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Stellar populations in the Local Group starburst galaxy IC10

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Abstract. We present preliminary results of a photometric investigation on IC10 using F555W and F814W data collected with WFPC2@HST covering two different regions. We provide a new estimate of both distance and reddening by adopting the Tip of the Red Giant Branch (TRGB). We find that the RGB stars in the two regions are located at the same distance, but present different reddening values. In particular, we find $DM_0 = 24.75 \pm 0.1$ and $E(B-V) = 0.44 \pm 0.14$ for the outer region, and $E(B-V) = 0.60 \pm 0.14$ for the central fields. Moreover we show that stellar isochrones at fixed metal content, distance and reddening account for both Main Sequence (MS) and evolved stellar components.

Key words. Galaxies: dwarf - Galaxies: Local Group - Galaxies: individual (IC10)

1. Introduction

IC10 is a dwarf irregular galaxy of the Local Group and it is the unique analogue in the nearby Universe for starburst galaxies. Although several theoretical and empirical investigations have been focused on IC10, current estimates of distance and reddening are still affected by large uncertainties. This means that we do not know yet whether IC10 is a member of M31 group. Moreover, by using optical space (HST) and Near-Infrared ground-based (Keck) data, Vacca, Sheehy & Graham (2007) found a puzzling feature concerning its stellar content. The fit of the young Main Sequence and evolved Red Giant stars would require, at fixed metal abundance ($Z = 0.008$) and distance modulus ($DM_0 = 24.5$), two different reddening values, $E(B-V) = 0.95$ for MS and $E(B-V) = 0.60$ for RG stars.

2. Data sets and reduction strategy

The data sets consist of two different archival HST/WFPC2 pointings, both observed with

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the F555W and F814W filters. The inner pointing (10×1400 sec images per band) is located across the center of the galaxy, while the outer pointing (24×500 sec per band) is shifted by 3′ toward the NE. The data have been reduced using the DAOPHOT/ALLFRAME package (Stetson, 1994) and calibrated to the VEGAMAG system following Holtzman et al. (1995) and Whitmore, Heyer & Casertano (1999). To study the radial gradients of different populations, we divided the sample in four different subsamples (see Fig. 1): Sample 1 (S1) covers the external pointing, while the Sample 2 (S2) and Sample 3 (S3) belong to the central pointing and Sample 4 (S4) includes the burst region.

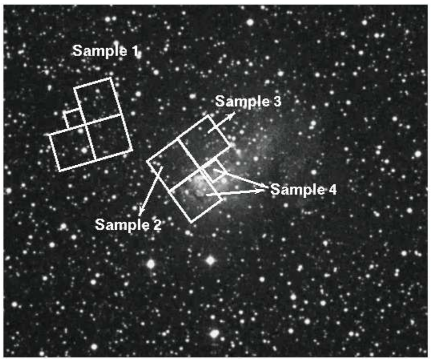

Fig. 1. Location of the four subsamples. S1 covers the external pointing, while S2, S3 and S4 cover different regions of the central field.

3. Results and discussion

IC10, due to its low latitude (b=−3°.3), is affected by Galactic reddening and by internal reddening. For this reason in order to determine the true distance modulus, we used the reddening-free Wesenheit magnitude W=F814W−β (F555W - F814W). Adopting the relation by Cardelli, Clayton & Mathis (1989) $\beta = -1.142$ for the WFPC2 camera. The apparent magnitude of the TRGB (m^{Tip}) has been estimated from the Color-Magnitude Diagrams (CMDs) and the observed luminosity function. The predicted absolute magnitude of the TRGB (M^{Tip}) was determined using the scaled solar isochrones by Cordier et al. (2007), assuming a fixed metallicity of [Fe/H] $= -0.35$, $Z = 0.008$ (Hunter 2001). Fig. 2 shows the M^{Tip} as a function of metallicity for both the F814W (*top panel*) and the W (*bottom panel*) magnitudes. The position corresponding to the metallicity adopted for IC10 is marked with the asterisk. We performed a polynomial fit of both F814W and W magnitude with respect the metallicity. This Figure shows that in the metallicity range $-0.75 \leq$ [Fe/H]$\leq$ 0.0 small variations in metal abundance cause large differences in M^{Tip} for the F814W magnitudes, while this does not apply for W magnitudes. In particular, for IC10 a variation in metal abundance of 0.2dex causes a variation of $\sim$ 0.2mag in M^{Tip} for the F814W magnitudes and a variation of $\sim$ 0.05mag in M^{Tip} for the W magnitudes. For this reason we adopted Wesenheit magnitudes to estimate the true distance modulus for the four samples. Moreover, we compared these estimations with the apparent distance modulus derived using the F814W, to derive an independent estimate of the reddenings.

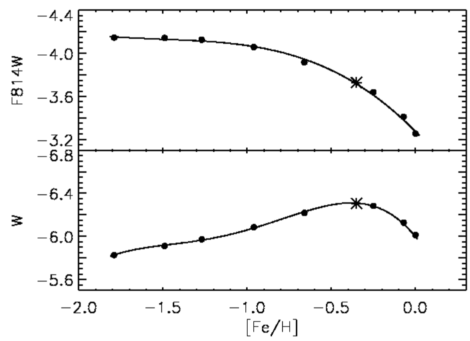

Fig. 2. Behaviour of M^{Tip} as a function of metallicity, for the F814W (*top*) and the Wesenheit (*bottom*) magnitudes, using the theoretical prediction by Cordier et al. (2007). The asterisk marks the position of IC10.

We obtain S1: $DM_0 = 24.75 \pm 0.1$, $E(B-V) = 0.44 \pm 0.14$; S2: $DM_0 = 24.70 \pm 0.1$, $E(B-V) = 0.57 \pm 0.14$; S3: $DM_0 = 24.70 \pm 0.1$, $E(B-V) = 0.58 \pm 0.14$; S4: $DM_0 = 24.70 \pm 0.1$,

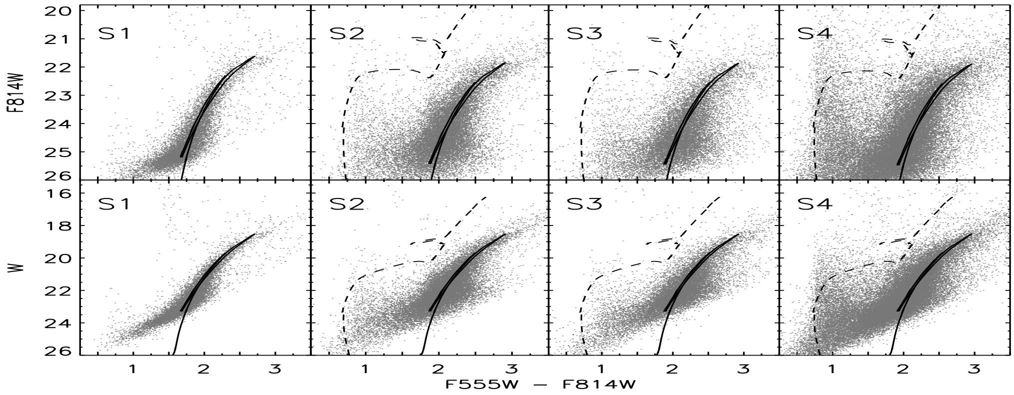

Fig. 3. CMDs of the 4 regions with superimposed theoretical isochrones from the BaSTI dataset, assuming $Z = 0.008$, $DM_0 = 24.70 \pm 0.1$ and different reddening values. The solid line shows a 4 Gyr isochrone, while the dashed line a 50 Myr isochrone. See text for more details.

$E(B-V) = 0.60 \pm 0.14$. Note that the errors for the distance moduli were calculated by adding in quadrature the uncertainty on the estimate of TRGB and the uncertainty on the theoretical calibration, while for the reddenings the errors were calculated by adding in quadrature the uncertainty on distance moduli in the F814W and in the W magnitudes. We find that the reddening decreases when moving from the centre to the outskirts of the Galaxy, while the distance is the same within the errors. Moreover, the number of young stars decreases when moving from the center to the external field. Fig. 3 shows that S4, located across the galaxy center, presents a significant fraction of young MS stars. The number of these objects decreases when moving towards the outskirts of the galaxy. In particular, in S3 the MS stars are only marginally present and in S1 they can be barely detected. However, data plotted in this Figure show that current theoretical predictions, at fixed metal content ($Z = 0.008$), distance modulus ($DM_0 = 24.75 \pm 0.1$) and reddening (four different values, see above) accounts for both young Main Sequence stars and evolved Red Giant stars.

We determined the distance modulus and the reddening of four regions across two WFPC2 pointings of IC10 using a new calibration of the TRGB. We found $DM_0 = 24.75 \pm 0.1$, in good agreement with the literature; this suggests that IC10 should be a member of M31 ($DM_0 = 24.4 \pm 0.1$, van den Bergh 2000). We found that the reddening decreases when moving from the central regions ($E(B-V) = 0.60 \pm 0.14$) to the external regions of the galaxy ($E(B-V) = 0.44 \pm 0.14$), and the value for the galaxy center seems to be $\sim$ 20% smaller than the estimate available in the literature ($E(B-V) = 0.85$, van den Bergh 2000). Moreover, current stellar isochrones at fixed metal abundance ($Z = 0.008$), distance ($DM_0 = 24.75 \pm 0.1$) and reddening ($E(B-V) = 0.60 \pm 0.14$) account for both young MS stars and evolved RG stars. We are also analyzing ACS@HST data of the same central region. This new dataset will allow us to study the variation of reddening and the stellar population gradients over a larger field of view.

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