NEBULAR VARIABLES

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Abstract

The nature of Nebular Variables and techniques of observing them are described.

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The Great Nebula veiling the multiple star theta in Orion's sword has fascinated both amateur and professional astronomers ever since its discovery by Cysatus in 1618. One of the most interesting features of the Orion nebula is the large number of variable stars found within, well over 100 stars, of which 50 are brighter than $14^m.0$, have been discovered in the region.

Harvard's first variable star discovery was made by Professor G. P. Bond in 1863 when he detected a star of varying brightness in the Great Nebula of Orion. The star embedded in the nebula is located not far from the Trapezium. This star was found in the course of a systematic examination, with "The Great 15-inch Refractor," of the stars in that particular nebula. It was later named T Orionis. Professor Bond later found other variables in this region.

The stars in this area are known as nebular variables. The term "nebular" is appropriate for these stars, as they occur in abundance in many of the dense patches of nebula that are features of the spiral arms of our galaxy. Joy in 1945 concluded from his observations that, as far as he knew, the Orion Nebula is the most striking example of the observed interaction between a diffuse nebula and dwarf stars of late spectral type. He suggests the following possibilities for the origin of these stars: either this group of emission stars has drifted into the nebula without any formal connection with it or these stars originated from the nebula itself.

Classification of these stars is difficult. Interference from the nebula is troublesome when photoelectric equipment is used. The General Catalogue of Variable Stars gives a general classification as: irregular variables connected with diffuse nebulae or observed in the region of such nebulae. On the spectrum-luminosity diagram they are situated mainly in the region of the main sequence and in the region of the subgiants. Four basic classes are then listed for Orion variables: Ina- Orion variables of early spectral classes (O-A), a typical representative is T Orionis, Inb- Orion variables of the intermediate or late spectral classes (F-M), a typical representative is AH Orionis, InT- irregular variables of the T Tauri type. Membership in this type is determined by the following exclusive spectral features: spectral classes are ranged in the limits (F-M). The spectrum of the most typical star resembles the spectrum of the solar chromosphere. A special feature of this is the presence of florescent emission lines Fe I at 4064A and 4132A, anomalously intensified at these stars, and [S II], [O I] lines. These stars are usually observed only in diffuse nebula, a typical representative is T Tauri. The last class are UVn- Flash variables connected with diffuse nebula. These stars are in fact Orion variables of late spectral classes characterized by rapid flashes. A typical representative is V389 Orionis.

The best known of the Orion variables is T Orionis. Its maximum light is usually around $10^m.0$ (Fig. 1). It remains at constant brightness for two or three months, but often drops to ~~the~~ $11^m.0$ or

12^m0. Most often its light variations are a succession of rapid irregular fluctuations. Sometimes the decreases to minimum light require but a few days and are followed by more gradual increases which are interrupted by a fading away, before another period of relative calm has been reached.

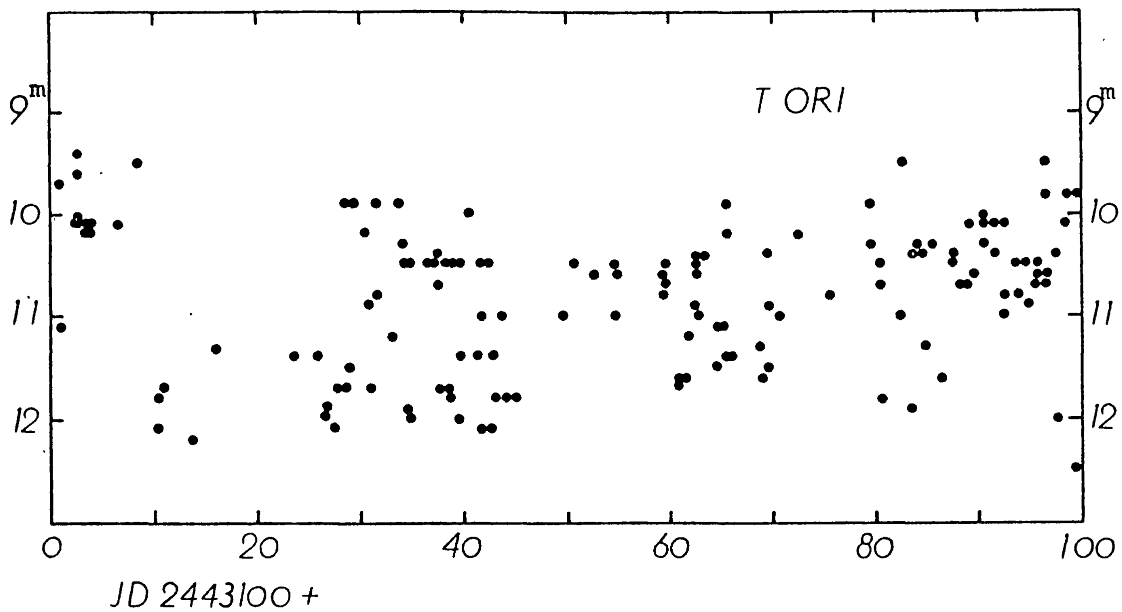

Figure 1. Light variations of the nebular variable T Orionis.

In December of 1977 I began a systematic observation of 17 variables of the 61 listed on the AAVSO charts of this region. Observations were carried out on every clear night using a 32cm reflector at 51x and a 20cm refractor at 69x at Seagrave Memorial Observatory. My observations agreed well with those published earlier. I found T Orionis to fluctuate nightly by up to $0^m.2$. A drop to $10^m.8$ from the average $10^m.0$ was recorded over the course of one month. I found that my observing window for this area was gone in early March and did not record a drop to the 11^m-12^m range in this observing session. Some stars in the entire observation time did not vary at all, as in the case of the star MX Orionis.

These stars offer a great challenge to those wishing to do valuable research in an area where photoelectric observing is very difficult. It must be mentioned that some basic rules must be followed when observing in this region. It is necessary that one observe on every clear night. For some stars 2-3 observations each night spaced by 2 hours or more will show variations of 3-4 tenths of a magnitude. It is good policy to use only one telescope for your observations and no more than 2 eyepieces. The lowest power possible should be used as there are some stars that have comparisons far out of the field of in the high power ocular. I have found that 50x is good for my 32cm reflector when observing down to 12th magnitude and about 69x for those stars down to 14th magnitude. The most important item is that observations of these stars be timed to the minute. This represents 4 decimal places after the Julian day.

These stars have unique light curves when compared to most variables. It is not unusual to have observations that vary by 1-2 magnitudes in one night. This fact makes it almost impossible to compare your observations with those other observers made several hours apart. It becomes necessary for the observer to go out each night, compile his estimates and compare the light curves as a whole at the end of each season to those of others using similar observing techniques. The scatter that is encountered when sporadic observations are compared is very misleading. Photoelectric observations are difficult and are left primarily for the professional astronomer. The background scatter of the nebula, especially in the central regions, makes calibration troublesome. Objective prism spectra in this area is quite complicated. Initial identification is made from objective prism spectrograms, later supplemented by slit spectrograms. A good method of detailed observation is to photograph the area in yellow light. This eliminates a good deal of the nebulosity. The photographs should be taken with the same regularity as would be done with visual observing. One can then blink the exposed plates for changes in brightness.

I hope this paper has been of some help to those already observing in this area. If you are interested in these stars, please remember that you are committed to a very rigid observing schedule, but you will find these stars very rewarding with their sudden changes and unusual characteristics.

I wish to thank Mrs. Mattei, the Director, for help on this topic.

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LIST OF PAPERS PRESENTED AT THE SPRING MEETING OF THE AAVSO HELD JUNE 3, 1978.

1. "Newly Revised 1978 Catalog of AAVSO Preliminary Charts"
   Clinton B. Ford

2. "A Study of AY Lyrae"
   Keith Danskin, Janet A. Mattei

3. "Modified 16-in. Cassegrain-Springfield for a Retiree"
   Edward Halbach

4. "The Present Sunspot Cycle"
   Herbert Luft

5. "The Giant February 20, 1978 Radio Outburst of HR 1099"
   Douglas S. Hall

6. "Seeing Spots Before Your Eyes: Solar Observing"
   David A. Huestis

7. "Orion Nebular Variables"
   Richard Lynch

8. "An Electronic Noise Suppressor"
   Casper H. Hossfield

9. "The Dwarf Nova UV Persei"
   John Coolbaugh, Janet A. Mattei

10. "The Frequency Distribution of Long-Period Variables in and around Globular Clusters"
    Dorrit Hoffleit

11. "Milwaukee Astronomical Society's Observatory"
    Raymond Zit