Shocking Tails in the Major Merger A2744

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# Major Mergers & Galaxy Transformation

- Pinnacle of hierarchical structure formation -> High velocities, increased ICM pressure, changing gravitational field/tides.
- Violent environment -> abnormal rates of galaxy evolution.
- Increased fraction of recently star forming galaxies in mergers (Caldwell+93/97, PoggiantiO4, Miller+03, Ferrari+05, Ma+10).
  - Waters muddied: some mergers don't show enhanced activity (A1750 cf. A168; Hwang & Lee 09).

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#### A2744: A post-core-passage major merger Owers+ 2011 ApJ, 728 V~-1600km/s AAOmega data: 343 spectro. confirmed cluster Interloper Northern/co members. · Two dynamically/spatially distinct major substructures plus central tidal debris. · 125ks Chandra data reveal two low entropy, metal enriched cores Shock Edge Southern compact core · Shock edge. 500 kpc



#### A2744: A post-core-passage major merger Owers+ 2011 ApJ, 728

- Data indicate a post-corepassage major merger with roughly N-S motion, inclined at ~30 degrees to our LOS.
- Combining LOS and shock velocity, total shock M<sub>tot</sub> ~ 3.1 -> ~4700km/s -> Bulletlike subcluster.
  - Northwestern interloper is minor merger, separate from major merger in core.



### Galaxy transformation: "jellyfish" in A2744. Owers+ 2012 ApJL, 750

- Archived HST/ACS F435W (16ks), F606W and F814W (12ks) data used by Merten+11 for lensing analysis.
- F435W redshifted to ~ u-band at z=0.3 -> excellent signpost for recent star formation.
- Close inspection of RGB image reveal four galaxies trails of extremely blue knots and filaments.









RGB image; R=F814W, G=F606W, B=F435W

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# Jellyfish: Interpretation and spatial distribution

- Knots due to in-situ star formation in tails of gas stripped from the parent galaxies (either tidal or ram pressure e.g. Cortese +07, Smith+10).
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### Comparison with other jellyfish galaxies.

- Rare at z ~ 0.2-0.3: only three known in A2125 (Owen+06), A1689 & A2667 (Cortese+07) -> four in A2744 alone!
- Knots in A2744 jellies have -13 < M<sub>1</sub> < -17 are brighter than low-z jellies in Coma and Virgo (M<sub>1</sub> > -13; Yoshida+08,12 and Smith+10, Hester+10).
  - Brightness comparable to ESO 137-001 in the merging cluster A3627 (Sun+2007; Woudt +2008).
  - A2744 harbours a relative excess of jellyfish galaxies which are a brighter, more extreme version of their low-z analogues.





# A merger-related orígín for the jellyfish in A2744?

- Hypothesis:
  - Large merger velocíties (~4500km/s) -> more efficient ram pressure -> higher incidence of gaseous tails.
  - Proximity to shock and Bullet-like subcluster -> overrun by shock.
  - Rapid increase in ICM pressure due to Mach 3 shock [P<sub>ICM, shock</sub>>10 P<sub>thresh, GMC</sub> (Elmegreen & Efremov 97)]-> promote star formation in the tails -> higher incidence of observable jellyfish.
  - Higher ICM pressure -> higher SFR -> brighter knots.

### Evidence for interaction with shock.

- Proximity of jellyfish to the shock.
- Large area covered by shock.
- Young ages of star forming regions (in 100Myrs, travel ~100kpc @1000km/s)
- All jellyfish have negative v<sub>pec</sub> -> not members of Bullet subcluster.
- <u>Highly likely that these galaxies have</u> been overrun by the shock.





### Summary

- A2744 is a high velocity, post-core passage major merger inclined to within ~30° to our line of sight with a Bullet-like subcluster having a Mach 3 shock.
- HST images reveal four "jellyfish" galaxies in close proximity to shock edge and Bullet-like subcluster.
- . Jellies rare at  $z^0.2-0.3$  but A2744 harbours four.
- Brighter than the more common examples at low-z.
- Suggest that the excess of bright jellyfish in A2744 is directly related to the merger.
- . Shock-triggered star formation in the stripped gaseous tails.
- Future work: obtain spectra of knots, search for other examples of jellyfish in a large sample of clusters to determine prevalence (e.g. in CLASH).

### Questions?

