

A NOTE ON THE FLARE STARS IN THE COALSACK

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R I N G K A S A N

Didalam tulisan ini dilaporkan penemuan 5 buah "flare stars" di daerah Coalsack.

A B S T R A C T

The discovery of 5 flare stars in the Coalsack is reported.

Introduction

Sanduleak (1969) presented an argument that the Southern Coalsack ($l = 302^\circ$; $b = -1.4$) is an area which is either rich in flare stars or greater activity per star as compared with other groups. Andrews (1972) has reported that the area is exceptionally rich in rapid-variable stars of a type possibly related to the flare stars in young aggregates.

Earlier, from spectroscopic surveys in an area of approximately 50 square degrees, Hidajat (1962) and The (1962) have found respectively 48 and 90 H-alpha emission stars. Out of these, 96 are certain H-alpha emission line stars, while 30 stars were classified as "possible H-alpha emission stars" due to the variable appearance of the H-alpha line. Furthermore, The (1962) concluded that the stars form three groups of late-type stars of T-Tauri type.

Following Sanduleak's discovery, the authors have reobserved the area of Coalsack by means of multiple-exposure photographic technique in 1969 and 1971. The observations were

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intended to check the possible rapid variation of the light from the 30 suspected H-alpha emission stars. In order to detect the possible flaring of Ca II line, blue spectral plates were also secured. These plates (2), together with the short-exposure plates obtained in 1961, were examined along the procedure employed by Sanduleak.

Observational Material

The technique of multiple-exposure photography utilized by Haro (1968) for the detection of flare stars has been employed in the present survey. The Bosscha Schmidt Telescope was used to collect multiple-exposure (6 images per plate) taken on I1a-0 plates in conjunction with a GG 13 filter. A pair of 103a-0 plates, taken without a filter, were also obtained. The centres of the areas reported in the present study coincide with the centres of the areas observed earlier by Hidajat (1962) and by The (1962). Thus, an area of approximately 30 square degrees are comprised, with a total observing times of 100 minutes for the direct plates and approximately 90 minutes for the spectral plates (I1a-0 spectral plates were exposed without a filter).

Visual inspection of the spectral plates has been employed to detect the possible emergence of the Balmer and K lines. In order to detect the possible flaring on the direct plates, a Zeiss microscope (15x) was used to scan the plates. The magnitudes were estimated by means of a "fly spanker" method. This procedure yielded an accuracy of 0.5^m .

Results

Out of the 30 suspected H-alpha emission line stars, three stars show definite "flaring" on our direct multiple-exposure plates. The magnitude differences are in the order of 1 magnitude in B. These are the stars designated by The (1962) as H 43, Th 61 and 76. Two other stars (Th 36 and H 12, in Hidajat, 1962, Catalogue) indicate the emergence of K line on their spectra taken on May 22, 1971. The result thus indicates that 5 out of 30 suspected H-alpha emission stars do show variability in the course of this study.

An investigation of other stars in the field does not suggest the existence of flare stars, within the limiting accuracy of the present study. This may be due to the fact that flare stars radiate more strongly toward the ultraviolet (Haro, 1968). The second possible cause was probably due to the crowding effect, that prevented us to detect slight vari-

ability. As has been pointed out by Andrews (1972) the narrower passband and shorter effective wavelength will be more suitable for a survey of flare stars.

A comparison of plates taken in 1961 and in 1969 indicates that Sanduleak's star no. 1, may be a variable star. However, there was no indication of eruptive flaring in the course of the present study. The observation of this star amounts to 100 minutes.

Discussion

The controversy has arisen about the high-rate of flaring in the Coalsack. On the contrary to that found by Andrews (1972), who detected 140 flare stars in the area, Weaver (1973) and MacConnell and Dixon (1974) found no evidence that the Coalsack is densely populated by rapid-variable stars. MacConnell and Dixon (1974) stated, after comparing their finding of 3 flare stars in the Coalsack and that found by Haro and Chavira (1955), that the number of flare stars in the Coalsack may well be below the number in flare stars in the Orion. However, the number may be comparable with that found in the Taurus regions.

The close association between flare stars and regions of emission nebulosity and with obscuring dust and gas clouds leads one naturally to expect large number of flare stars in the area like Coalsack, which is known to contain T-Tauri type stars. Weaver (1974) found that among Andrews' stars only few can be classified as UV Ceti, T-Tauri or Nebular flare stars. Unfortunately, none of Andrews' stars are in common with that studied by Hidajat or by The. Therefore it would be interesting to look for the evidence whether the 30 suspected H-alpha emission stars belong to one or the other groups of stars mentioned earlier. If the majority of the suspected H-alpha emission stars were of UV Ceti type, their M spectra would have been detected on our infrared spectral plates (1N plates exposed behind an RG 8 or RG 2 filters). This was not the case.

The two stars that have shown variability in their spectra at best can be assigned as stars later than K0. Due to the faintness of the other stars, and due to the limiting magnitude reached by our spectroscopic plates ($B = 11^m$) it was not possible to observe the H-alpha emission stars in the blue spectral regions. Thus among the brighter H-alpha emission stars ($m < 11^m$) stars compiled in the Hidajat and The Catalogues, together with Sanduleak's stars, only 6 out of 36 stars belong to K special types.

It is noted that Weaver (1974) in his photometric UBVI

studies of the Andrews stars arrives at the conclusion that the majority of Andrews' stars are of reddened early type (B-A) stars. While MacConnell and Dixon (1974) found no evidence of eruptive ultraviolet activity among the Andrews' stars. In our study we have altogether found 5 flaring activities among the 30 suspected H-alpha emission stars. This number should be considered as lower limit due to larger effective wavelength employed in the present survey. Although a strict comparison is not possible (due to different plate-filter combinations used in the surveys), it may be interesting to note that there are at least 6 stars out of 36 brighter H-alpha emission stars ($m < 11^m$) in the list of Hidajat (1962) and The (1962), have shown flaring activities. A UBVI photometric study similar to that carried out by Weaver should be able to offer a better explanation about the nature of H-alpha emission stars in the Coalsack.

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References:

- Andrews, A.D. (1972), Bol. Obs. Tonantzintla y Tacubaya, 6, 179.
- Haro, G. (1968), in *Nebulae and Interstellar Matter*, Ed. B.M. Middlehurst and L.H. Aller (Chicago: University of Chicago Press), p. 141.
- Hidajat, B. (1962), *Contrib. Bosscha Obs.*, No. 16.
- MacConnell, D.J. and Dixon, M.S. (1974), *Astron. J.*, 79, 705.
- The, P.S. (1962), *Contr. Bosscha Obs.*, No. 17.
- Weaver, W.B. (1973), *Astroph. J.*, 184, 881.
- Weaver, W.B. (1974), *ibid* 189, 81.

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