Wasilewski 72: An Extragalactic H II Region

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ABSTRACT. The emission-line galaxy Wasilewski 72 was misidentified on the chart published for it. We report the correct identification of this object, which is an H II region-type galaxy, like many of the other Wasilewski objects.

1. INTRODUCTION

Some years ago Wasilewski (1983) made a moderate-dispersion objective-prism survey for low-redshift emission-line galaxies in a field covering 825 square degrees near the north galactic pole. Osterbrock and Shaw (1988) obtained spectra of all the Seyfert galaxy candidates and many other emission-line galaxies from his list. Later Bothun et al. (1989) obtained spectra of nearly all the emission-line galaxies in the list. They reported that four of the Wasilewski “galaxies” are really stars. At the suggestion of one of us (W.P.B.), the late N. Sanduleak checked the original objective-prism plates. He found that although three of these objects are stars, one, Wasilewski 72, is indeed an emission-line object; W.P.B. suggested that D.E.O. and H.D.T. obtain slit spectra of it. These spectra, as described below, immediately showed that Was 72 is an emission-line galaxy, an “extragalactic H II region.”

2. POSITION

The position given for Was 72 by Wasilewski (1983) is approximately correct, but the wrong object is marked on the chart in his Fig. 2(c). The accurate position, kindly measured for us by Dr. A. R. Klemola on the Lick Proper-Motion Survey plates, is α=13h27m00.9, δ=+22°52′38″ (1950). Was 72 is too faint to show on that chart but is visible on the POSS red plate and print from which the chart was made. It is approximately 52″ north, 07 east of the object marked on the chart, which no doubt is the star Bothun et al. (1989) observed. Was 72 is considerably brighter on the POSS blue plate, and we reproduce in Fig. 1 a chart made from it, with the correct object marked.

3. SPECTRA

We obtained one exposure with the CCD spectrograph at the Cassegrain focus of the Shane 3-m telescope of Lick Observatory using a 420 line mm\(^{-1}\) transmission grating-prism (grism) in 1991 May, and two exposures with the same spectrograph and a 600 line mm\(^{-1}\) grism in 1991 June. The slit width, projected on the sky, was 2″ for all three exposures. They were calibrated and reduced to energy units using standard Lick Observatory procedures (see, e.g., Osterbrock and Shaw 1988). The emission lines are so strong with respect to the continuum that [O III] \(\lambda 5007\) was saturated on all three spectra, but [O III] \(\lambda 4959\), H\(_β\), and the other lines are all measurable. A plot of the lower-resolution spectrum, which covers the wider wavelength interval, is shown in Fig. 2. Note the very great strength of the emission lines, their narrowness, the high relative intensity of [O III] \(\lambda 4959\), the weakness of [N II] \(\lambda \lambda 6548, 6583\) and [S II] \(\lambda \lambda 6716, 6731\), and the absence of [O I] \(\lambda 6300\) and He\(_\pi\) \(\lambda 4686\). Was 72 is clearly an extragalactic H II region (Sargent and Searle 1970) or an “H II region-like galaxy” (French 1980).

The redshift, measured from H\(_β\), [O III] \(\lambda 4959\) and H\(_α\) in the two higher-dispersion spectra, reduced to the Sun, is \(z=0.0252\pm0.0001\), corresponding to \(cz=7555\pm30\) km s\(^{-1}\). The emission lines are very narrow. The observed full width at half maximum of H\(_β\) and [O III] \(\lambda 4959\) on our higher-dispersion spectra (as determined by a Gaussian fitting program) are about 8.6 and 9.0 Å, respectively, while the measured full widths of He I and Cd I comparison lines in the same wavelength region are about 9.4 Å, somewhat wider. This difference simply indicates that the galaxy emission lines are unresolved, and since Was 72 is nearly a point source and the seeing was good, they appear narrower than the comparison lines, which come from a uniformly illuminated source larger than the slit.

4. MEASUREMENTS

The relative emission-line fluxes were measured on all three spectra. In the region from H\(_β\) to [S II] \(\lambda 6724\)
(λλ6716, 6731 measured together) common to all three spectra the agreement is very good, to within a few percent. The resulting mean values are listed in Table 1. Note that [N II] λλ6548, 6583 are so faint with respect to Hα they could not be resolved on any of the exposures. Only the total Hα+[N II] complex could be measured. From synthetic profiles, formed from models based on the [O III] λλ4959 profile, we estimate the [N II] λ6583/Hα intensity ratio 0.10, and from it (and the [N II] transition probabilities) derive the relative Hα and [N II] intensities listed in Table 1. [S II] λλ6716, 6731 could be deblended on the two higher-resolution spectra, and then individual relative intensities are listed in Table 1. The equivalent width of the Hβ emission line is 180 ±4 Å.

5. DISCUSSION

The spectrum of Was 72 as plotted in Fig. 2, the redshift and linewidths mentioned in Sec. 3, and the measured relative line intensities listed in Table 1 establish it as an extragalactic H II region, as discussed by Searle and Sargent (1972), French (1980), Kunth and Sargent (1983), Copetti et al. (1985), and several other authors. Twenty-two of the other 96 Wasilewski galaxies are of this type (Bothun et al. 1989). The equivalent width of Hβ emission, 180 Å, is about the same as the median equivalent width among the 12 "metal poor galaxies" listed by Kunth and Sargent (1983) and somewhat above the median 92 Å for the 23 "isolated" extragalactic H II regions in the compilation of Copetti et al. (1985).

The reddening of Was 72, as judged from the Hα/Hβ/Hγ ratios, is very nearly zero. The relative intensity of Hδ suggests a nonzero reddening, but as this is the weakest line, measured only near the end of the sensitivity on the lower-dispersion spectrum, we disregard it. The [O III] (λλ4959+λ5007)/λ4363 line ratio gives \( T = 15500 \) K in the O + ion zone, the [S II] λ4616/λ6731 ratio gives \( N_e \lesssim 10^4 \) cm \(^{-3} \), He I λ4861/Hβ, λ4861 gives He ++/H ++ = 0.10, and [O III] λ4959/Hβ gives O ++/H ++ = 7.3 \times 10^{−5} \). All these values are quite well in accord with typical values found for other similar objects by French (1980), Kunth and Sargent (1983), Copetti et al. (1985), and other authors, except that the He abundance in Was 72 is a trifle high; a more typical value would be He ++/H ++ = 0.08. The absolute magnitude is \( M_B = −18.1 \), based on the apparent magnitude \( m_B = 16.9 \) estimated by Wasilewski (1983) and an assumed \( H_0 = 75 \) km s \(^{-1} \) Mpc \(^{-1} \). This would put Was 72 among the more luminous objects of this class. We have reexamined the object on the POSS plate, and it appears that Wasilewski estimated the magnitude of the correct object, and that this magnitude is approximately right. Both the blue and red magnitudes of Was 72 are clearly affected by its strong emission lines. Clearly it would be desirable to measure its magnitude more accurately, and obtain its image, as Bothun et al. (1989) have done for the other Wasilewski galaxies.

Was 72, like other objects of this type, is undoubtedly either very young, or is dominated by very young stars. Over the wide range of assumptions included in the recent models by Mas-Hesse and Kunth (1991), its Hβ equivalent width 180 Å indicates the age of the stars which dominate its optical spectrum cannot be over \( 3 \times 10^6 \) yr.

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## REFERENCES