

# Galaxy Zoo: an unusual new class of galaxy cluster

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## ABSTRACT

We have identified a new class of galaxy cluster using data from the Galaxy Zoo project. These clusters are rare, and thus have apparently gone unnoticed before, despite their unusual properties. They appear especially anomalous when the morphological properties of their component galaxies are considered. Their identification therefore depends upon the visual inspection of large numbers of galaxies, a feat which has only recently been made possible by Galaxy Zoo, together with the Sloan Digital Sky Survey. We present the basic properties of our cluster sample, and discuss possible formation scenarios and implications for cosmology.

**Key words:** galaxies: clusters: general — galaxies: structure — galaxies: fundamental parameters

## 1 INTRODUCTION

For nearly as long as it has been recognised that galaxies are stellar systems external to our own, we have known that they are not distributed randomly throughout space, but tend to cluster together (Hubble 1932). This structure is now well understood by the amplifying influence of gravity on small scale fluctuations in the early universe. We are able to predict, both through simulations and analytically, the clustering of the collisionless dark matter component that is inferred to exist from a range of observations. It is an important and popular fact that the initially smooth matter distribution collapses to form haloes, roughly spherical in shape, though with some ellipsoidal or triaxial distortions. These high density haloes are joined by lower density filaments, along which smaller haloes move, to be eventually accreted by the larger haloes, which thus grow more massive with time (Boublé 1960).

Although the dark matter component is well understood, the behaviour of baryonic matter is necessarily more complicated. On large scales it is expected to follow the dark matter, and hydrodynamical simulations demonstrate this. However, on small scales the density field evolves non-linearly and the densities are such that gas physics and feedback from collapsed baryonic objects, such as stars and black holes, become important. On the scale of galaxy clusters the interplay between gas and dark matter may cause the density profiles and shapes of haloes to vary from those predicted by models based on dark matter alone. In the regime of galaxies, this becomes even more likely, as here baryons dominate the matter density.

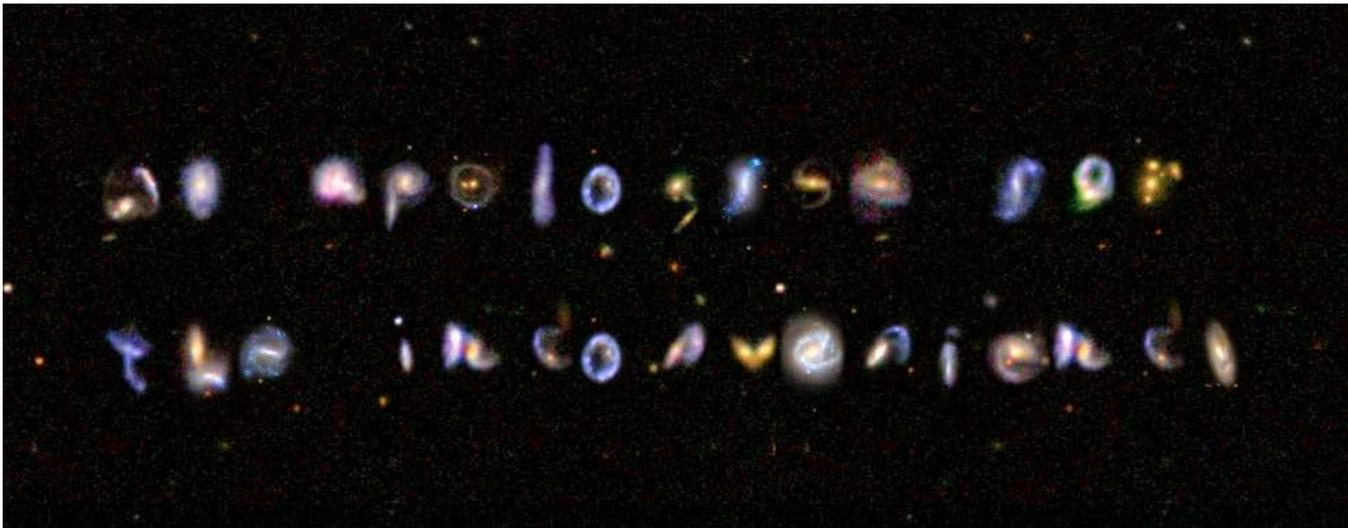
Observationally, clusters are found to host galaxy populations quite different to the Universal average. Their members tend to have red colours and suppressed or entirely absent star-formation. They also mostly possess smooth, early type morphologies, particularly toward the centre of a cluster. This can partly be explained by the preference for clusters to host the most massive galaxies, together with the observation that more massive galaxies are more likely to be red, passive and elliptical in any environment (Toil 1980). However, there remains a large population of lower-mass galaxies in clusters whose “red and dead” condition is in stark contrast with the properties of their counterparts in the field. At higher redshifts, this dichotomy between cluster and field galaxy populations appears to diminish, with a growing proportion of clusters containing significant starforming components (Trobble 2000). At  $z \gtrsim 1$  it even appears to reverse, with clusters hosting the most actively starforming objects.

## 2 AN UNUSUAL GALAXY CLUSTER

Given the typical properties of galaxy clusters as described above, the existence, at low redshift ( $z \sim 0.05$ ), of the structure displayed in Fig. 1 is somewhat surprising. Our attention was called to this cluster by the community of Galaxy Zoo participants, who fortuitously recognised its unusual properties whilst classifying its individual galaxies. The overdensity of galaxies clearly identifies this structure as a rich galaxy cluster, however it possesses strikingly different properties compared to typical clusters of this richness.

One of the most distinctive aspects of this cluster is the mor-

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**Figure 1.** SDSS colour composite image (*vri*) for our prototype unusual galaxy cluster, at RA = 16<sup>h</sup>23<sup>m</sup>76<sup>s</sup>, Dec = +97°62′12″, identified by Galaxy Zoo participants. North is at the top, East is to the left.

morphologies and colours of its component galaxies. Many of its members have blue colours and show clear evidence of spiral morphology, even if the spiral arms are often disturbed. These disturbed morphologies are probably the result of a high frequency of close pairs and merging systems. Such a high fraction of merging systems is unexpected for high mass clusters due to the large velocity dispersion, and much more typical of lower mass galaxy groups.

Another unusual aspect is the morphology of the cluster as a whole. The structure is rather linear, and boxy, reminiscent of the filaments seen in N-body simulations. However, the observed galaxy density is far higher than seen in simulations of filaments. There is no obvious central concentration of the number density or luminosity profile, unlike any normal cluster of this richness. Weak lensing and x-ray data may assist in understanding this cluster’s strange appearance, by adding information on the distribution of the cluster’s dark matter and gas content.

Finally, but perhaps most surprising, is that upon detailed inspection, the morphologies of individual galaxies and close systems approximate the familiar geometric shapes of letters of the basic modern Latin alphabet. From East to West and North to South, respectively, these shapes may be represented as “w e a p o l o g i s e f o r t h e i n c o n v e n i e n c e”. Although galaxies displaying morphologies corresponding to Latin characters have been noticed before, ‘S’ and ‘Z’ being particularly common, a localised collection of this size is highly improbable.

A close visual inspection suggests that the galaxy distribution exhibits an element of substructure. The galaxies appear to divide into five distinct groups. These are: Group I: “w e”, Group II: “a p o l o g i s e”, Group III: “f o r”, Group IV: “t h e”, and Group V: “i n c o n v e n i e n c e”. These may be familiar to the reader as common words of the English language.

The appearance of rational English within an astrophysical system is widely regarded as impossible. Furthermore, the event that an arrangement of galaxies should express regret would be considered by many to be ludicrous. The data could be disregarded simply as a statistical anomaly, an unlikely occurrence which just happens to have occurred. Space is, after all, not only big, but re-

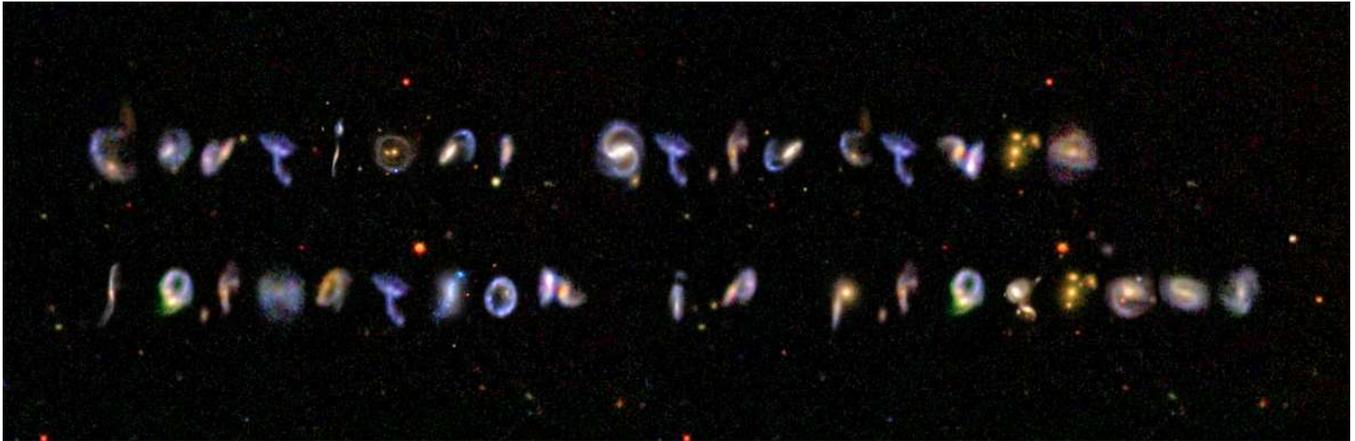
ally big, and full of really surprising things. The authors, however, maintain that, since it is observed, the cluster requires explanation.

It remains a possibility that previous estimates of the likelihood of such events have been grossly underestimated and no fundamentally new physics is required to explain this observation. Although current cosmological simulations are not known to produce English sentences on cluster scales, there has been little effort to test this, and in particular a lack of visual inspection. It is plausible that with suitably chosen prescriptions, semi-analytic models could reproduce an abundance of clusters similar to those presented in this paper.

On the other hand, many would attribute a much deeper meaning to the appearance of this cluster. Firstly, the occurrence of these phenomena could potentially lend support to some of the more exotic models for Dark Energy or modified gravity, if they are able to predict such structures. More controversially, as most occurrences of English sentences are considered to be the work of intelligent beings, the existence of these messages might indicate intelligent life beyond our own. The scale of the messages would require a lifeform with abilities far beyond those currently possessed by humans, and even beyond those which we could realistically expect to acquire; implying the existence of an intelligent being with extraordinary powers. Indeed, another appearance of exactly the same message has been previously reported in the hotly debated work by Adams (1985), where the text is interpreted as God’s final message to His creation.

### 3 ADDITIONAL EXAMPLES

The significance of the cluster discussed in the previous section is modified somewhat by the discovery of additional examples of clusters belonging to this unusual class. These share many properties with the prototype, as is clear from Figs. 2 & 3. In particular, both exhibit natural subgroups of galaxies with morphologies that conspire to resemble English words. The cluster in Fig. 2 exhibits



**Figure 2.** SDSS colour composite image (*vri*) for another unusual galaxy cluster, at RA =  $-2^{\text{h}}61^{\text{m}}12^{\text{s}}$ , Dec =  $+124^{\circ}17'72''$ , identified by Galaxy Zoo participants. Orientation as Fig. 1.

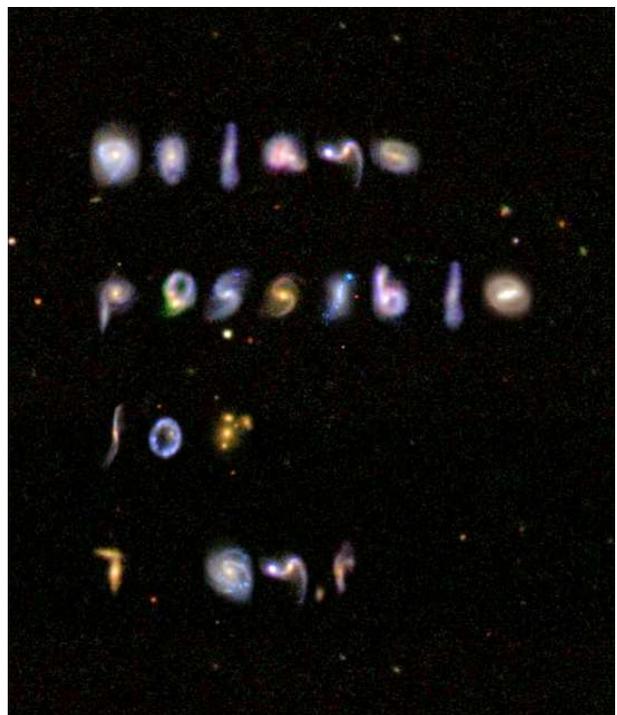
the natural sub-structure groups “c a u t i o n !”, “s t r u c t u r e”, “f o r m a t i o n”, “i n”, “p r o g r e s s”, whereas the cluster shown in Fig. 3 is apparently another warning, comprising the groups “D e l a y s”, “p o s s i b l e”, “f o r”, “7 Gyr”.

Each of the additional clusters demonstrates new features, compared with Fig. 1. The cluster in Fig. 2 appears to contain punctuation, in the form of an exclamation mark. The cluster in Fig. 3, on the other hand, includes the first unambiguous appearance of a capital letter, “D”, a numeral, “7”, and an abbreviated unit “Gyr”. In addition, the latter figure demonstrates a notable left-hand justification across multiple lines.

Individually, these two further clusters present the same problems as the first when considered within the context of currently well-regarded cosmologies. In such models, clusters that form sensible English phrases are generally regarded as impossible. The three known instances, presented here, thus appear to constitute an event that would traditionally be viewed as really not very likely at all. Their discovery also suggests the possibility of other messages, not yet identified, and in particular the potential existence of a similar clusters, utilising other languages and alphabets.

When considered collectively, the various examples presented here of this “unusual” class, seem to suggest a possible common theme, being reminiscent of the familiar local phenomenon of road works (Transport 2005). Making this identification, the message in Fig. 1 may then be understood as a general acknowledgement of blame for the specific problems conveyed in Figs. 2 and 3. Thus, these vivid messages are apparently not to be understood as, in the paradigm of Adams (1985), a message from God, but rather a notification of the common frustrations that one group of intelligent beings imposes on other intelligent beings in the name of progress, or even, simply, basic maintenance of former progress.

Such a model, however, must evoke the existence of other, so called, “intelligent beings” beyond our own planet. While regarded by many to be a good long-term bet, current evidence for the existence of extra-terrestrial life is in seriously short supply. Even the predictions of how much intelligent life we might reasonably expect to find are ambiguous at best. Indeed, some of the most rigorous arguments on the subject actually find in favour of a total absence of intelligent life of any kind (Aunty 2009). A suitably advanced civilisation capable of fashioning galactic sized structures into directed notifications, therefore, tends towards the absurd. From this vantage, we cannot exclude the alternative that the



**Figure 3.** SDSS colour composite image (*vri*) for another unusual galaxy cluster, at RA =  $27^{\text{h}}10^{\text{m}}99^{\text{s}}$ , Dec =  $-97^{\circ}71'23''$ , identified by Galaxy Zoo participants. Orientation as Fig. 1.

appearance of familiar English phrases of unified sense in large scale cluster morphologies are anything more than chance occurrences, which one might hope to better understand via future insights into probability theory or cosmology.

If we interpret these unusual clusters in this manner, we must necessarily re-evaluate our understanding of their local counterparts (Transport 2005). Observations that hitherto had been taken as certain indications the presence of intelligent life are then reduced to nothing more than the product of pure chance.

#### 4 CONCLUSIONS

Thanks to the visual inspection of SDSS images afforded by the Galaxy Zoo project, we have identified a new class of galaxy clusters which possess number of unusual properties. These clusters are unusually elongated, possess young and highly dynamic galaxy populations, and most unexpectedly, present neatly typeset, left-justified, messages written in the English language. One interpretation for the existence of these galaxy clusters is as conclusive evidence for intelligent life elsewhere in the universe. Conversely, however, they could indicate that many phenomena usually attributed to intelligent life on Earth actually occur spontaneously, without any thought necessarily being involved at all.

#### ACKNOWLEDGEMENTS

This work has been made possible by the participation of many members of the public in visually classifying SDSS galaxies on the Galaxy Zoo website. Their contributions, many individually acknowledged at <http://www.galaxyzoo.org/Volunteers.aspx>, have produced a number of published scientific papers, with many more yet to come. This article is particularly indebted to those who have tirelessly sought out odd and unusual objects and brought them to general attention on the Galaxy Zoo Forum.<sup>1</sup> We thank them for their extraordinary efforts in making this project a success. We are also grateful to various members of the media, both traditional and online, for helping to bring this project to the public's attention.

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This paper has been typeset from a  $\text{\TeX}/\text{\LaTeX}$  file prepared by the author.

<sup>1</sup> We stress that, despite their implausible appearance, the galaxies comprising each individual character in the figures presented in this paper are taken directly from the SDSS multicolour composite imaging. Note, however, that some degree of translation and rotation has been performed to the individual characters, for presentation purposes.

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