The photometric structure of young blue compact dwarf (BCD) candidates

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A tiny fraction of blue compact dwarf (BCD) galaxies exhibits a nearly galactic-wide starburst activity and no signatures of an old stellar host galaxy. The evolutionary status and formation history of these most metal-deficient BCDs are still a subject of debate. Various lines of evidence suggest, however, that these systems do not contain a substantial population of stars older than ~1 Gyr and hence qualify as nearby young BCD candidates.

Elaborated multiwavelength studies of these rare, young BCD candidates may therefore provide valuable insights into the formation and starburst-driven evolution of low-mass galaxies in the early universe. In order to assess the photometric structure and evolutionary status of these systems it is of critical importance to correct for the effect of extended nebulae emission, as the latter may severely affect colors and age estimates obtained therein.

One such example is i Zw 18 (Fig. 1), the most metal-poor BCD galaxy known (~Z=0.005). This system is embedded within a filamentary low-surface brightness (LSB) envelope, extending out to 18° (~3 kpc, assuming a distance of 15 Mpc). Papaderos et al. (2002), using broad (R & I) and narrow-band (Ha) (IBRO) filters, have shown that the extended LSB envelope of this young BCD candidate is entirely due to nebula emission: isolated gas accounts for more than 90% of the line-of-sight emission at a galactocentric distance of 8° (~0.65 kpc) and for up to 50% of the total R light of i Zw 18.

Consequently, a twodimensional subtraction of extended nebula gas emission is indispensable for a meaningful study of the photometric structure of this system. As evident from Figures 2&4, the latter correction leads to the reduction of the exponential scale length of the LSB component of i Zw 18 by 50%, moving the BCD into the parameter space typically populated by the most compact dwarf galaxies.

Izotov et al. (2002) have shown that the extended LSB envelope of this young BCD candidate is entirely due to nebulae line emission: isolated gas accounts for more than 90% of the line-of-sight emission at a galactocentric distance of 8° (~0.65 kpc) and for up to 50% of the total R light of i Zw 18. Consequently, a twodimensional subtraction of extended nebula gas emission is indispensable for a meaningful study of the photometric structure of this system. As evident from Figures 2&4, the latter correction leads to the reduction of the exponential scale length of the LSB component of i Zw 18 by 50%, moving the BCD into the parameter space typically populated by the most compact dwarf galaxies.

Fig. 1: A composite of the structural properties of the entire host galaxy of i Zw 18 with those of other types of dwarf galaxy: an extended LSB envelope (blue), a spiral arm (red), a dwarf irregular (yellow), and a normal spiral (green). The central region of the LSB host galaxy of i Zw 18 is a ring of low-mass stars (inner contours) and 23.1 to 23.55 B mag surface brightness (outer contours).

Another example of a young BCD candidate with extraordinarily strong extended gas emission (EW(Ha)=910 Å; Guidera et al. 2010) is Tol 65 (Fig. 5c). The UV and B-R colors of its host galaxy have been determined from deep VLT surface photometry to be +0.40±0.06 and 0.56±0.06 mag, respectively, consistent with a comparatively young age of the order of 1 Gyr. Roughly 1/4 of the band emission of Tol 65 originates from a clump of Super-Star Cluster (SSC) candidates located at the NE tip of the BCD with a Mg range between -10.0 and -13.5 mag (Papaderos et al. 1999).

The impact of extended nebulae emission in scales of ~500 pc from the starburst knots on the observed broadband colors is evident from the color maps (Fig. 6). The (U-B) map (panel a) reveals two blue, diffuse (1.08±0.06 mag) regions (sedov) located opposite to each other at the tip of the SSC sequence, having linear extents of ~500 pc. The (B-R) map (panel b) displays a strikingly different color pattern: the Bluest color (+0.15±0.05 mag) is observed midway of the SED clump with the detached regions sedov are partly redder than the stellar host galaxy, with average B-R colors between 0.4 and 0.5 mag. This again bears witness to the severe contamination of optical colors by nebulae line emission on scales of several hundred pc from the starburst regions.

Other examples of young BCD candidates with colors significantly affected by intense, spatially extended nebulae line emission are, e.g., SBS 0335+025 (Fig. 3a), Thuan et al. 1997, Papaderos et al. 1998, Izotov et al. 2008b, Pustilnik et al. 2004, Tol 1214-277 (Fig. 5b: Fricke et al. 2001, Izotov et al. 2004) and Pon 18b (Figs. 5a: Guseva et al. 2004).

References

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