Objects and SNe	☐ Milky Way	☐ Local Group	☐ ISM
☐ Nearby Galaxies	☐ Starburst Galaxies	☐ AGN and QSO Activity	☐ QSO Absorption Lines and IGM
☑ Clusters of Galaxies	☐ Gravitational Lenses	☐ High-z Galaxies	☐ Deep Surveys
☐ Large-Scale Structure	☐ Cosmological Parameters	☐ Miscellaneous	

4. Abstract *(approximately 200 words)*

We request 1 night of imaging in S07B for a complete Subaru Suprime-Cam weak gravitational lensing survey of the 20 most massive clusters of galaxies in the northern hemisphere (X-ray temperature selected, with $M \gtrsim 10^{15} h^{-1} M_{\odot}$ at redshifts $0.15 < z < 0.3$). The primary goal is to measure the *scatter* in the mass-temperature relation for massive clusters, which is essential to the use of clusters for cosmological constraints, and is a strong test of models of cluster formation. Measuring the intrinsic $M-T$ scatter requires a complete sample and the minimization of random and systematic errors: the Subaru telescope is the best available instrument for weak-lensing measurements to the virial radius. When combined with pre-existing Chandra X-ray imaging, space-based strong lensing data, and multi-band photometry from KPNO to obtain source photometric redshifts (proposal pending), the Subaru data will permit many tests of galaxy-cluster physics to high statistical precision with minimal systematic error on a large, fairly-selected cluster sample.

5. Co-Investigators

Name	Institute	Name	Institute
Rachel Mandelbaum	Institute for Advanced Study	Charles R. Keeton	Rutgers University
Gary Bernstein	University of Pennsylvania	Neta Bahcall	Princeton University
Satoshi Miyazaki	NAOJ	Nikhil Padmanabhan	LBNL
Tim Schrabback	Universitaet Bonn	Kenneth Cavagnolo	Michigan State University
Megan Donahue	Michigan State University	Andrey V. Kravtsov	University of Chicago

6. List of Applicants' Related Publications *(last 5 years)*

Mandelbaum R., Hirata C. M., Seljak U., Guzik J., **Padmanabhan N.**, Blake C., Blanton M. R., Lupton R., Brinkmann J., 2005, MNRAS, 361, 1287

Mandelbaum R., Seljak U., Cool R. J., Blanton M., Hirata C. M., Brinkmann J., 2006, MNRAS, 372, 758

Mandelbaum R., Seljak U., preprint (astro-ph/0703114)

Massey R., ..., **Bernstein G.**, ... **Mandelbaum R.**, ... **Nakajima R.**, ... **Schrabback T.** et al., 2006, preprint (astro-ph/0608643)

Nakajima N., **Bernstein G.**, 2006, preprint (astro-ph/0607062)

Schrabback T. et al., 2006, preprint (astro-ph/0606611)

information for these purposes. The entire proposal including scientific justification will be passed to support astronomers for preparation of observations upon acceptance.

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8. Observing Run

Instrument	# Nights	Moon	Preferred Dates	Acceptable Dates	Observing Modes
Suprime-Cam	1	Dark/grey	Dec/Jan	Nov–Jan	Imaging (r')

Total Requested Number of Nights [1] Minimum Acceptable Number of Nights [1]

9. List of Targets *(Use an additional sheet if this space is not sufficient)*

☐ I do **not** want observatory staff to see the target names for the technical review.

Target Name	RA	Dec	Equinox	Magnitude (Band)
DEEP2 calibration field	02 30 00.0000	+00 00 00.00	J2000	$r'_{\rm lim} = 25.1$
ABELL 0068	00 37 06.2000	+09 09 33.00	J2000	$r'_{\rm lim} = 25.1$
ABELL 0267	01 52 41.9597	+01 00 25.60	J2000	$r'_{\rm lim} = 25.1$
ABELL 0611	08 00 56.8176	+36 03 23.59	J2000	$r'_{\rm lim} = 25.1$
ABELL 0665	08 30 57.1656	+65 50 31.67	J2000	$r'_{\rm lim} = 25.1$
ABELL 0697	08 42 57.5575	+36 21 59.27	J2000	$r'_{\rm lim} = 25.1$
ABELL 0773	09 17 53.4264	+51 43 37.33	J2000	$r'_{\rm lim} = 25.1$
ABELL 0963	10 17 03.6360	+39 02 49.40	J2000	$r'_{\rm lim} = 25.1$
ZwCL 3146	10 23 39.6346	+04 11 10.65	J2000	$r'_{\rm lim} = 25.1$
ABELL 1576	12 36 58.4844	+63 11 12.91	J2000	$r'_{\rm lim} = 25.1$
ABELL 1682	13 06 49.9997	+46 33 33.38	J2000	$r'_{\rm lim} = 25.1$
ABELL 1689	13 11 29.4998	-01 20 27.91	J2000	$r'_{\rm lim} = 25.1$

10. Scheduling Requirements ☒ *Request Remote Observation*

As shown from the target list (sorted in order of right ascension), there are 21 targets including calibration fields. If observations are taken in Nov/Dec/Jan, 10 of those targets will be easily observable, which splits the target list quite evenly between S07B and S08A. Observation in Aug/Sept/Oct would lead to only 6 visible targets, about 1/2 night worth of time; this would then require 15 targets to be observed in S08A (possibly more than one night's worth of observing).

11. Instrument Requirements

N/A

12. Experience

The likely observers (Nakajima and Mandelbaum) have not observed at Subaru before.

13. Backup Proposal in Poor Conditions *(specify object names)*

If seeing is poor, imaging of the same targets will be obtained but will be used only for photo-z's, not weak lensing.

Please describe in detail about instrument configuration, exposure time, required sensitivity, and so on.

We propose single-band (r') imaging of 19 cluster targets (20 clusters, since one target is a double cluster 8' apart) plus two calibration fields, a single pointing per target. Of these targets, we request time for 10 pointings this semester and will request time for the remaining 11 when they are visible early in the next semester. With an exposure time of 1800s, we can reach a limiting magnitude of 25.1 ($S/N = 10$ for 2" extended source in 0.7" seeing) which will allow us to measure shapes of source galaxies to $z \sim 1$. We require high imaging quality for weak lensing measurements (seeing $< 0.8''$ FWHM). We split the integration time up into 6×300s observations, and when including overhead of 60s per exposure, we obtain a total time this semester of $6 \times 10 \times (300 + 60)$s, or 6 hours. Any additional time available will be used to obtain i' or z' imaging for photometric redshift determinations.

Images in r' or R band of 5 of the 21 clusters are available in the Subaru archive. We will make use of these whenever they have seeing and depth at good or better than our requirements. Uniformity of filters and image quality is essential to the primary scientific goal of estimating the intrinsic scatter in the mass-temperature relation.

The balance of the photometric-redshift data (*ugiz* bands) will be obtained from Kitt Peak National Observatory, because the excellent seeing of Subaru is not required to obtain galaxy colors.

15. Condition of Closely-Related Past Observations

Please fill in here, if this proposal is a continuation of (or inextricably related with) the previously accepted proposals. This is to describe what kind of relevant/similar proposals have existed in the past and how such previous observations were carried out.

Proposal ID Title (may be abbreviated)	Observational condition	Achievement (%)

16. Post-Observation Status and Publications

Please report the status or outcome of your main Subaru observations carried out in the past. All observations relevant to this proposal (e.g., those enumerated in the above entry 15) must be included here; otherwise, only those within last 3 years suffice.

Year/Month	Proposal ID	PI name	Status: data reduction/analysis	Status: publication

17. Thesis Work

☐ This proposal is linked to the thesis preparation of _____

_____

18. Subaru Open Use Intensive Programs

☐ This is a proposal for Intensive Programs.

☐ I do **not** want observatory staff to see the target names for the technical review.

Target Name	RA	Dec	Equinox	Magnitude (Band)
ABELL 1758	13 32 39.4584	+50 28 50.34	J2000	$r'_{\rm lim} = 25.1$
ABELL 1763	13 35 20.0950	+41 00 04.13	J2000	$r'_{\rm lim} = 25.1$
ABELL 1835	14 01 02.0714	+02 52 42.48	J2000	$r'_{\rm lim} = 25.1$
ABELL 1914	14 25 56.6678	+37 48 59.24	J2000	$r'_{\rm lim} = 25.1$
ABELL 2111	15 39 40.4930	+34 25 27.32	J2000	$r'_{\rm lim} = 25.1$
ABELL 2218	16 35 49.1832	+66 12 45.12	J2000	$r'_{\rm lim} = 25.1$
ABELL 2219	16 40 19.8096	+46 42 41.34	J2000	$r'_{\rm lim} = 25.1$
ABELL 2261	17 22 27.1920	+32 07 57.43	J2000	$r'_{\rm lim} = 25.1$
DEEP2 calibration field	+23 30 00.00	+00 00 00.00	J2000	$r'_{\rm lim} = 25.1$