

Chain galaxies in the COSMOS field

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Abstract : Chain galaxies, characterized by elongated knotty structures, are not well-understood and remain mysterious in its origin due to small samples used in previous studies. Hence it is crucial to examine much larger sample of chain galaxies for further understanding. For this purpose, we search chain galaxies in the COSMOS field and have found 86 chain galaxy candidates, one of which is 6 times brighter than that in previous studies.

1. Introduction

What are chain galaxies? (Fig. 1)

Chain galaxies (Fig.1 red circles) have elongated knotty structures at relatively high redshifts ($z > 0.2$). They are characterized by some inner clumps and no bulge. They are first discovered by the Hubble space telescope (HST) due to its high spatial resolution (Cowie et al. 1995, AJ, 110, 4). Since then, approximately 200 chain galaxies have been discovered with the HST. Although some models to explain their structures and formation have been proposed, their origin is still controversial.

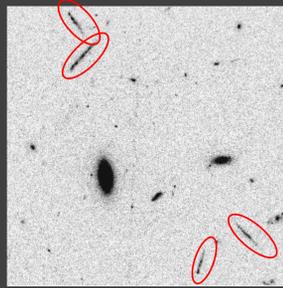


Fig. 1 chain galaxies (Elmegreen et al. 2004)

How different are chain galaxies from edge-on disk galaxies? (Fig.2)

Chain galaxies are different from edge-on disk galaxies in the point that they have larger clumps and do not have normal exponential disks and bulges.

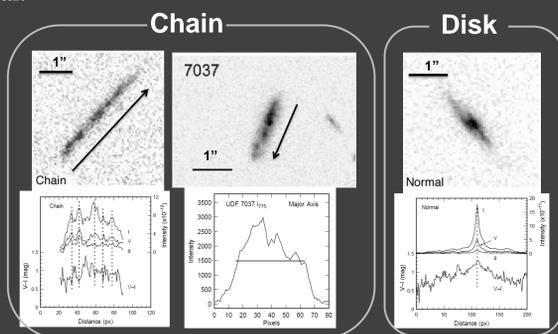


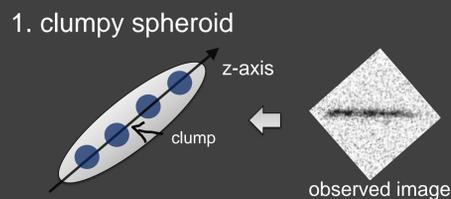
Fig. 2 chain galaxies and an edge-on disk galaxy (Elmegreen et al. 2004, ApJ, 603, 74, Elmegreen & Elmegreen 2006, ApJ, 650, 644)

Structure models (Fig.3)

Two structure models, clumpy spheroid model (Taniguchi & Shioya 2001, ApJ, 547, 146) and clump cluster model (Elmegreen et al. 2004, ApJ, 604, L21), are proposed.

1. Clumpy spheroid model

Clumpy spheroid model explains chain galaxies have structures like real chains or beans.



2. Clump cluster model

Clump cluster model explains chain galaxies are edge-on clump clusters which are ancestors of disk galaxies.



Fig. 3 structure models

Though their formation models have also been proposed, it is still controversial.

2. Road map

We study chain galaxies in the COSMOS (Scoville et al. 2007, ApJS, 172, 1) field as following steps :

- Search for chain galaxies with the Hubble I band data** ← We are here.
- Analyze the chain galaxy candidates with different wavelength data
- Study their spatial distribution
- Study color and morphology with high-resolution Hubble/CANDLE observations

What are meanings of our study to astronomy?

Chain galaxies are not found in the local universe but only at high redshift universe. It may mean that they would be ancestors of some local galaxies. Some authors report that chain galaxies evolve into spiral galaxies or elliptical galaxies. Also, chain galaxies are not rare at high redshifts (Elmegreen et al. 2005, ApJ, 631, 85). Therefore it is important to understand them for galaxy evolution.

What is the purpose for searching chain galaxies?

We aim to put more constraints to the putative chain galaxy models and to give statistic discussions of the following questions :

- Are there any brighter ($I < 22$ AB mag) chain galaxies?
- Do chain galaxies form densely populated region (e.g. clusters)?
- Do chain galaxies tend to form in bunch?
- Do real chain galaxies look like simulated one?

What is the advantage of our study?

The COSMOS field is the largest field of the deep field surveys of the HST whose high resolution is needed for our chain galaxy detection (Fig.4). The COSMOS field is ~ 10 times larger than previous studies. We expect to find many more chain galaxies and be able to discuss their property statistically.

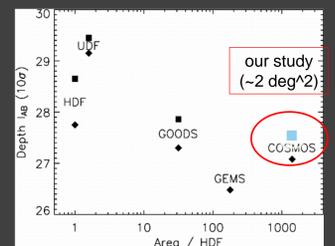


Fig. 4 deep field surveys (COSMOS website)

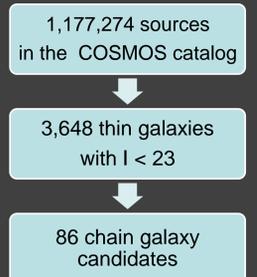
3. Search for chain galaxies

Aim

We aim to search chain galaxies with the HST/ACS I (F814) band in the COSMOS field.

Method

We selected apparently thin ($a/b > 3$ where a is the length of the semi-major axis and b is that of the semi-minor axis of an ellipse) galaxies in appearance with $I < 23$ AB magnitude from the COSMOS/ACS catalog (Leauthaud et al. 2007, ApJS, 172, 219). We classified their morphology by eyeball inspection. We found 86 chain galaxy candidates.



Results

Fraction of chain galaxies (Fig. 5)

Among all thin galaxies, the fraction of chain galaxies, edge-on disk galaxies, galaxies which we can not determine their morphology are 2%, 59% and 29%, respectively. But the eye-ball inspections are not reliable enough for statistical discussions. So it is necessary to select chain galaxies in quantitative method (e.g. intensity profile).

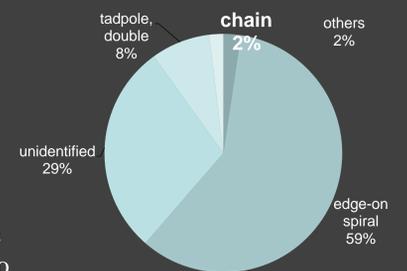
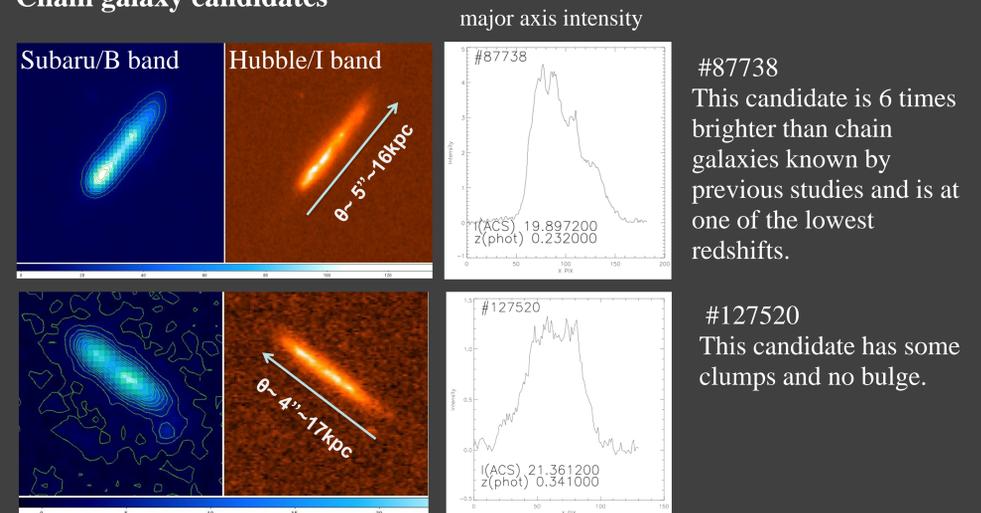


Fig. 5 fraction of chain galaxies

Chain galaxy candidates



Conclusion

We found 86 chain galaxy candidates with the HST I band in the COSMOS field. For reliable discussions, it is necessary to select chain galaxies in quantitative method (e.g. intensity profile).