DLSCL J0916+2953: A New "Bullet-like" Cluster Merger

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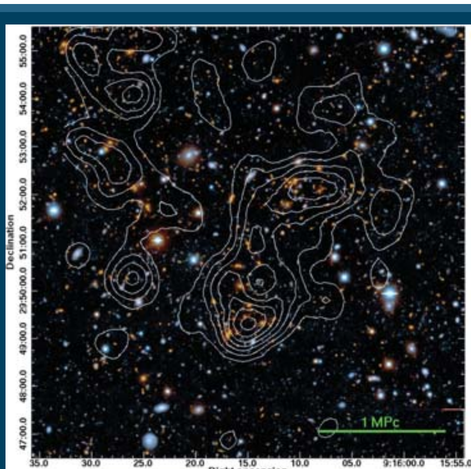
INTRODUCTION

Merging galaxy clusters are becoming important laboratories in our understanding of galaxy evolution as well as fundamental physics. Of particular interest is the post merger phase following the first pass through, during which the **"collisonless" galaxies and dark matter become separated from the collisional intracluster gas**. The most famous such merger is the "Bullet Cluster" 1E 0657-56 which has been used to provide a non-gravitational argument for the existence of dark matter [1], a constraint on the dark matter self-interaction cross-section [2], an upper limit to the matter/antimatter ratio on larger scales than ever before [3], and place tension on ΛCDM [4].

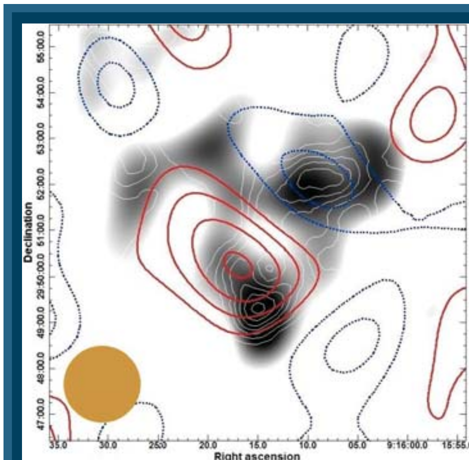
With **only 3 such mergers currently published and discrepant results** [1,5,6,7], more examples are needed. This is the work of an on-going investigation into a new transverse post merger.

DATA



DLSCL J0916+2953 WITH CLUSTER GALAXY NUMBER DENSITY CONTOURS

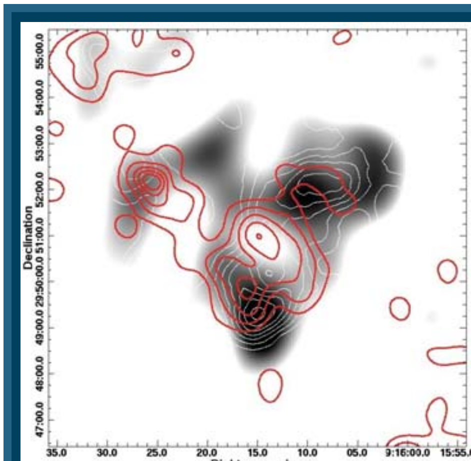
The Deep Lens Survey color image of DLSCL J0916+2953. Overlaid are galaxy number density contours for the galaxies at the cluster redshift of z=0.53 (achieved by binning according to photo-z = 0.53 ± 0.06). The cluster members are the red galaxies. The main two peaks are spectroscopically confirmed to be at the same redshift to within Δz_{spec}=0.002±0.0009 .



WEAK LENSING (GRAY SCALE) WITH SZE CONTOURS

The weak lensing convergence map, or *mass map*, based on Subaru *i'*-band imaging shows two $M_{WL}\sim2.3\pm0.5\times10^{14}M_\odot$ ($\sigma\sim5$) peaks and a third $M_{WL}=1.8\pm0.5\times10^{14}M_\odot$ ($\sigma\sim4$) peak.

The 4σ SZE decrement (red contours) in the CMB at 30 GHz from the SZ-Array Survey [8] is a *probe of the hot intra-cluster gas* and provided the first evidence for an offset of the cluster gas from the galaxies and system mass. The beam size is represented by the gold circle.

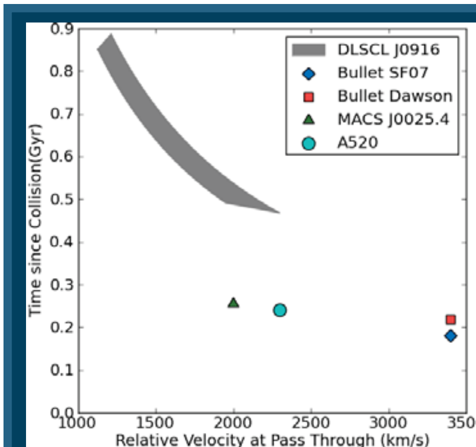


X-RAY

Chandra observed *X-ray emission of the cluster gas* shows a 9.1σ concentration between the main subclusters confirming the post merger scenario.

Additionally the morphology of the central gas is as expected for a post major merger and the morphology of the east gas peak suggests that it is currently infalling.

RESULTS



NEW PHASE OF CLUSTER EVOLUTION

We use a simple analytical model, where the clusters are treated as uniform spheres and the velocity range of DLSCL J0916 is bound by: the maximum free-fall velocity and minimum velocity required to reach their current separation. The measured velocities of the other mergers [5,6,9] were input into the model to calculate their time since collision (point of closest approach). The analytical model "Bullet Dawson" agrees well with N-body simulations "Bullet SF07" [9].

CONSTRAINING DARK MATTER

Following the work of Markevitch et al. [2] we can now conservatively constrain the dark matter self-interaction cross-section:

$$\sigma_{DM}/m_{DM} < 4\ \mathrm{cm^2/g}$$

With further analysis we expect to improve this constraint by at least a factor of two.

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