Ongoing Investigations of Dark Matter in the Merging Cluster Collaboration

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KIAS Survey Science Workshop 2019
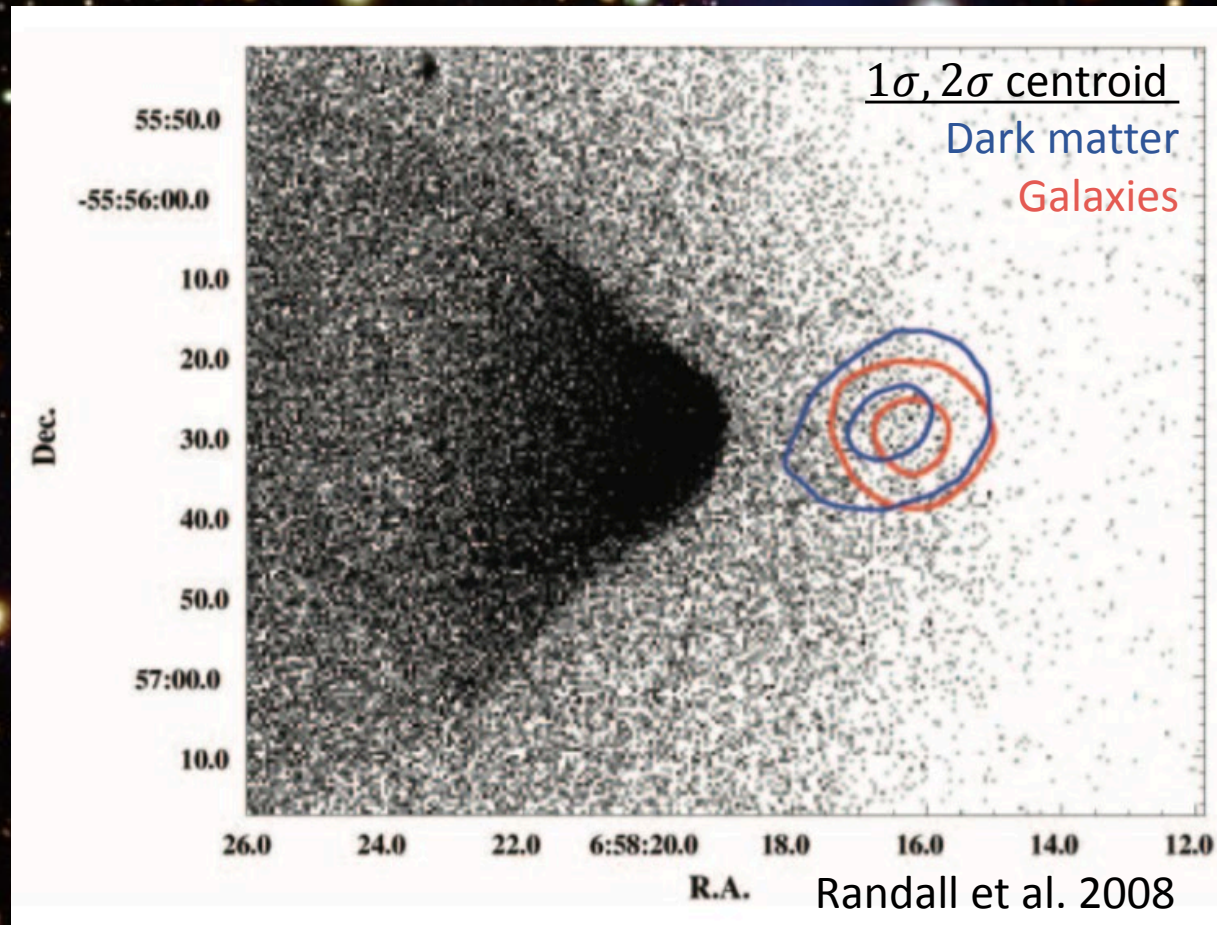
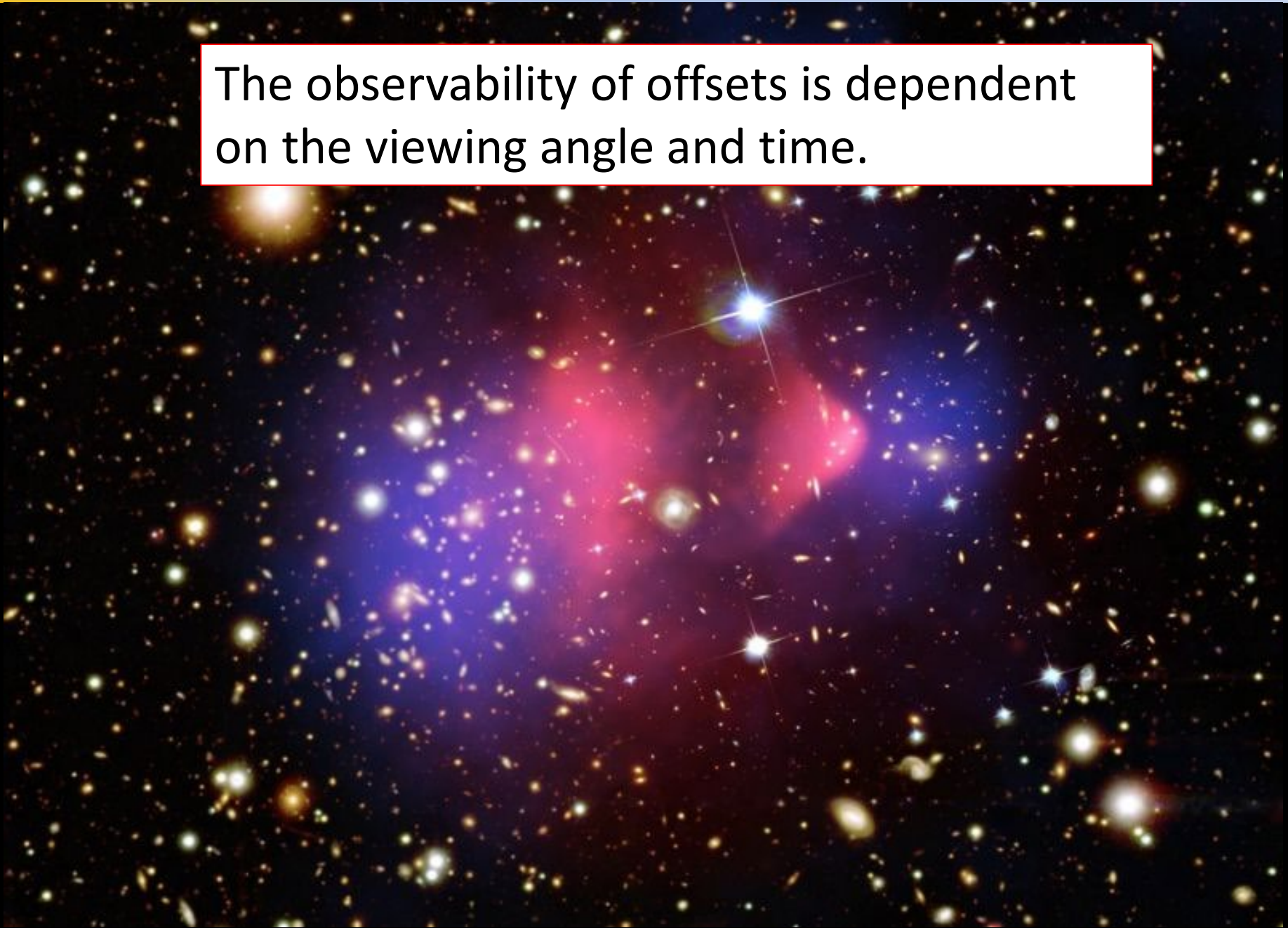High1 February 20-22 2019

Constraining Dark Matter

NASA

Simulations Improve Constraints

$1\sigma, 2\sigma$ centroid
Dark matter
Galaxies

Randall et al. 2008

The observability of offsets is dependent on the viewing angle and time.

Sample Selection

- Ideal mergers:
  - Merging in the plane of the sky.
  - Observed between first pericenter passage and apocenter.
  - Equal mass (Kim et al. 2017)

Radio Relic Clusters:
  - Radio relics are synchrotron from merger induced shocks in ICM.
  - Relic constrains viewing angle to near the plane of sky.
  - Relic is good indicator of post-merger system.
  - Double relics likely to form in major mergers.

Sausage Cluster

Jee et al. 2015
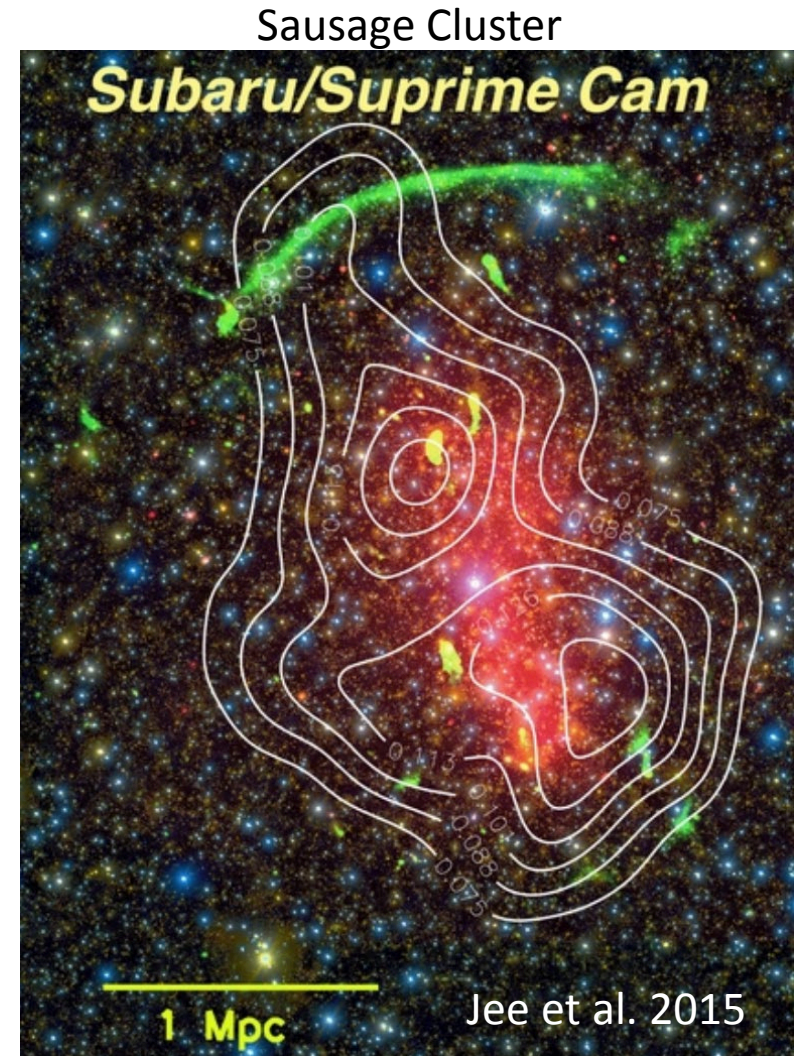
Multiwavelength Approach

Radio

- Relic constrains merger axis, collision velocity, and viewing angle.

Deep optical imaging

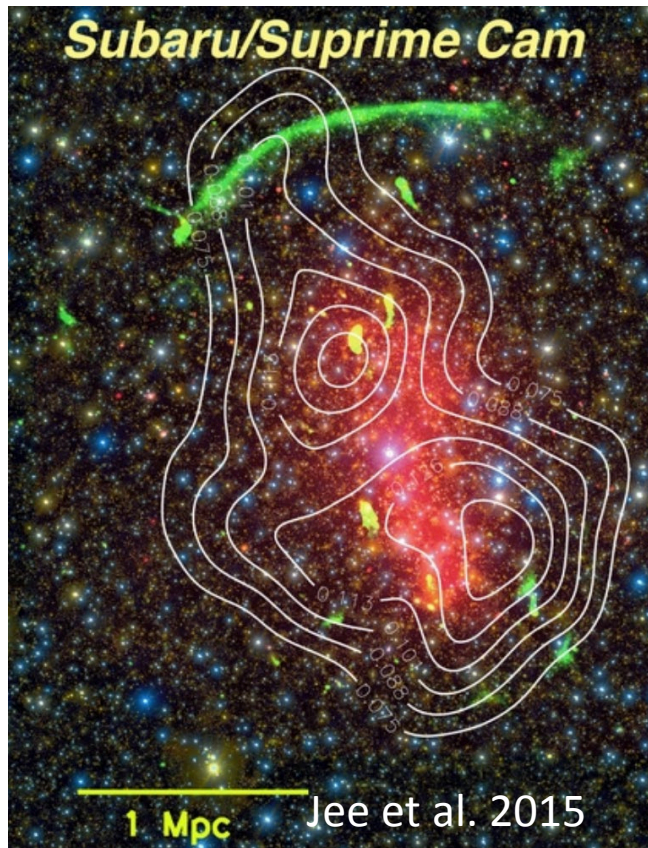- WL mapping of dark matter distribution.
- Accurate mass estimate.

Spectroscopy

- Cluster galaxy selection.
- LOS velocity of clusters.

X-ray

- ICM distribution.
- Investigate shocks.

Numerical Simulations

Subaru/Suprime Cam

1 Mpc

Jee et al. 2015

Galaxy luminosity

Jee et al. 2015

MC^2 Cluster Sample

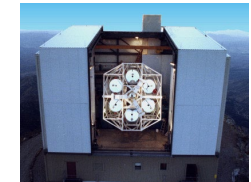| Name	RA	Dec.	z	Xray Peaks	Radio Relics
1RXSJ0603	6:03:13	+42:12:31	0.226	2	3
A115	0:56:00	+26:19:14	0.193	2	1
A521	4:54:09	-10:14:39	0.247	2	1
A523	4:59:01	+08:46:30	0.104	2	1
A746	9:09:37	+51:32:48	0.214	1	1
A781	9:20:23	+30:26:15	0.297	2	1
A1240	11:23:32	+43:06:29	0.195	2	2
A1300	11:32:01	-19:53:34	0.306	2	1
A1612	12:47:43	-02:47:32	0.182	1	1
A2034	15:10:11	+33:30:22	0.114	1	1
A2061	15:21:21	+30:40:15	0.078	2	1
A2163	16:15:34	-06:07:26	0.201	2	1
A2255	17:12:50	+64:03:11	0.08	1	1
A2345	21:27:10	-12:09:59	0.179	2	2
A2443	22:26:03	+17:22:41	0.11	1	1
A2744	0:14:19	-30:23:22	0.306	2	1
A3365	5:48:12	-21:56:06	0.093	2	1
A3411	8:41:55	-17:29:05	0.163	1	1
CIZAJ2242	22:42:51	+53:01:24	0.189	2	2
MACSJ1149	11:49:36	+22:23:55	0.544	1	2
MACSJ1752	17:52:02	+44:40:46	0.365	2	2
PLCKG287	11:50:49	-28:04:37	0.383	1	2
PSZG108	23:22:30	+48:46:30	0.335	1	2
RXCJ1053	10:53:44	+54:52:21	0.072	2	1
RXCJ1314	13:14:24	-25:15:21	0.247	2	2
ZWCL0008	0:08:26	+52:31:41	0.104	2	2
ZWCL1447	14:49:28	+26:07:57	0.376	1	1
ZWCL1856	18:56:41	+66:21:56.0	0.304	2	2
ZWCL2341	23:43:40	+00:16:39	0.27	2	1

29 Radio Relic Selected Clusters

A few numbers on the data set:

- 40 hours of Subaru imaging

- 5500 cluster member galaxy spectra

- 4000 ks of X-ray observations

- 250 hrs of radio

MC^2 Cluster Sample

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29 Radio Relic Selected Clusters

Megaparsec sized radio relics

Redshift range: 0.07 < z < 0.55

Disturbed X-ray morphologies

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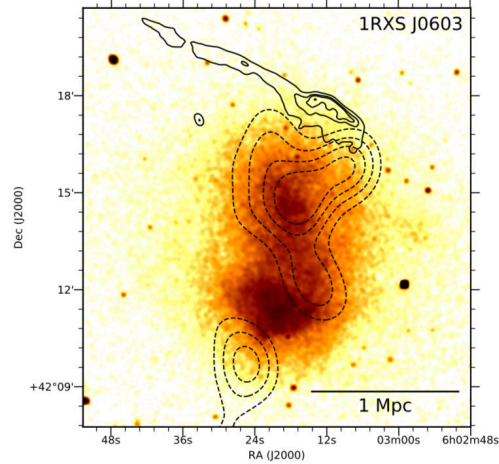**29 Radio Relic Selected Clusters**

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Disturbed X-ray morphologies

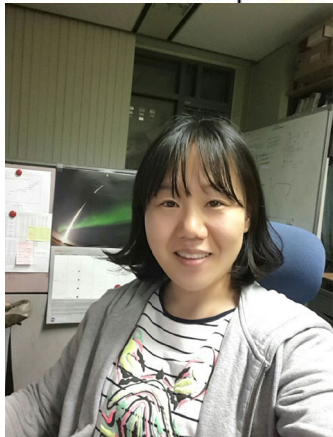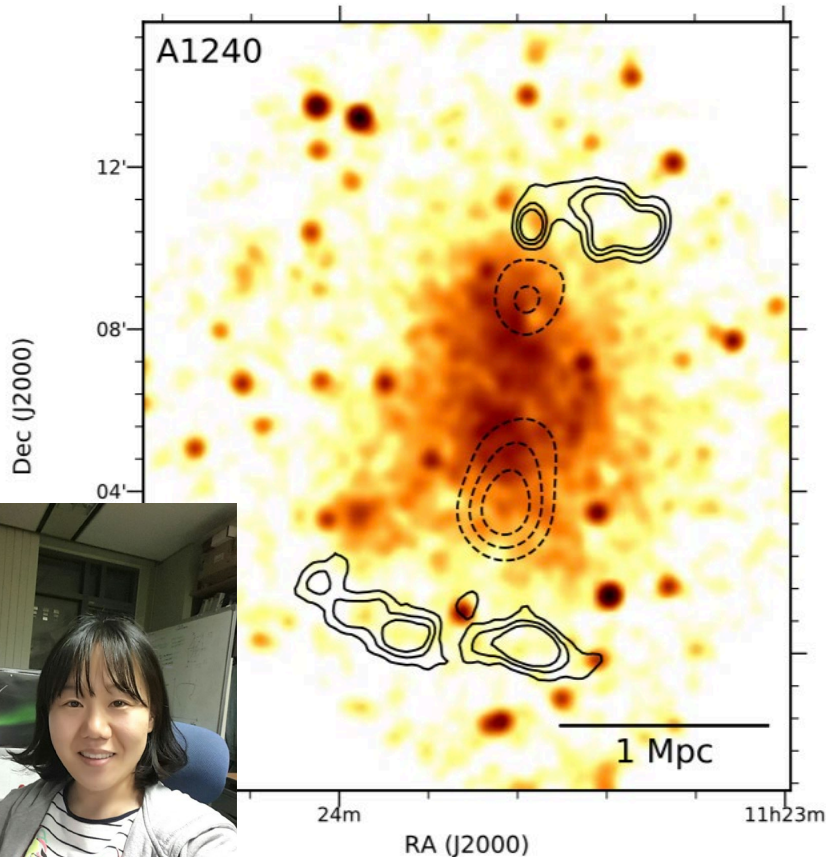11 of the clusters contain 2 radio relics.

Two Relic Systems
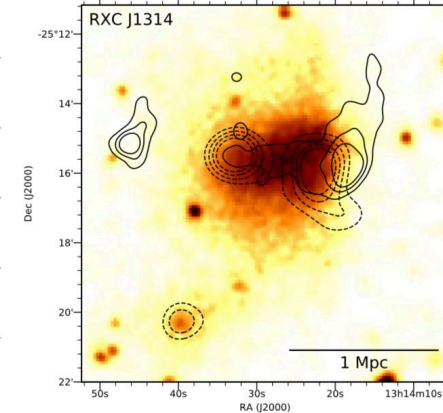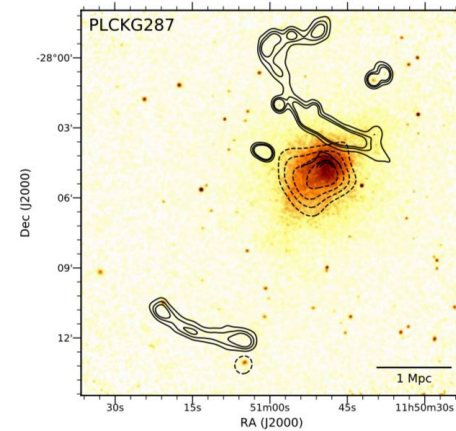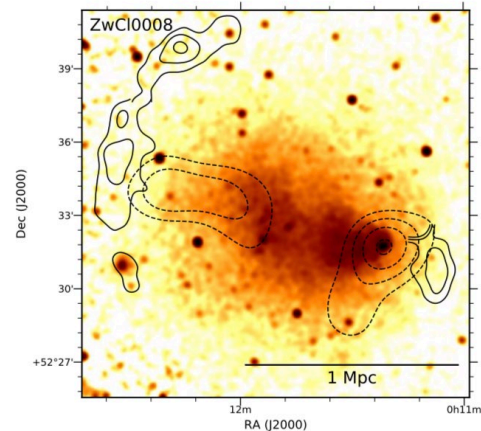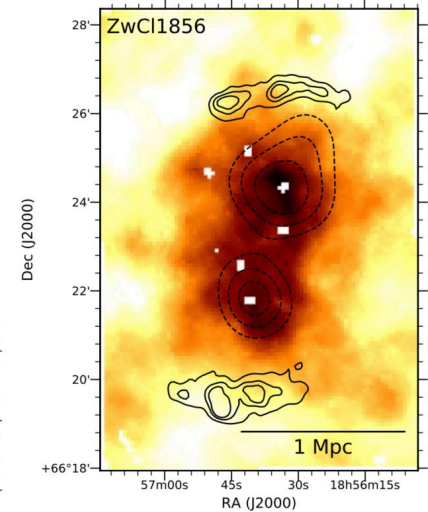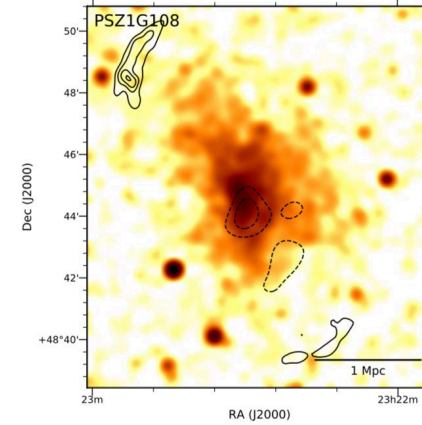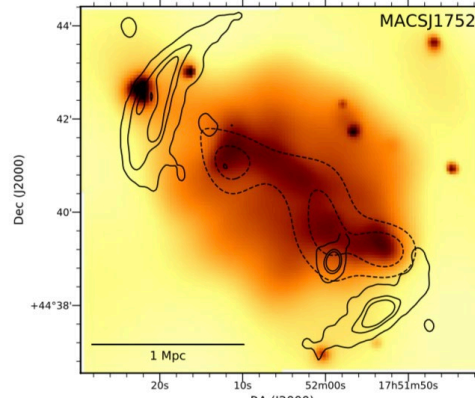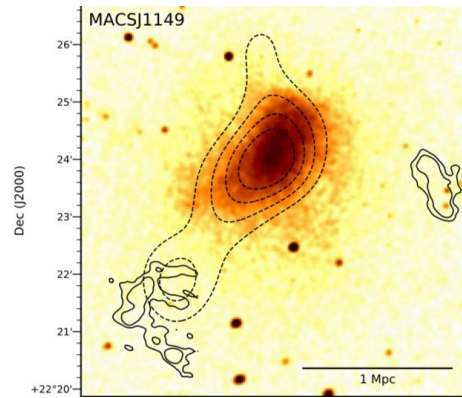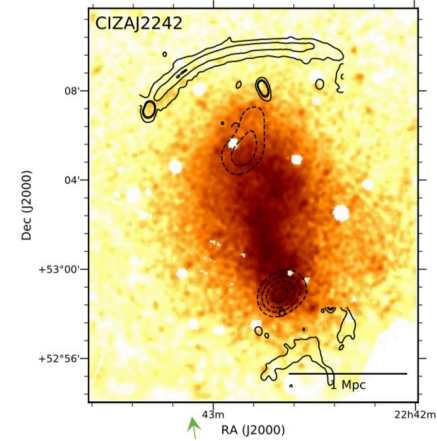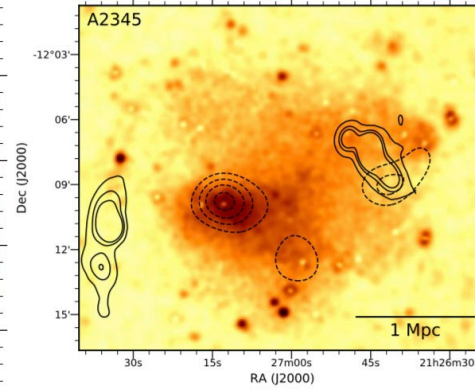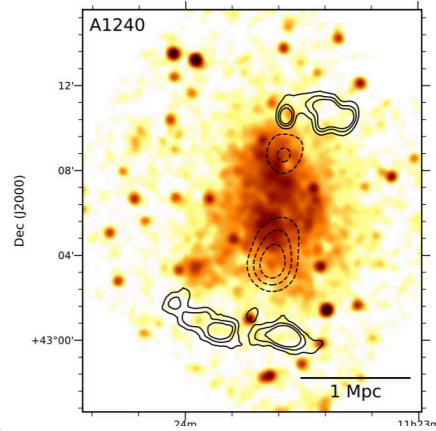
Golovich et al. 2017

Ongoing Lensing Investigations

- Improving the characterization of the galaxy populations with *new* MMT-Hectospec observations thanks to the KGMT.
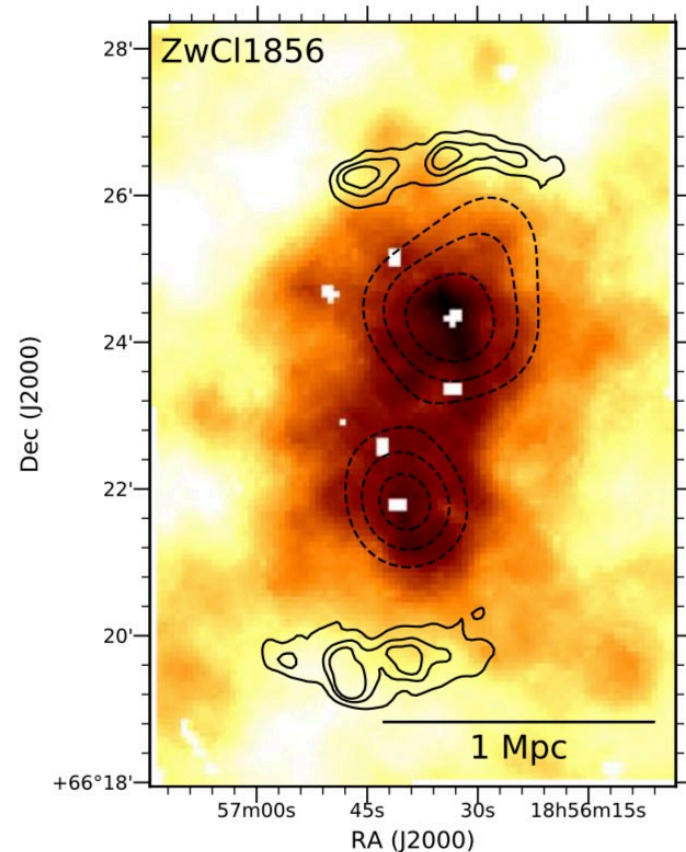

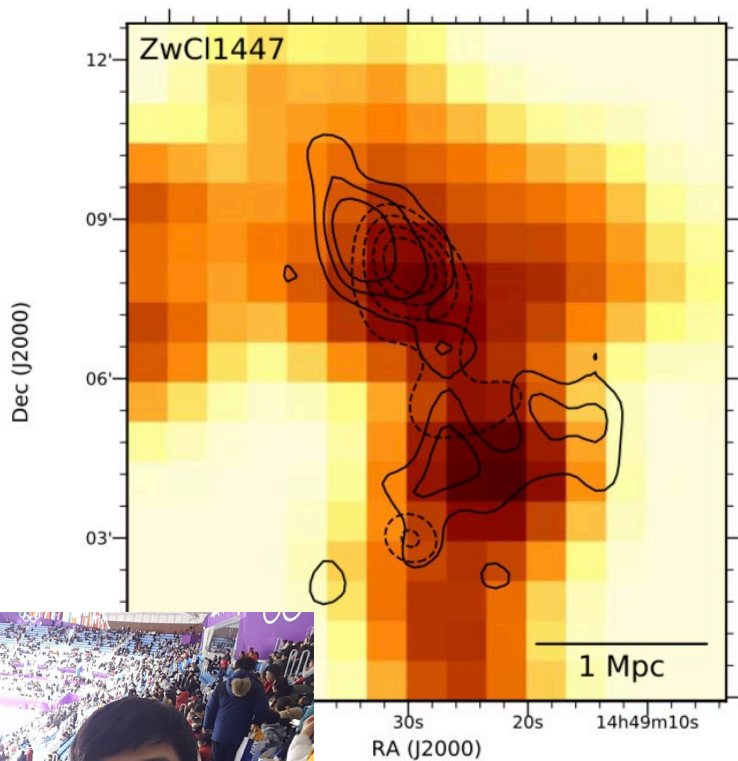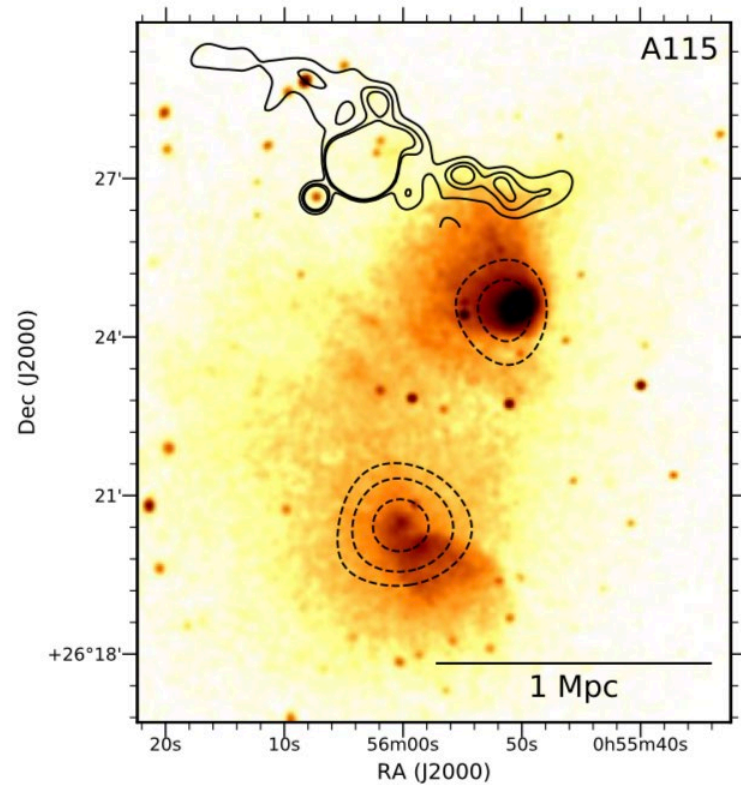Cho et al. in prep.

Finner et al. in prep.

Image credit: Golovich et al.. 2017

Ongoing Lensing Investigations

Lee et al. in prep.

Kim et al. submitted

Image credit: Golovich et al.. 2017