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REVIEW OF "ESTUDIO ESPECTROSCÓPICO Y FOTOMÉTRICO DEL CÚMULO ESTELAR EN COMA BERENICES" BY MENDOZA (1963)

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RESUMEN

Se presenta una reseña del trabajo "Estudio Espectroscópico y Fotométrico del Cúmulo Estelar en Coma Berenices" de E. E. Mendoza V., 1963, BOTT, 3, 23, 137. Se inicia con una breve introducción histórica del campo de la fotometría de cúmulos abiertos. Posteriormente se hace ver el desarrollo seguido por Mendoza en sus publicaciones hasta llegar al artículo en cuestión. Se hace un resúmen de éste y, finalmente, se encuadra el trabajo en el marco de las investigaciones actuales.

ABSTRACT

A review of the paper "Estudio Espectroscópico y Fotométrico del Cúmulo Estelar en Coma Berenices" by E. E. Mendoza V., 1963, BOTT, 3, 23, 137 is presented. This review begins with a brief historical introduction of the open clusters field. Later, the development of the publications by Mendoza is presented up to the publication of the article in question. A brief summary of it is presented and, finally, it is placed in the current state of the research.

Key Words: open clusters and associations: individual (Coma Berenices) — techniques: photometric — techniques: spectroscopic

1. INTRODUCTION

A review of the paper "Estudio Espectroscópico y Fotométrico del Cúmulo Estelar en Coma Berenices" by E. E. Mendoza V. (1963) is presented. We begin quoting Mendoza's Introduction because the most relevant material up to that date was mentioned: *"Johnson & Knuckles (1955) found, from photoelectric observations, that the F and G stars in Coma Berenices have an ultraviolet excess of 0.035 mag with respect to similar stars in the Hyades. Strömgren found, from m-index measurements that four F stars in Coma Berenices have a lower m-index than five F stars in the Hyades, five F of the Pleiades and eight F stars in Praesepe. Both results can be interpreted saying that the F and G stars in Coma have a metal deficiency when compared to similar stars in the Hyades and that, perhaps, Coma's age could be larger than that of the Hyades".*

"On the other hand, Sandage & Eggen (1959) found, from composite diagrams in ($B - V$, M_v) that Coma Berenice's age is 2×10^8 less than that of the Hyades. These authors, when assuming that the abundance of heavier elements of the pre-stellar material does not increase uniformly with time since the galaxy formation, exclude the metallic content as a criterium for determining the age of Coma".

"The present paper is an investigation, based on combined spectroscopic and photoelectric material that has the aim of finding out up to which point the spectroscopic and photoelectric peculiarities can clarify, with higher precision the age of Coma Berenices".

As we can see, previous to this paper by Mendoza (1963), some uncertainties with respect to the age of the open cluster Coma Berenices existed. Mendoza (1963), based on combined spectroscopic and photoelectric data, proposed to determine the age of Coma Berenices more accurately, utilizing its spectroscopic and photoelectric peculiarities.

2. HISTORICAL OVERVIEW ON COMA BERENICES

Prior to the study of Coma Berenices by Mendoza (1963), there were some works by Johnson and collaborators (Johnson 1950, 1952; Johnson & Morgan 1951a; Johnson & Schwarzschild 1951b) who carried out the photometric studies on several clusters: NGC 2362, M 15, Pleiades, Praesepe. There were further studies on M 39, NGC 752, IC 4665, M 7, M 3 until 1963 when the paper in Coma was published. It is clear, although unnecessary to mention that Johnson was one of the leaders in the study of photoelectric photometry in open clusters.

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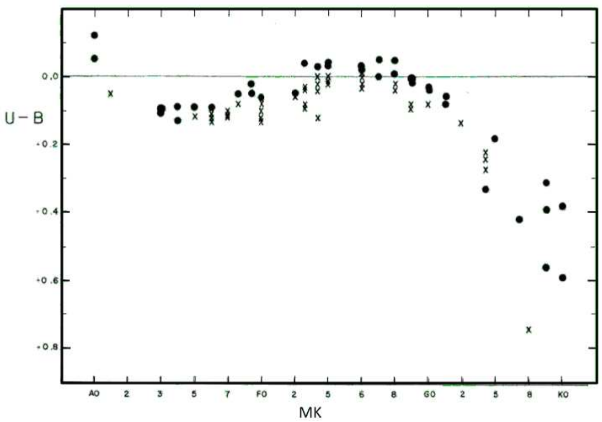

Fig. 1. "Color-Spectrum relation. The abcisa provide the spectral type; the ordinates the $(U - B)$ color index for the Hyades (crosses) and the physical members of Coma Berenices (circles). The metallic, peculiar and composite spectra stars do not appear in the figure. The larger symbols denote more than one star with the same coordinates. Observe that the Hyades lie below than those of Coma".

Searching the literature from SIMBAD to discover previous knowledge on this cluster, in a time span from 1946 to 2009, we found the following main references for Coma Berenices: Becker (1963) and Johnson & Knuckles (1955).

This latter source, Johnson & Knuckles (1955), produced interesting diagrams from U, B, V photoelectric observations of most of the known members of the Hyades cluster and 40 stars in Coma Berenices, which led them to conclude that the ultraviolet observations in the Coma Berenices cluster show that its F and G type stars probably radiate about 0.035 mag more ultraviolet than do similar stars in the Hyades.

3. PREVIOUS WORKS BY MENDOZA

Before his study of Coma Berenices, Mendoza published the following papers: (i) A spectroscopic study of the Pleiades (Mendoza 1956), (ii) A spectroscopic and photometric study of the Be stars (Mendoza 1958), (iii) Flare stars in the region of the Orion Nebula (Haro, Chavira, & Mendoza 1960a), and (iv) Wolf-Rayet stars in the vicinity of the association VI Cygni (Herbig & Mendoza 1960b). All of these works show the developing expertise by Mendoza in the field. In 1963 Mendoza published the paper under consideration: Spectroscopic and photometric study of Coma Berenices.

4. OBSERVATIONAL MATERIAL

The study was based on fifty-four stars from Trumpler's (1938) lists for which spectroscopic and photoelectric data were acquired. Of these stars, thirty seven are physical members of the Coma Berenices cluster, six are probable members. The remaining eleven stars were chosen because they had measured radial velocities (Fehrenbach 1956). A detailed description of these stars included:

(a) Forty-one spectrograms for stars considered to be possible members of Coma Berenices were taken with the forty-inch refractor at the Yerkes Observatory with a 125 A/mm dispersion centered at $H\gamma$. The spectra were obtained in 1955 and 1956. These stars were observed photoelectrically by Johnson & Knuckles (1955).

(b) The corresponding spectrograms of the remaining thirteen stars were taken in 1963 with the nebular spectrograph with the forty-inch reflector telescope at the Observatorio Astonomico Nacional, UNAM. The dispersion was of 260 A/mm.

The spectral types and luminosity classes of these fifty-four objects were assigned utilizing the revised criteria of Yerkes (MK type) as described by Morgan (Johnson & Morgan 1953).

(c) Combined spectroscopic and photometric data of the fifty four stars under study were done in Johnsons (1963, private comm.) and Johnson & Mitchell's (1962)(U, B, V, R, I) system. All the photoelectric observations were made at the 40 inch reflector of the Observatorio Astronómico Nacional, UNAM and a digital photometer designed by Johnson. The observations were reduced by Mitchell.

(d) Two red plates of 90 and 180 min of exposure time were obtained with the Schmidt camera and its objective prism at the Observatorio de Tonantzintla.

(e) With the same Schmidt camera twenty two direct plates were obtained. This material was part of a search which had been implemented at Tonantzintla for several years to detect rapid variables in stellar associations and galactic clusters. The twenty-four plates obtained with the Schmidt Camera cover a region of twenty-five square degrees and are centered at $\alpha = 12^h\, 18^m$ and $\delta = +25.5$ (1900.0).

5. RESULTS

Four metallic stars, three peculiar stars, one composed spectrum (G2III + A4V) and one star of luminosity IV-V were found among the physical members of Coma Berenices. At the same time, because of their spectroscopic and photometric characteristics, four new probable members were determined.

The findings from the Schmidt camera were negative because they found no star with Hα emission, nor rapid variables of the same type as those found with the same camera and technique in Orion (Haro & Morgan 1953; Haro & Chavira 1955) in the Taurus region (Haro & Rivera-Terrazas 1954) and in the Pleiades (Haro 1964). Despite these negative findings, Mendoza (1963) considered them inconclusive and suggested that a larger sample of plates in Coma's region was needed to decide on the existence or not of rapid variables.

From his plots and Keenan & Morgan's (1951) calibration, Mendoza (1963) derived a distance modulus for Coma Berenices of 4.5 mag whereas Sandage & Eggen (1959) obtained a value of 4.48.

6. ULTRAVIOLET EXCESS IN COMA BERENICES

Since one of the aims that Mendoza (1963) pursued was to determine the ultraviolet excess found by Johnson & Knuckles (1955), he used the combined spectroscopic and photometric data obtained in Coma Berenices to determine the $(U - B)$ excess for each spectral type with respect to the same spectral types for the Hyades, Pleiades and Praesepe clusters, measured by Johnson & Knuckles (1955), Johnson & Mitchell (1962) and Johnson (1952), respectively.

After all his handling of the data: averaging spectral type groups and some other considerations, Mendoza (1963) states that it can be easily seen that the stars in Coma radiate 0.05 mag more ultraviolet than the stars in the Hyades and the Pleiades. He further stated that, with respect to Praesepe, the stars in Coma have an ultraviolet excess of 0.04 mag.

7. CONCLUSIONS

Mendoza (1963) concluded, based on the results derived from the spectroscopic and photometric data, that:

(a) An ultraviolet excess of Coma Berenices was confirmed when the color index $(U - B)$ was compared with analogous color indexes of stars with the same spectral types, but belonging to other galactic clusters.

(b) The color indexes (U-B) under discussion are not well-related to the ages of the Hyades, Pleiades and Praesepe. For example, no ultraviolet excess between the Hyades and the Pleiades was found, although is well-known that the Hyades are older than the Pleiades.

(c) The photoelectric observations cannot be used to conclusively determine the age of Coma Berenices because there were no other galactic clusters in the (U, B, V, R, I) system.

8. RELEVANCE OF THE WORK

In the last 10 years 29 papers related to Coma Berenices have been compiled in WEBDA, a site devoted to Open Clusters. Some of them have utilized *Hipparcos* to improve the accuracy and some are devoted to variable stars as well as binaries. A fair number are dedicated to determining the age of the cluster based on spectroscopic studies determining its chemical composition.

Some recent references deal with related topics that Mendoza (1963) was pursuing: Lithium in the low-mass stars of the Coma Berenices open cluster (Jeffries 1999); The Pleiades, Coma, Hyades and Praesepe open clusters: Li, Al, Si, S, Fe, Ni, and Eu abundances compared in A stars (Burkhart & Coupry 2000); Li abundance in Pop I stars (Pasquini 2000); Lithium in the Coma Berenices open cluster (Ford et al. 2001); Chemical composition of A and F dwarf members of the Coma Berenices open cluster (Gebran, Monier, & Richard 2008) and Cousins Photometry and Temperatures for the Hyades, Coma, NGC 752, Praesepe, and M67 (Taylor, Joner, & Jeffery, 2008).

In view of the recent, related works on Coma Berenices we can see that the pioneer work of Mendoza (1963) pointed out relevant issues that still remain unsolved. That is the reason this is an important work in developing the astronomical groups in Mexico.

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