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AS 239: THE DECLINING PHASE OF A SLOW NOVA?

AS 239 was discovered during the Mount Wilson objective-prism survey for Be stars, undertaken in the 1940's. It was designated and classified by Merrill and Burwell (Ap.J., 112, 72, 1950) in their list of "Additional Stars" with Hα emission. They rated AS 239 as 12th magnitude, and tersely described the spectrum as containing "lines of highly ionized iron atoms". In a similar survey, made about 1950, Henize (Ap.J.Suppl.,30,491,1976) also recorded AS 239 (=Hen 1465) as 12th magnitude, but rated the Hα emission less strong than had Merrill and Burwell. Experience with magnitude estimates in the AS and Hen catalogues suggests that $V \sim 13-14$ is more appropriate at that epoch.

Searches over the last decade by this and other observers had failed to rediscover any suitable 13th magnitude star near the Merrill and Burwell position. This dilemma was finally resolved when N. Sanduleak (private communication) provided a finding chart for AS 239 based on his own objective prism survey made about 1968. Sanduleak described AS 239 as much fainter than 12th magnitude; indeed it was too faint to have been noted on his original search of the prism plates.

On the Palomar Sky Survey plates, taken in 1950, AS 239 is a slightly red star of about 15th magnitude. On the U.K. Schmidt Sky Survey IIIaJ plate J2351, taken in 1976 May, it is about 18-19th magnitude. In 1978 February the star was observed spectroscopically with the 3.9 m Anglo-Australian Telescope (AAT); the magnitude was then estimated at 19-20 on a television viewing system which responds well at Hα.

Despite the strong emission lines in the spectrum of this star, and the nonhomogeneous nature of the magnitude estimates, these data indicate that a decline of more than 7 magnitudes has occurred in the last 30 years.

Spectra of AS 239 were taken by Minkowski (see Merrill and Burwell) in 1943 and 1945, but no publication ensued. These plates were kindly made available to the author by the Director of the Hale Observatories. The plate numbers and dates are listed below. All appear to have been taken at low dispersion with a prism spectrograph on the Mount Wilson 100-inch telescope.

Plate	Date	Spectral region (A)
JS 540	31.5.43	3850 - 5000
E 872	29.6.43	3950 - 7000
E 895	29.7.43	3950 - 7000
E 932	1.9.43	3850 - 5050
E 1442	3.7.45	4000 - 7000

The four plates taken in 1943 show a very-high-excitation spectrum with the following salient features. There is a weak continuum, rather red. The Balmer series is strong. [O III] λ5007 is weaker than Hβ but λ4363 is almost as strong as Hγ. [S III] and [Ne III] are fairly strong. [N II] λ5755 is strong; the red lines, if present, are blended with Hα. He II λ4686 is of comparable intensity to Hβ, and He I is quite strong. The N III blend at λ4640 is weak. Lines of [Fe VI], [Fe VII] and [Ca V] are strong, and [Ca VI] and [Ne IV] are weak.

Minkowski's 1945 plate revealed spectral changes towards higher excitation. He II, [Fe VII] and [Ca VI] had strengthened; He I, [O III], [S III] and [Fe VI] had weakened. The continuum had also weakened on the 1945 plate, and the unidentified band at λ6830 had appeared.

These spectra suggest that AS 239 is a symbiotic star or slow nova. The high-excitation lines are certainly typical of those found in symbiotic stars, but Minkowski's plates are unsuited to a search for TiO absorption. Slow novae tend not to show TiO absorption in their early stages. In 1943, AS 239 resembled the slow nova RR Tel in the early 1960's, whilst its 1945 spectrum is more closely matched by that of RR Tel in 1973 (Thackeray, Mem,R.A.S., 83, 1, 1977).

Whether AS 239 be classified as a symbiotic star or a slow nova, its $>$7 magnitude decline is extreme. Thus the AAT spectrum of 1978 Feb. 15 is of particular interest. It was taken with the image-photon counting system and covered the wavelength range 3400-7500 A with a resolution of 5A. Because the star was so faint, the spectrum shows few features. However, a change has probably occurred in the last 35 years. The emission lines now recorded appear to be of lower excitation. Hα is prominent and flanked by weak [N II]. The [O III] lines are seen with λ5007 ~ Hβ. λ6300 of [O I] may be present. No continuum is detected throughout most of the spectrum, and no lines to the blue of Hβ. The V magnitude, strictly defined by the V filter, is about 22. Longwards of 6900 A a weak continuum rises from the noise, dissected by TiO absorption and demonstrating the presence of a star later than about M3 in the system. The R magnitude is about 19. The Balmer decrement is steep and indicates reddening as high as A_V=11 magnitudes if case B applies. The dereddened R magnitude is about 11.

An infrared measurement of AS 239 was also made with the AAT in 1977 April, using an InSb photometer kindly made available by P.M. Williams. The star was not visible at the telescope owing to strong moonlight, so the measured magnitudes may be slightly affected by centering and guiding errors. Data were taken at 1.6 μm (H) and 2.2 μm (K), yielding:

$$K = 8.2 \quad H-K = 1.0$$

Correction for $A_V \sim 11$ yields $K_o = 7.2$ $(H-K)_o = 0.3$, and this is consistent with the continuum of the star seen in the far red of the optical spectrum if its spectral type is mid M. Thus there is no evidence for any infrared excess at these wavelengths.

If the ~11 magnitudes of extinction were present in the 1940's, it is unlikely that Minkowski could have secured spectra in the blue. Whilst the characteristics of the spectrograph are not known, the appearance of Minkowski's plates suggests that A_V did not exceed 5 magnitudes, and may have been much less. Moreover, had AS 239 been reddened by 11 magnitudes in 1950, the Palomar Sky Survey plates would have shown the object to be much redder than is the case.

We are forced to accept that the reddening has increased. Condensation of dust grains in the circumstellar nebula provides the obvious mechanism for this, and the phenomenon is well-established in conventional novae (e.g. Hyland and Neugebauer, Ap.J.160, L77,1970). Since the reddened M star alone can adequately account for the H and K fluxes, whatever dust exists must be cooler than ~1000 K, or must have low emissivity at 1.6 and 2.2 μm. A detectable excess at longer infrared wavelengths might be expected. If the star is intrinsically as luminous now as in the 1940's ($m_{bol} \sim 13-14$), the 10 μm magnitude could be as bright as 3-4.

Apart from the high reddening, and the likelihood that this has increased during the decline, AS 239 resembles the recurrent nova T CrB in both its amplitude and its high-excitation spectrum. If its maximum occurred shortly before Minkowski's spectra were secured, around 1940, the similarity would be greater. T CrB has no significant infrared excess (Geisel, Kleinmann and Low, Ap.J. 161, L101,1970).

The optical continuum of AS 239 is now too faint for useful photometry. The star should, however, be more fully observed at infrared wavelengths in order to ascertain whether circumstellar dust does exist. A light curve showing the variations of AS 239 during this century, and based on an uniform set of plate material, would also be of value. To this end, a finding chart is provided below. The chart is based on the recent U.K. Schmidt plate of the region and shows stars to about 21st magnitude near AS 239. The 1950 coordinates of AS 239, read off the AAT encoders and corrected for pointing errors, are:

$17^h40^m30\overset{s}{.}8 \quad -22^\circ44'16''$.

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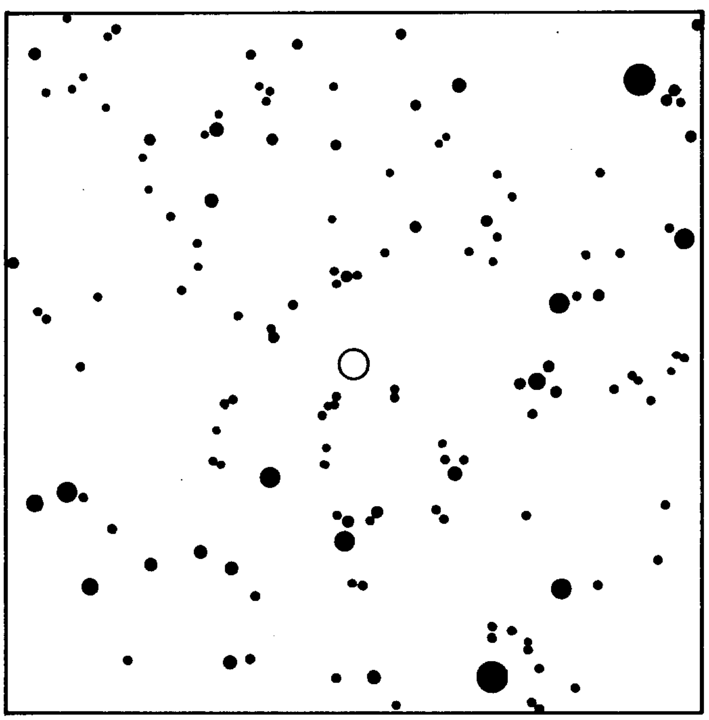

Finding chart for AS 239. North is at the top and east to the left. The box is 5′arc across.