**Top Ten Reasons I had to go Last**

10) that joke about the Minotaur, the Kiwi, and the Aussie
9) Fell asleep during Duncan’s talk
8) Skipped to front of coffee line every morning
7) “England: World Rugby Champions” t-shirt I sent Glen
6) Thought Swinburne was pronounced Swinebum
5) LOC assumed everyone would be at the Olympics by now
4) I’m from California: ‘nuff said
3) Got caught writing “CDM sucks!” on the theory posters
2) Ιτσ αλλ Γρεεκ το με!
1) The LOC didn’t like my idea for the Conference poster
Outline

• IRAC Observations of High-z Clusters

• Weighing Galaxy Clusters

• Unofficial Conference Summary, featuring prizes/refreshments
An IRAC Survey of High Redshift Galaxy Clusters

w/ Peter Eisenhardt (JPL), Piero Rosati (ESO), Brad Holden (UCSC), and Mark Dickinson (NOAO)

• GTO program, ~40 clusters at $0.6 < z < 4.1$
• $5 \times \sim 12$ arcmin field at 3.6, 4.5, 5.8, and 8.0 µm
• Depth of $\sim 3$ mag below $L^*$
RXJ1252-2927, $z=1.24$

IRAC 3.6 $\mu$m

$B + z + 3.6 \mu$m
A New Look at an Old Way to Estimate the Mass of Galaxy Clusters

Lin, Mohr, & Stanford (2004)
The IRAC Shallow Survey
4.5 μm image
8.5 sq degrees
in NDWFS Boötes
3 x 30 sec/position

NGC 5646

UGC 9315

Extreme 8 μm/l flux object

z > 1 cluster candidate
How to Estimate the Mass of a Galaxy Cluster

• Velocity dispersion
• X-ray temperature
• Weak lensing
Revisit the M/L Approach

• Measure total light, estimate mass from assumed M/L
Previous work in the optical

Girardi et al. (2002)
Revisit the M/L Approach

- Measure total cluster light, estimate mass from assumed M/L
- Realize/believe better to estimate masses from IR than the optical
Bell et al. (2003)

\[ \log \frac{M}{L} \]

\[ M(K) \]

\[ \log_{10}(M/L) \]

\[ \mu_K \text{ (mag arcsec}^{-2}\text{)} \]

\[ 
\begin{array}{c}
\log_{10}(M/L) \\
M_K \text{ (mag)} \\
\log_{10}(M/L) \\
f_g \\
\end{array}
\]

\[ 
\begin{array}{c}
\log_{10}(M/L) \\
\mu_K \text{ (mag arcsec}^{-2}\text{)} \\
\log_{10}(M/L) \\
B - R \text{ (mag)} \\
\end{array}
\]
Revisit the M/L Approach

• Measure total optical light, estimate mass from assumed M/L

• Realize/believe better to estimate galaxy masses from IR than the optical

• So how well can we estimate total cluster mass using NIR light measurements?
Total Cluster Mass

• Sample is 93 clusters at $0.01 < z < 0.09$

• Measured X-ray temperatures taken from David et al. (1993), Mohr et al. (1999), Finoguenov et al. (2001), Reiprich & Bohringer (2002), Sanderson et al. (2003)

• $M_{500} = 2.55 \times 10^{13} M_{\text{sun}} T_x^{1.58}$

Finoguenov et al. (2001)
Total Cluster Light

- From 2MASS extract K photometry within $r_{200}$ down to $K_s = 13.2$ for each cluster

- Background correct using 2MASS log N - log S relation (Jarrett 2003)

- Determine faint end slope $\alpha$
Composite K-band LF
Dependence of M/L on System Mass

• Yes: Girardi et al. (2002), Rines et al. (2004), Ramella et al. (2004)

• No: Balogh et al. (2001), Kochanek et al. (2003)

• sort of: Bahcall & Comerford (2002)
Explanations of a variable M/L

• low mass clusters/groups are more efficient at producing stars

• high mass clusters destroy more galaxies than low mass clusters

• galaxies have merged more often in high mass clusters
BCG+ICL Luminosity Fraction within 300 kpc

BCG+ICL light fraction

Poster by Anthony Gonzalez
Halo occupation number

\[
N(M_{500} \leq M_{-21})
\]

\[
\alpha_p
\]

\[
M_{500} \ (h_{70}^{-1} \ M_\odot)
\]
Future Work

• New study of ~40 clusters at $0.2 < z < 1.3$, using rest H-band (ground-based and Spitzer/IRAC) photometry and Chandra/XMM temperatures

• A separate project underway to better constrain the faint end slope of the LF in the rest frame K-band in a low-z cluster sample