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ORIGINAL ARTICLE

Tidal dwarf galaxies at intermediate redshifts

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Abstract We present the first attempt at measuring the production rate of tidal dwarf galaxies (TDGs) and estimating their contribution to the overall dwarf population. Using HST/ACS deep imaging data from GOODS and GEMS surveys in conjunction with photometric redshifts from COMBO-17 survey, we performed a morphological analysis for a sample of merging/interacting galaxies in the Extended Chandra Deep Field South and identified tidal dwarf candidates in the rest-frame optical bands. We estimated a production rate about 1.4×10^{-5} per Gyr per comoving volume for long-lived TDGs with stellar mass $3 \times 10^{8-9}$ $M_\odot$ at $0.5 < z < 1.1$. Together with galaxy merger rates and TDG survival rate from the literature, our results suggest that only a marginal fraction (less than 10%) of dwarf galaxies in the local universe could be tidally-originated. TDGs in our sample are on average bluer than their host galaxies in the optical. Stellar population modelling of optical to near-infrared spectral energy distributions (SEDs) for two TDGs favors a burst component with age 400/200 Myr and stellar mass 40%/26% of the total, indicating that a young stellar population newly formed in TDGs. This is consistent with the episodic star formation histories found for nearby TDGs.

Keywords Galaxies: dwarf galaxies · Galaxies: evolution

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1 Introduction

The last two decades have witnessed much progress in understanding galaxy formation and evolution on both observational and theoretical sides. While the formation and evolution of massive galaxies have been empirically explored in great detail out to $z \sim 4$ with cosmic deep surveys, a complete picture for the origin of dwarf galaxies is still missing. Generally speaking, a dwarf galaxy can be formed from either collapse of primordial gas cloud in the framework of cosmology (i.e., classical dwarf), or materials driven by tidal force away from massive galaxies in interactions and/or mergers (so-called "tidal dwarf"—Zwicky 1956). The classical dwarf galaxies are characterized by small size and dominated by dark matter halo (Aaronson 1983; Mateo et al. 1993; Simon and Geha 2007; Geha et al. 2009). They are metal poor because of inefficient chemical enrichment in shallow gravitational potential which keeps little metal against supernova winds (Tremonti et al. 2004), and thus sensitive for testing physical mechanisms driving galaxy evolution (e.g. supernova feedback). Moreover, the cosmologically-originated dwarf galaxies give rise to a well-known challenge to the theory of galaxy formation, i.e., the "missing satellites problem" (Klypin et al. 1999; Moore et al. 1999). In contrary, tidal dwarf galaxies (TDGs) are believed to contain likely no dark matter halo (Barnes and Hernquist 1992; Braine et al. 2001; Wetzstein et al. 2007) and be metal rich (Duc et al. 2000). They often have episodic star formation histories (SFHs; Weisz et al. 2008; Sabbi et al. 2008), compared to the constant SFH for classical dwarfs (Marconi et al. 1995; Tolstoy et al. 2009). Understanding of the nature of TDGs and their contribution to the local dwarf population is therefore an important issue in dwarf galaxy astrophysics.