



The Origin of Galaxy Bimodality

what makes galaxies red & dead?

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The Bi-Modal Distribution of Galaxies

Introduction

- The Bi-Modal Distribution of Galaxies
- The Standard Paradigm
- Galaxy Transformations
- Outstanding Questions

Centrals vs. Satellites

Environment Dependence

Conclusions

Early-Types



Spheroidal Morphology

Old Stellar Populations

No or Little Cold Gas

Red Colors

Late-Types



Disk-like Morphology

Young Stellar Populations

Abundant Cold Gas

Blue colors

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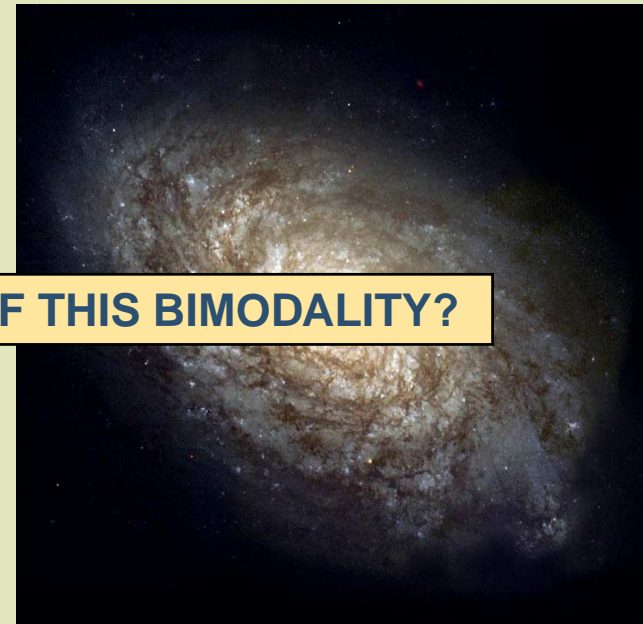
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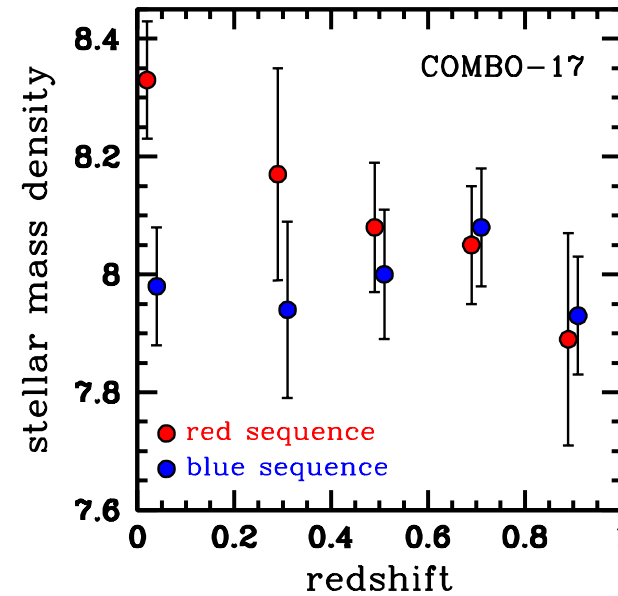
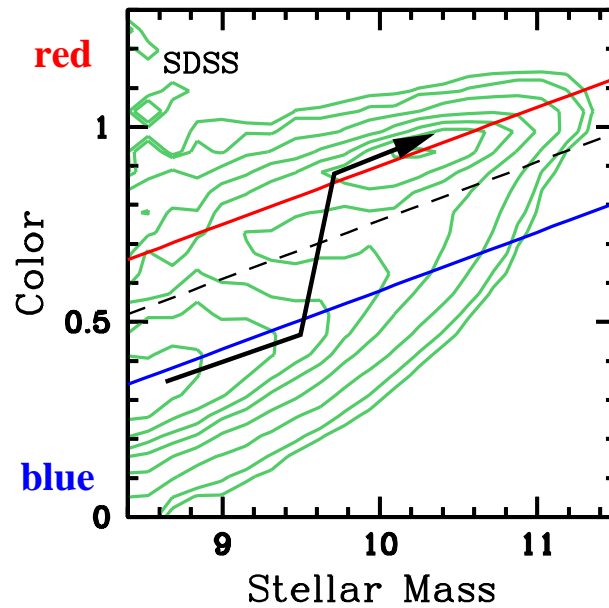
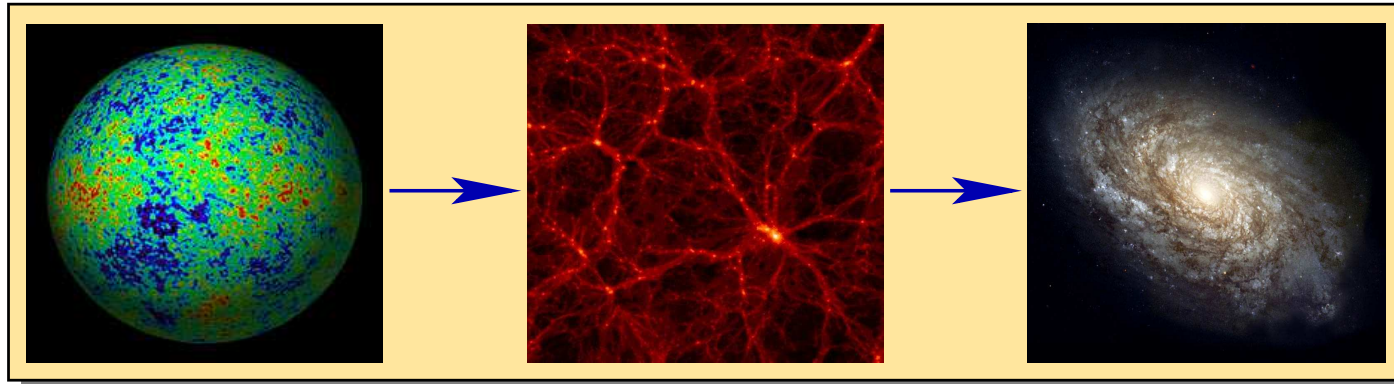


Disk-like Morphology
Young Stellar Populations
Abundant Cold Gas
Blue colors

WHAT IS THE ORIGIN OF THIS BIMODALITY?

The Standard Paradigm

PARADIGM: All galaxies originally form as central disk galaxies.



(Wolf et al. 2003; Bell et al. 2004; Borch et al. 2006)

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Environment Dependence

Conclusions



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Introduction

- The Bi-Modal Distribution of Galaxies
- The Standard Paradigm
- Galaxy Transformations
- Outstanding Questions

Centrals vs. Satellites

Environment Dependence

Conclusions

- **What fraction of the red-sequence satellites underwent their transformation as a satellite?**
- **Which Transformation Process is Most Important?**
- **In what Environment (dark matter halo) do Galaxies undergo their Transformation?**
- **To what extent are Satellite-Specific Transformation Processes responsible for Environment Dependence of Galaxy Population?**



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Introduction

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Centrals vs. Satellites

Environment Dependence

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To address these questions we constructed SDSS **galaxy group catalog**

(Yang et al. 2005, 2007)

This allows us to split galaxy population in **centrals** and **satellites**, and to study galaxy properties as function of **halo mass**

(vdB et al. 2005, 2007; Weinmann et al. 2006; Yang et al. 2006; Moster et al. 2007)

We study impact of **satellite-specific** transformation processes by comparing satellites to centrals of the same stellar mass, M_*

Centrals vs. Satellites: matched in stellar mass

Introduction

Centrals vs. Satellites

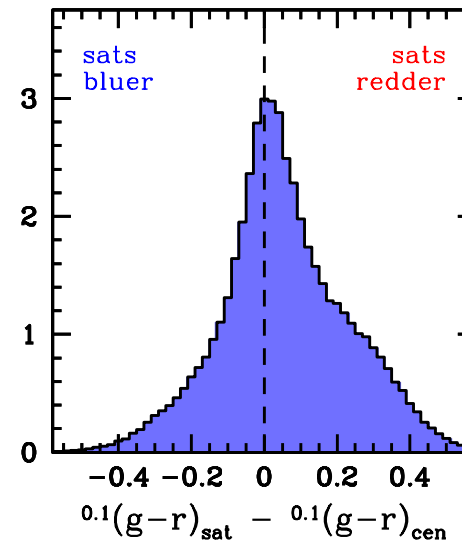
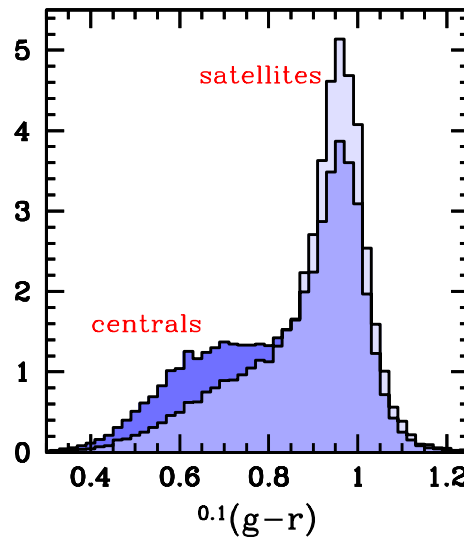
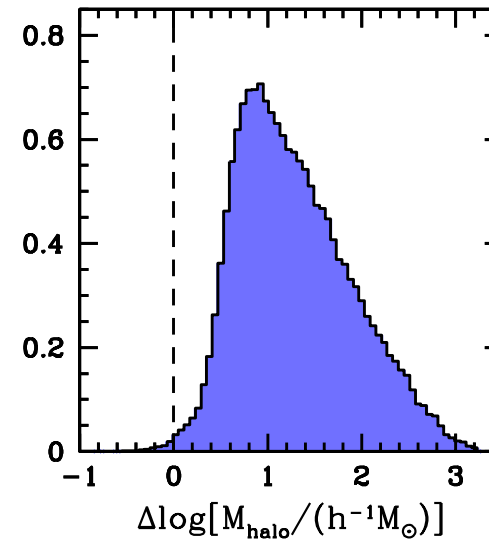
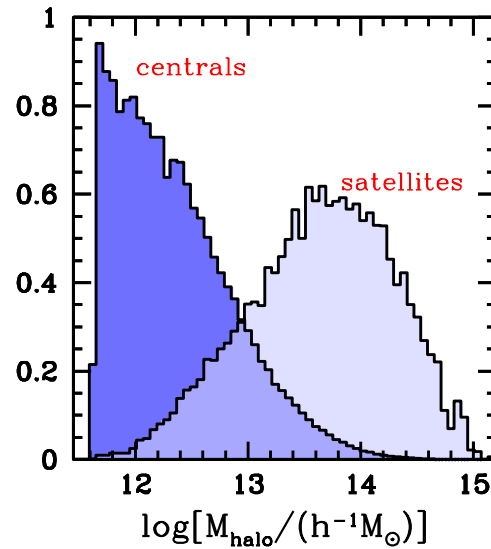
● Centrals vs. Satellites:
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● Blue-to-Red Transition

Fractions

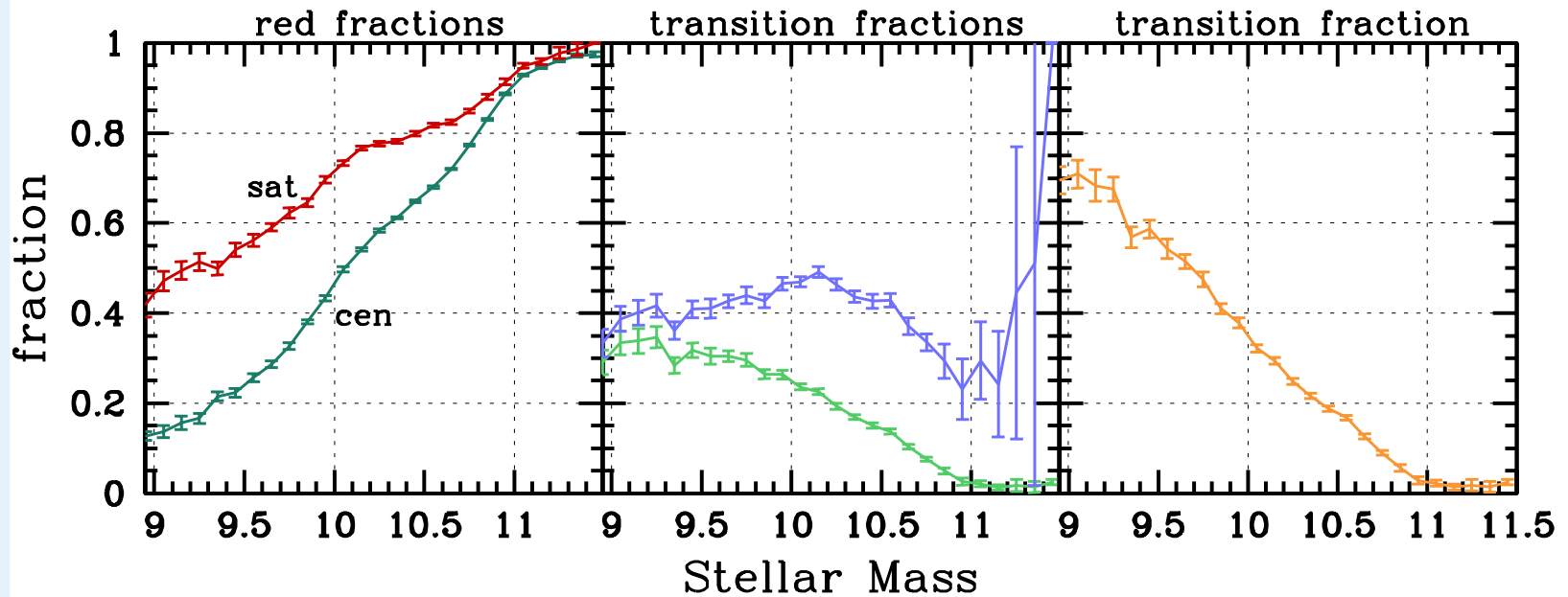
Environment Dependence

Conclusions



Sats are marginally **redder** than centrals of same M_{star}

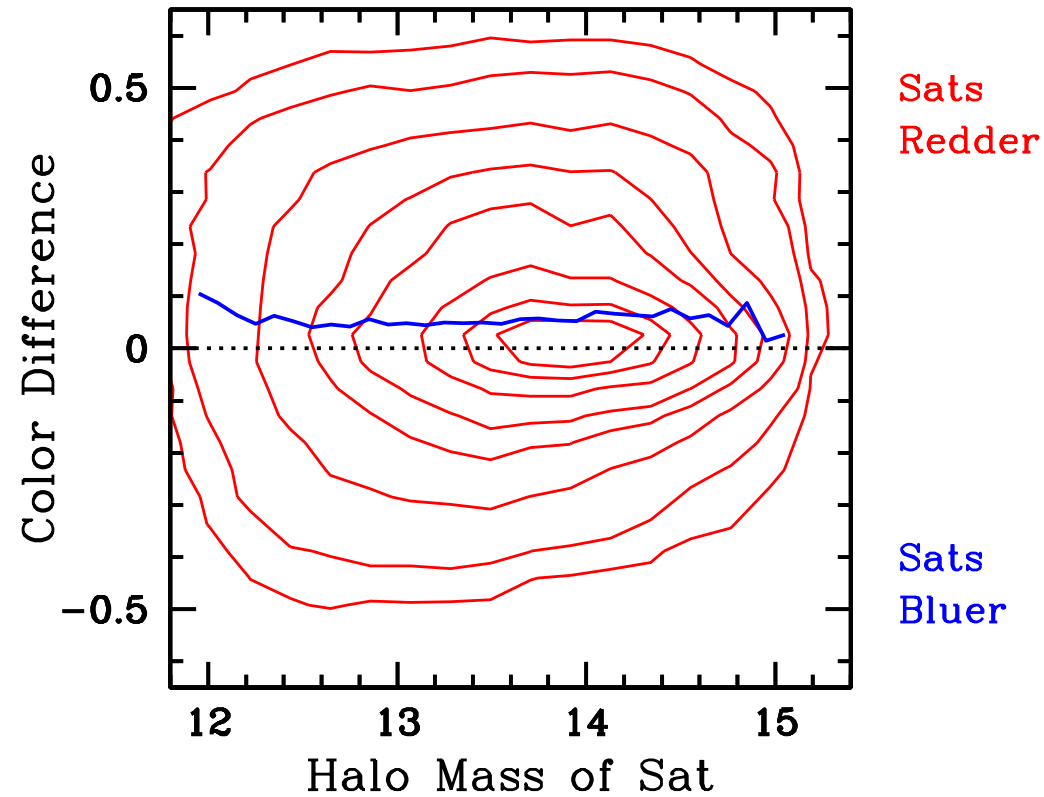
Blue-to-Red Transition Fractions



- The **red** fraction of SATs is higher than that of CENs of same M_{star} .
- Roughly 40% of SATs that are **blue** at accretion undergo transition.
- Above $10^{10} h^{-2} M_{\odot}$ majority of SATs were already **red** at accretion.

Satellite transformation processes only important at low M_{star}

Dependence on Halo Mass



- Color difference is independent of halo mass of satellite
- Transformation efficiency is independent of halo mass

Strangulation is main satellite-specific transformation mechanism

Satellite Ecology

Introduction

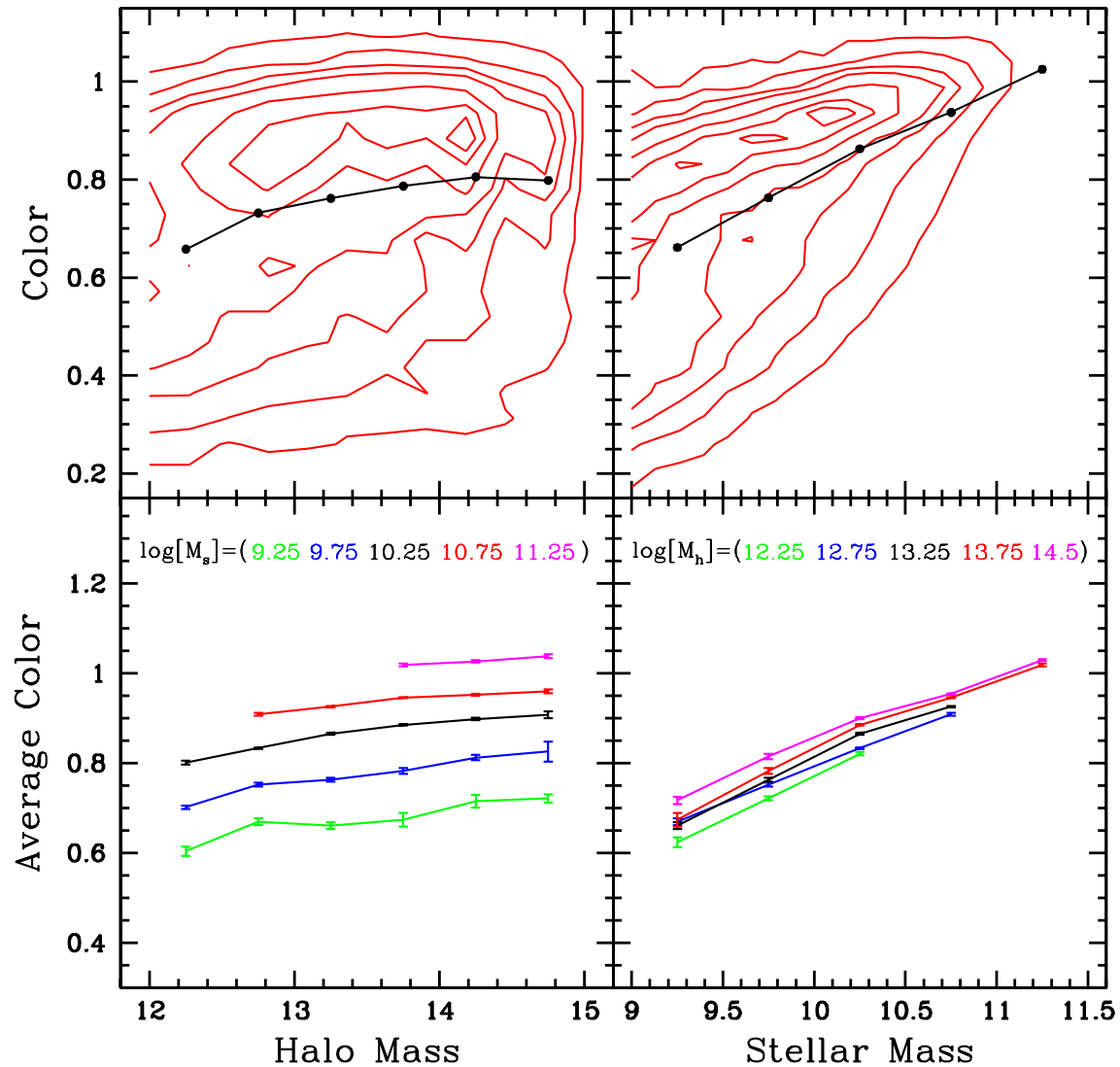
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Environment Dependence

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At fixed M_{star} , average satellite color independent of environment



Conclusions

Introduction

Centrals vs. Satellites

Environment Dependence

Conclusions

● Conclusions

● Conclusions

● Conclusions

● Conclusions

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Introduction

Centrals vs. Satellites

Environment Dependence

Conclusions

● Conclusions

● Conclusions

● Conclusions

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From 70% at $\log(M_*) = 9$ to 0% at $\log(M_*) = 11$

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Introduction

Centrals vs. Satellites

Environment Dependence

Conclusions

● Conclusions

● Conclusions

● Conclusions

● Conclusions

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Introduction

Centrals vs. Satellites

Environment Dependence

Conclusions

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- Conclusions
- Conclusions
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Introduction

Centrals vs. Satellites

Environment Dependence

Conclusions

- Conclusions
- Conclusions
- Conclusions
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Introduction

Centrals vs. Satellites

Environment Dependence

Conclusions

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- Conclusions
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Environment dependence largely vanishes when separating centrals and satellites and when keeping stellar mass fixed.