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Letter to the Editor

The distance to NGC 5253 and the absolute magnitude at maximum of SN 1972E

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Abstract. We have determined the distance to NGC 5253 using the relationship between velocity dispersion and the integrated Hβ luminosity for giant HII regions. We find a distance of 4.6±0.7 Mpc, or a true distance modulus $(m-M)_{\circ} = 28.31 \pm 0.30$. This implies an absolute magnitude at maximum of $M_B = -19.90 \pm 0.35$ for the extensively studied type Ia supernova SN1972E in NGC5253.

Key words: Distance Scale – Galaxies: NGC 5253 – Supernovae: 1972E - HII regions

1. Introduction

Due to their bright absolute maximum magnitudes, $M_B \approx -20$ (Leibundgut and Tammann, 1990, Capaccioli et al. 1990) and the small dispersion in the absolute magnitude near maximum light (Barbon et al. 1973), type I-a SNe are generally considered to be excellent standard candles. However, Van den Bergh and Pazder, (1992) have recently claimed that the mean absolute magnitude at maximum of type Ia SNe in late type galaxies may be up to one magnitude brighter than that of SNeI-a occurring in Ellipticals. It is of great importance therefore to obtain accurate calibrations for the peak luminosities of type Ia supernovae in late type and early type galaxies separately.

One of the best studied type Ia supernovae is SN1972e in the irregular galaxy NGC5253 (Branch *et al.* 1983 and references therein). A direct determination of the distance to NGC 5253, however, does not exist in the literature, and the use of the other members of the group is hampered by the possibly large depth of the cluster (van den Bergh, 1989).

In the present paper we present an estimate of the distance to NGC 5253 based on the properties of its largest giant HII region and we derive a value for the absolute magnitude at maximum of SN1972e.

2. Observations

The observations reported here were obtained in July 1991 with the 3.6m at La Silla equipped with EFOSC. The Hβ flux of the largest giant HII region in NGC5253 **A** (Fig. 1) was measured from a spectrum obtained in the range 380–700 nm through a 10″ wide slit (Fig. 2). The width of the slit was chosen to be 3 times larger than the FWHM of region **A** to make sure that the integrated Hβ flux was properly measured.

The zero point of the flux calibration was obtained via two spectrophotometric standards. Both standards yield the same value for the Hβ flux, F(Hβ)=3.3 $\times 10^{-12}$ erg cm^{-2} s^{-1} within 1 %.

In order to derive the Hβ luminosity of the HII region, the fluxes must be corrected for absorption (both foreground and internal) and for contamination due to the adjacent HII regions (**B** and **C** in Fig. 1). The extinction correction of A_B=0.25 mag, was determined from the Balmer decrement assuming Case B ionization. For comparison, the foreground absorption derived from the Burstein and Heiles (1984) maps is $A_B = 0.19$.

To estimate the contamination by the nearby HII regions we have carefully measured on a B image the flux from each HII region using ROMAFOT (Buonanno et al. 1979). This indicates a correction of ≈ 10%. A further source of uncertainty in measuring the Hβ flux can rise from residual contamination by the [OIII] lines which are strongly blended with Hβ on our spectrum. Using a spectrum taken through a 5″ slit (Fig. 3) we obtain an Hβ flux of 3.1 $\times 10^{-12}$ erg cm^{-2} s^{-1} indicating that residual contamination from the [OIII] lines in the 10″ spectrum is not important.

The velocity dispersion of the HII region $\sigma = 23.3 \pm 0.8$ km s^{-1} was determined using a spectrum obtained in April 1982 with the echelle spectrograph at the 4-m telescope at CTIO. Details of these observations and the data reduction procedure are given by Melnick et al. (1988).

3. Results and Discussion

Melnick *et al.* (1988) have shown that the integrated Hβ luminosities of giant HII regions can be accurately predicted from the the velocity dispersion and oxygen abundance as:

$$log\ L(\mathrm{H}\beta) = (1.0 \pm 0.04) log M_z + (41.32 \pm 0.08) \qquad [1]$$

where $\quad log M_z = 5 log\sigma - [12 + log(O/H)]$.

Introducing $\sigma = 23.3 \pm 0.8$ km s^{-1} and (O/H)=149±16 $\times 10^{-6}$ (Melnick et al. 1992) in equation 1 and using the observed Hβ flux after correction for extinction and contamination, F(Hβ)=3.7 $\times 10^{-12}$ erg cm^{-2} s^{-1} we derive a distance of 4.6 ± 0.7 Mpc to NGC 5253 which corresponds to a true distance modulus of $(m-M)_{\circ} = 28.31 \pm 0.30$.

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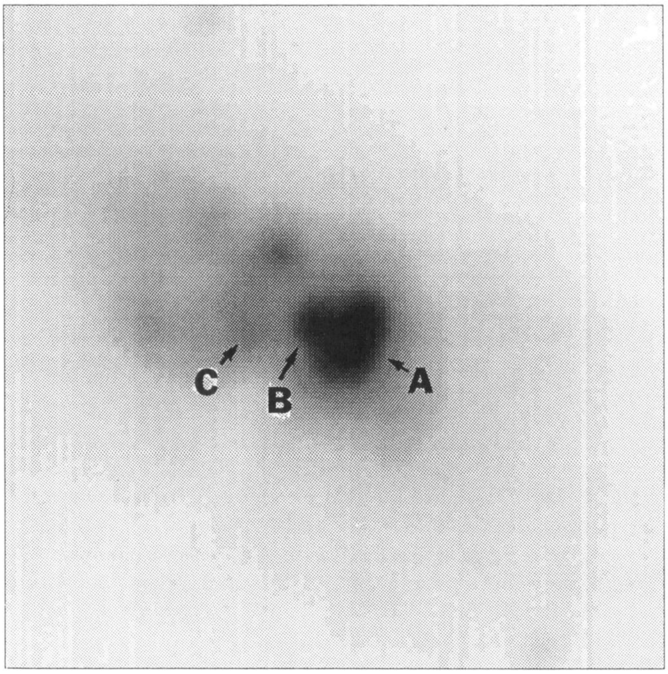

Fig. 1. Image of the HII regions **A**, **B**, and **C** in B colour obtained on July 1991 with the 3.6m telescope at La Silla.

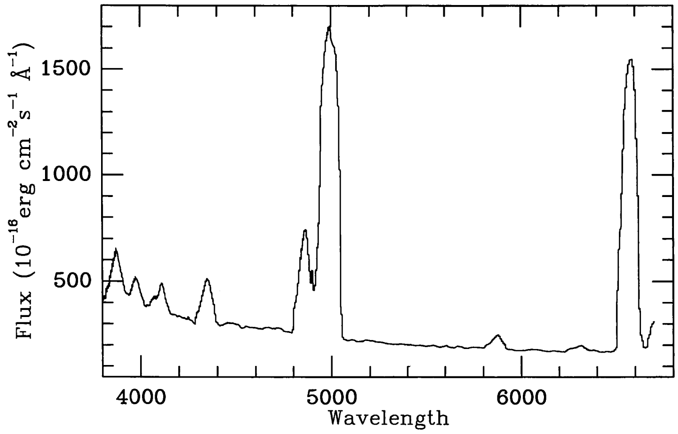

Fig. 2. Spectrum of the giant HII region **A** obtained with the 3.6m telescope at La Silla. Slit=10″.

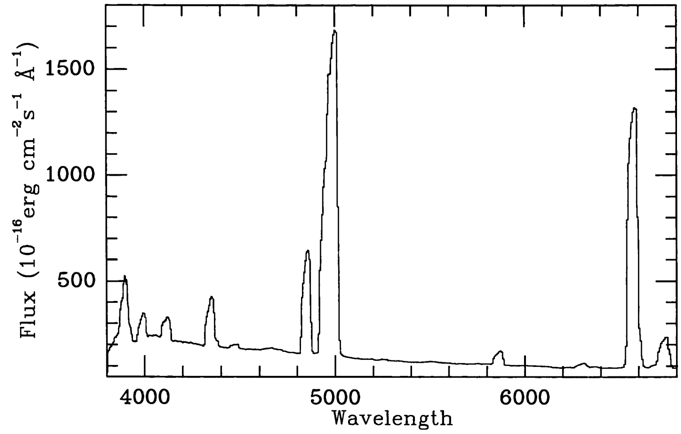

Fig. 3. Spectrum of the giant HII region **A** obtained with the 3.6m telescope at La Silla. Slit=5″.

Our distance for NGC 5253 is approximately 20% larger than that derived for NGC 5128 by Jacoby *et al.* (1988) using the luminosity function of Planetary Nebulae. This discrepancy may be due to problems related to the use of planetary nebulae as distance indicators (see Bottinelli *et al.* 1991) or may simply reflect the depth of Centaurus Group (Hesser *et al.* 1984; van den Bergh 1989). A distance of $3.7^{+0.9}_{-0.7}$ Mpc to NGC5253 was obtained by Caldwell and Phillips (1989) by comparing the V magnitudes at maximum of 1972E and S And. However, its peculiar lightcurve (de Vaucouleurs and Corwin, 1985), cautions against the use of S And as a standard candle.

NGC 5253 is the host of 2 supernovae: SNe 1972E (Kowal 1972) and 1895B (Fleming and Pickering 1895). From the description of the spectrum (Herbig 1972, Barbon and Ciatti 1972) it seems beyond any doubt that SN1972E was a type Ia event. On the other hand, the usefulness of 1895B is marginal. Its spectral classification (Barbon *et al.* 1989) can not discriminate between the different kinds of type I SNe. Also the quality of the photometry is very poor. The m_{pg} magnitudes differ, at the same epoch, by up to 1–2 magnitudes (Fleming and Pickering 1895, Hussey 1898, Walker 1923) making SN 1895B unsuited for calibrating the peak of luminosity of type Ia SNe at the level of accuracy required for a standard candle.

On the basis of the photometric observations of SN1972E (Ardeberg and de Groot 1973, Lee *et al.* 1972), Branch *et al.* (1983) determined an apparent magnitude at maximum of B=8.6. After the correction for absorption using the Burstein-Heiles value ($A_B = 0.19$), and applying our distance to NGC5253 we find an absolute magnitude at maximum for 1972E of $M_B = -19.90 \pm 0.35$. This value is in good agreement with the value $\langle M_B \rangle = -19.79$ given by Leibundgut and Tammann (1990) for the absolute magnitude at maximum of type Ia supernovae and confirm the conclusion reached by Capaccioli *et al.* (1990) that the cosmic scatter for typical Ia events should be ≤ 0.3 magnitude. When taking into account the uncertainties, our result matches the statistical calibrations of Miller and Branch (1990), $\langle M_B \rangle = -18.95 \pm 0.11(1\sigma) + 5\log(H_o/75)$ and Della Valle and Panagia (1992), $\langle M_B \rangle = -19.24 \pm 0.18(1\sigma) + 5\log(H_o/75)$, for values of Hubble constant smaller than 70 km s^{-1} Mpc^{-1}.

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