A Puzzling Object: V 348 Sgr

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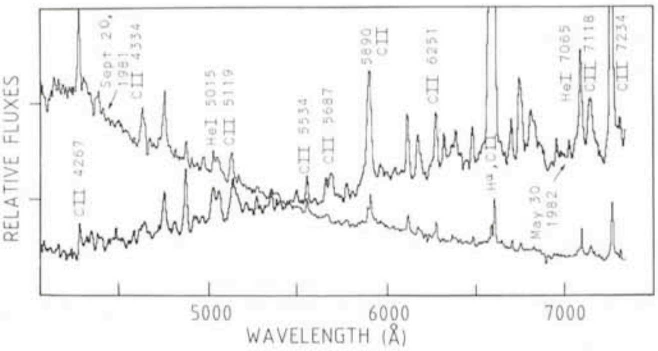
V 348 Sagitarii is one of the many variables discovered by Miss Ida Woods on Harvard plates *(Harvard Bulletin* 838, 1926). Later, in the 1950s, 500 patrol plates have been scrutinized by Mrs. Jean Hales Anderson (Hoffleit, *Astronomical Journal,* **63,** 78, 1958) at Maria Mitchell Observatory. This material covered the period 1906–1939 and the derived light curve suggested a semi-regular variability with cycles of 200 to 400 days. Because of the resemblance of its light curve with the ones of stars undergoing at irregular intervals sudden drops of brightness before recovering more slowly their previous magnitude, that star was once classified as belonging to the R Coronae Borealis type by Schjan, who rediscovered the star in 1929 and gave it the number 3976 in the H(amburg) V(ariables) catalogue *(Astronomische Nachrichten,* **235,** 417, 1929). V 348 Sgr, however, is seen more often at minimum light than at maximum, contrarily to the R Coronae Borealis stars. These objects are known to be carbon rich and this is indeed the case for V 348 Sgr; however, as shown first by George Herbig *(Astrophysical Journal,* **127,** 312, 1958) the spectrum, unlike the other stars of the type reveals the presence of a hot diluted atmosphere around the star where many lines of ionized atoms of carbon are seen instead of absorption bands due to molecular compounds. So both by its light curve and by its spectrum V 348 Sgr is indeed a peculiar object.

In 1960, I happened to sail to California with plates of this star obtained in 1958 by J.L. Greenstein at Palomar. The spectra had been measured in Liège by a student. Looking at them, I was struck by the very peculiar line profiles and I decided to record them with the at that time newly designed intensitometer at Caltech, before handing them back to the custodian of the famous plate vault at Mount Wilson offices. Some time later, while staying at Harvard College Observatory, I had a casual discussion with Cecilia Payne Gaposhkin who stressed the uniqueness of the characteristics of the object. I went back to my tracings and indeed more and more peculiarities showed up; for instance, Herbig mentioned the presence of numerous emission lines: there were indeed quite a few pure emission lines but I noticed that many of them were flanked by an absorption component on their violet side, a rather unusual feature. Moreover certain emission lines appeared as double. When looking at the atomic levels implied I noticed that the double lines arose from levels due to configurations with one electron excited. Other ionized carbon lines were either of the "inverted P Cygni" type or single emissions.

This was the situation in 1968, when I decided to obtain more information both on the photometric and spectroscopic behaviour of this puzzling object. But in Europe the observing season for a star never brighter than the 11th magnitude and located at 23 degrees of southern declination in the summer sky is rather short. Furthermore, with the equipment available at that time, spectra could be obtained successfully only at light maxima. The latter could not be foreseen and some years the star remained stubbornly at minimum for the whole summer. I was fortunate to meet at that time M. Duruy, a very active observer of variable stars near Nice, who kindly accepted to put the object on his rather crowded observing programme. Already during the 1970 campaign, he succeeded in making visual estimates of the star's brightness and immediately noticed that its light curve had no resemblance with any of the numerous variables on his list. *(Bull. Soc. R. Sc, Lg,* **39,** 600, 1970). He was warning me when a light maximum was on the way and this permitted Mrs. Andrillat and myself to obtain a first spectrum in the one-micron region, which, despite bad observing conditions, exhibited the He I λ 10830 line in emission (1971). When the possibility appeared of obtaining spectra of weak sources in the ultraviolet, I applied for time at the IUE. In order to have some chance of success because of the nature of the observations ("on alert") and the unavoidable conflicts with a crowded schedule, it was almost indispensable to obtain the complicity of an astronomer right at the observing ground station. I got my former student André Heck interested in the project. But we entered a period when the star did not want to cooperate in remaining desperately faint for months and months. In the meantime the patrol was continuing both by M. Duruy and his associate in Tahiti (and later by M. Verdenet *[Bull. AFOEV,* **18,** 33, 1981 and **19,** 33, 1982]), and with the Liège-CNRS Schmidt telescope at Haute-Provence. At ESO, a much better location, H. Debehogne from Uccle started taking plates with the GPO astrograph and observed a drop of more than four magnitudes from April 22 to 26, 1979. In the meantime, a few nights were obtained on the ESO spectrographic telescope, with bad luck with the weather. Finally in August 1981, as André Heck was observing at La Silla, the star suddenly fainted from the 12th to fainter than the 17th magnitude in six days. So the hope to observe it with the IUE during the allotted time in September vanished once more and we were again in a sad mood when we heard from F. Bateson in New Zealand that the star had recovered to a magnitude of 12.2 and remained apparently stable. The IUE telescope could then be pointed towards the object and a weak noisy spectrum was obtained.

Because of the nature of the spectrum with dozens and dozens of bright lines I expected a spectrum showing emissions of several carbon ions like in Wolf-Rayet stars or in planetary nebulae. Actually, the noisy spectrum was quite disappointing, showing besides an enormous continuum absorption feature around 2250 Å ill-defined absorptions at 1550 Å (C IV) and 1335 Å (C II) together with some lines of Si III and possibly the interstellar Mg II line at 2800 Å. M.P. Véron obtained shortly later at the ESO 1.5 m telescope a



ESO IDS spectra of V 348 Sgr. The spectrum labelled "Sept 20, 1981" has been obtained by M.P. Véron with the 1.5 m telescope at maximum light. The continuous spectrum strongly decreases with increasing wavelength. The strongest lines belong to C II, He I and [NII] (blended with H_α). The spectrum labelled "May 30, 1982" was taken by M. Pakull at the 3.6 m telescope, when the star was about magnitude 17. The 224 Å/mm reciprocal dispersion permits to see an important change in the emission line intensities compared to the continuum. The blend around H_α is quite conspicuous, as already noted by Herbig (Astrophys. J. **127,** *312, 1958). Spectra calibrated by A. Heck.*

spectrum with the image dissector scanner which displayed features similar to the ones of the Palomar spectra of 1958, also taken at maximum. In the meantime, infrared photometry had been obtained by Feast and Glass in South Africa *(Monthly Notices of the Royal Astronomical Society,* **161,** 293, 1973) and by Webster and Glass *(M.N.R.A.S.,* **166,** 491, 1974), which indicated that the star was both a strong and variable infrared emitter. At minimum light, the only spectrum described is the one mentioned by Herbig *(Astrophys. J.,* **127,** 312, 1958). It shows typical lines seen in the spectra of planetary nebulae ([OII], [NII], [SII]), but no carbon line in the usual wavelength range. An interesting optical spectrum was obtained by M. Pakull at ESO on May 30, 1982 when the star was becoming very faint. It shows a very different spectrum from the spectrum at maximum. C II lines are stronger with respect to the continuum (see figure), which itself has an opposite slope with respect to the energy distribution at maximum light, fairly typical of a B-type star. All these data are presently being analysed in collaboration with U. Heber (Kiel).

This object clearly deserves more attention, and observations (filter photographs, photometry and spectrometry) at various phases and in a wide energy range will be necessary before we understand the nature of this hot carbon star and its possible association with a neighbouring nebula. A possible model is the one of a moderately hot object surrounded by nebular material. Temporary but substantial ejection of gas leads to the formation of dust by condensation at high altitude and the star is obscured, while the infrared emission is strong. When the matter falls towards the central star, dust evaporates, due to the increasing temperature, and we see the infalling material as ionized carbon, giving rise to "inverted" P-Cygni profiles. At that phase the extension of the envelope is small and its volume emission in the lines is weak compared to the continuous photospheric emission. Therefore we do not see emission lines in the ultraviolet, but in contrast the emission lines appear in the visible and in the infrared where the photospheric emission is much weaker. This could be a qualitative model for the behaviour of this star, but many features remain to be explained and as Webster and Glass mention in the conclusion of their paper *(M.N.R.A.S.,* **166,** 451, 1974) "V 348 Sgr has something important to tell us" about stars at this stage of their evolution.

A New Guider for the ESO 1 m Schmidt Telescope

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Introduction

A new guider for the ESO 1 m Schmidt telescope was installed inside the telescope tube in June-July 1982. After about one year experience one can say that the system has proved to be very efficient. This device may be useful for other Schmidt telescopes where long exposures are hampered by guiding problems. Historically, the ESO Schmidt was equipped with two guiding telescopes of 20 cm diameter and 300 cm focal length. However, differential flexure between guiders and camera made long exposures impossible. Only a one-hour exposure, symmetrical with respect to the observer's meridian and using a low resolution 103 a-O or II a-O emulsion, was the very best one could obtain. To improve guiding conditions, two off-set guiders were constructed in succession and each one was used for a sufficiently long time to learn the requirements for an efficient off-set system. The new guider has its guide probe in the observer's meridian and at the North edge of the photographic plate. At this position the corrector plate is not vignetted by the main mirror's edge.

Compared with the 20 cm guiders there is a light gain of 3 magnitudes. An acquisition area of 0.071 square degree is available. In small field mode stars of $14^{m}_{.}2$ are detectable and guiding, although with some effort, can be done on a 13th magnitude star. At the galactic pole 1.7 stars $\leq$ 13 m per 0.071 square degree can be acquired and at the Galactic equator 14 (Allen, *Astrophysical Quantities,* page 243). So star acquisition gives no problems.

In order to ensure a differential flexure-free link between guider and photographic plate, all optical parts of the guider between the guide probe and the cross wire are mounted as one strong unit on top of the North surface of the plate holder support device. The optics, imaging crosswire and star on the television camera detector are partly mounted on the tube wall because, for this part, differential flexure bears no consequences for perfect guiding.

With the 4-degree objective prism mounted, the guider sees spectra just as the photographic plate. These spectra are useless for guiding. Therefore, a two-prism system can be activated reducing the guide probe spectra into star images. This reduction can only be performed with the prisms placed in a parallel beam. So two objectives are used, the first one making the star beam parallel and the second one imaging the star on the cross wire. To avoid too large refracting angles for the prisms the focal length of the second objective must be not less than 600 mm. As a consequence the optical path between guide star and cross wire is so large that the beam must be folded within the area of the north surface of the plate holder support. This is achieved by introducing six mirrors. Two more mirrors are used to project guide star and cross wire on the television camera detector.

As the spectral dispersion of the objective prism must be in the direction of the declination, to obtain the best quality spectral plates, and the dispersion of the compensating prisms must be perpendicular to the declination direction, for reasons of mechanical stability, the spectra in the guide probe must be rotated over 90 degrees before they reach the compensating prisms. This rotation is achieved by a three mirror system in front of the first objective. In total eleven flat mirrors form part of the guider. At a reflexion angle of 45 degrees 87 % of the light is reflected. Therefore, the mirror system causes a light loss of about 1.7 magnitudes. To this should be added a light loss of about 0.2 magnitude due to the coated objectives. This loss of about 1.9 magnitudes is already taken into account in the limiting magnitude discussed above. All flat mirrors, except the first 3, have an accuracy of $\lambda/10$ and the first three $\lambda/5$. For long exposures and for declinations South of $-50°$ the differential refraction between plate centre and guider is corrected by an electronic cross. (See Muller, *Abhandlungen der Hamburger Sternwarte,* Band X, Heft 2, 79.)

Mechanical Description of the Schmidt Guider

Fig. 1 shows, inside the indicated ellipse, the location of the guider, and fig. 2 the detailed outlay of the optical parts. Mode