Recent CCD-Image Observations of RW Ursae Minoris

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Abstract We find an expansion parallax for the slow nova RW Ursae Minoris. An Hα image shows that the diameter of the nova shell in 1995 was 2.94 arcsecs. We derived a distance of 5,250 pc and an absolute magnitude at maximum of –7.7 for the nova.

1. Introduction

The very poorly studied old nova RW UMi has thus far received little attention from observers, and little information about it is available in the literature. Its outburst, which took place in September 1956, was discovered seven years later on old sky-patrol plates by Kukarkin (1962). The actual maximum brightness of the nova is unknown. According to Duerbeck (1987), the pre-nova is visible at the limit of the glass copy of the POSS plate. Its photographic magnitude is equal to about magnitude 21.

Classical novae at maximum light appear to obey a luminosity-rate of decline relationship. The most reliable distance determinations for galactic novae are those obtained from the angular expansion of nova shells. In this short contribution, we present an expansion parallax and distance estimate for RW UMi.

Our target object was selected both from the group of classical novae of known *speed classes* (rate of decline from optical maximum) in order to construct a new classification method (Esenoğlu 1996, 1997), and from the objects investigated with varying degrees of success by Cohen (1985). We obtained direct images of the nova shell of RW UMi on March 5, 1995, with the 1.82-m telescope at Ekar (Asiago), Italy. We used a Tektonix TK512M CCD at the *f*/9 Cassegrain focus, which yielded a pixel scale of 0.3375 arcsec pixel^{-1}. The exposure times were 1,200 and 2,400 seconds in the 6,670Å band (bandpass 50Å), and 3,600 seconds with an Hα filter of 45Å bandpass. We took only a bias frame, but neither the bias nor flat-field data was subtracted from each image. To determine the extent of the Hα nebulosity, we used an automatic procedure with point-spread function (PSF) in an IRAF environment to measure the full width at half-maximum (FWHM) for a large number of stars in the field.

2. Results

The spatially-resolved shell of RW UMi using image observations with a digital detector was found first by Cohen (1985), who derived a radius of 1.0 arcsec in 1984. We determined the second estimated shell of the nova in 1995 with the CCD detector, using the new direct-imaging observations. The new radius of the shell was found as 1.47 arcsec in the following way: The mean seeing from five nearby stars around the nova in the 6670-band combined image was 2.75 arcsec, to which RW UMi with a FWHM of 3.11 arcsec and a resulting nebular diameter of 1.45 arcsec conformed well. In the Hα image, however, it had a width of 4.23 arcsec, the largest of any star in our sample, compared with a mean of 3.04 arcsec for the other stars. Therefore, a nebular diameter of 2.94 arcsec from its Hα image for RW UMi was found.

We conclude that, considering a constant expansion speed of 950 km s^{-1} given by Cohen since outburst, in the 27.3 and 38.5 years between the outburst and the time the Hα images for the first and the second observation dates were taken, the nova shell would have expanded to the radii of 8.18×10^{16} and 1.15×10^{17} cm, respectively. Taking into account the expansion velocity, we find an average expansion rate of 0.038 arcsec yr^{-1} and a distance of 5,250 pc from the observed diameter. These results are comparable with the results of 0.037 arcsec yr^{-1} and 5470 pc by Cohen. Slavin *et al.* (1995) estimated a distance of 5,000 ± 2,000 pc by nebular expansion parallax from its nebular remnant, too.

Since the maximum magnitude RW UMi attained was $m_{vis} = 6.0$ (Kukarkin 1962), our distance estimate suggests an absolute magnitude at maximum of $M_v = -7.7$ with an interstellar extinction $A_v = 0.1$ (Cohen 1985). This result is in good agreement with $M_v(\max) \leq -7.8$ given by Cohen. An absolute bolometric magnitude at maximum is derived after applying a bolometric correction of –0.1 (Livio 1992), yielding $M_{bol} = -7.8$. It is seen that RW UMi briefly exceeded the Eddington luminosity in spite of being a slow nova with $t_3 = 140$ days (Duerbeck 1987).

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