PECULIARITIES OF STRONG LENSING CLUSTERS

MASSIMO MENEGHETTI

INAF - OSSERVATORIO ASTRONOMICO DI BOLOGNA

COSIMO FEDELI (BOLOGNA) FRANCESCO PACE (HEIDELBERG) STEFAN GOTTLOEBER (BERLIN) GUSTAVO YEPES (BARCELONA) ADI ZITRIN (TEL AVIV) MATTHIAS BARTELMANN (HEIDELBERG) LAURO MOSCARDINI (BOLOGNA)

ISSUES IN SL CLUSTERS

- ARC STATISTICS PROBLEM (BARTELMANN ET AL. 1996): TOO MANY GIANT ARCS (L/W>10) FOR LCDM (X10)
- EINSTEIN RINGS PROBLEM (BROADHURST & BARKANA, 2008): EINSTEIN RINGS ARE TOO BIG FOR LCDM (X2)
- OVERCONCENTRATION PROBLEM (BROADHURST ET AL, 2005+): CONCENTRATIONS ARE TOO LARGE FOR LCDM (X2)

ARE CLUSTERS TOO STRONG LENSES OR JUST PECULIAR OBJECTS?

THE MARENOSTRUM UNIVERSE

Meneghetti M., Fedeli C., Pace F., Gottloeber S., Yepes G., 2010, A&A, in press, arxiv:1003.4544 Fedeli C., Meneghetti M., Gottloeber S., Yepes G., 2010, A&A, in press, arxiv:1007:1551

- COSMOLOGICAL BOX: 512³
 MPC/H, 1024³ DM + 1024³
 GAS PARTICLES (NON RADIATIVE)
- ~957000 HALOS WITH M>5x10¹¹ M_{sun}/H
- 4000 HALOS WITH M>10¹⁴ M_{SUN}/H
- RAY-TRACING THROUGH THREE PROJECTIONS, SOURCES AT Z=2
- MEASURE THE LENSING STRENGTH DEFINING THREE CLASSES OF LENSES
 - CRITICAL LENSES
 - LENSES PRODUCING GIANT ARCS
 - SUPERLENSES (LARGE LENSING CROSS SECTION FOR GIANT ARCS)



ORIENTATION BIAS

• CLUSTERS ARE FITTED WITH TRIAXIAL MODELS.

• THERE ARE NO SIGNIFICANT DIFFERENCES BETWEEN THE AXES RATIOS OF LENSING AND NON-LENSING CLUSTERS NOR AN EVIDENCE FOR LARGER TRIAXIALITY FOR INCREASINGLY LARGER CROSS SECTIONS (SEE ALSO HENNAWI ET AL. 2007). HOWEVER...



Oguri et al. ApJ 632(2005)841



CONSISTENT WITH HENNAWI ET AL. 2007; OGURI ET AL. 2009









DYNAMICAL ACTIVITY

- TORRI ET AL. 2004 ALREADY SHOWED THAT MERGERS BOOST THE LENSING CROSS SECTIONS
- TWO PARAMETERS TO QUANTIFY THE DYNAMICAL STATE OF EACH CLUSTER
 - β: DEVIATION FROM
 VIRIAL EQUILIBRIUM
 - F: DEVIATION FROM HYDROSTATIC EQUILIBRIUM
- THE DISTRIBUTION OF CLUSTERS IN THE β - Γ PLANE ARE CALCULATED AS A FUNCTION OF THE LENSING EFFICIENCY

$$\beta = 1 + \frac{2T - S}{U} = 1 - \frac{2T - S}{|U|}$$
$$\Gamma(r) = 1 - \frac{M_{hydro}(r)}{M(r)}$$



OBSERVABLES AND SELECTION



A COMPLETE SAMPLE OF X-RAY SELECTED CLUSTERS AT Z>0.5



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A COMPLETE SAMPLE OF X-RAY SELECTED CLUSTERS AT Z>0.5



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COMPARISON TO SIMULATIONS

LENS MODEL



LENSING OF Z=2 SOURCES

LENSING CROSS SECTION, CRITICAL LINES,..

WHAT SHALL WE EXPECT FROM AN X-RAY SELECTED SAMPLE?

NOT EASY TO ANSWER THIS QUESTION BECAUSE OF THE SIMPLE GAS PHYSICS IMPLEMENTED IN THE **MN** UNIVERSE





MACS: MEDIANS DIFFER BY ~23% (ZITRIN ET AL.: ~44%)

ARC STATISTICS



MACS: ~2X MORE ARCS THAN EXPECTED FROM THE MARENOSTRUM UNIVERSE



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MACS CLUSTERS ARE EXPECTED TO HAVE LENSING DERIVED CONCENTRATIONS BIASED HIGH

THE BIAS IS
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WITH THE LENSING
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SUMMARY

- SL IS A POWERFUL METHOD TO INVESTIGATE THE MATTER DISTRIBUTION IN CLUSTERS, HOWEVER...
- **SL** CLUSTERS ARE PECULIAR OBJECTS
- NUMERICAL SIMULATIONS PROVIDE A VIABLE METHOD TO PREDICT THE PROPERTIES OF CLUSTER SAMPLES, GIVEN A SELECTION FUNCTION
- WE PERFORMED A COMPARISON BETWEEN THE MARENOSTRUM UNIVERSE AND A SAMPLE OF X-RAY SELECTED CLUSTERS (MACS@Z>0.5)
- LOOKING FOR A LARGER SAMPLE... LOCUSS (RICHARD ET AL. 2010), CLASH!