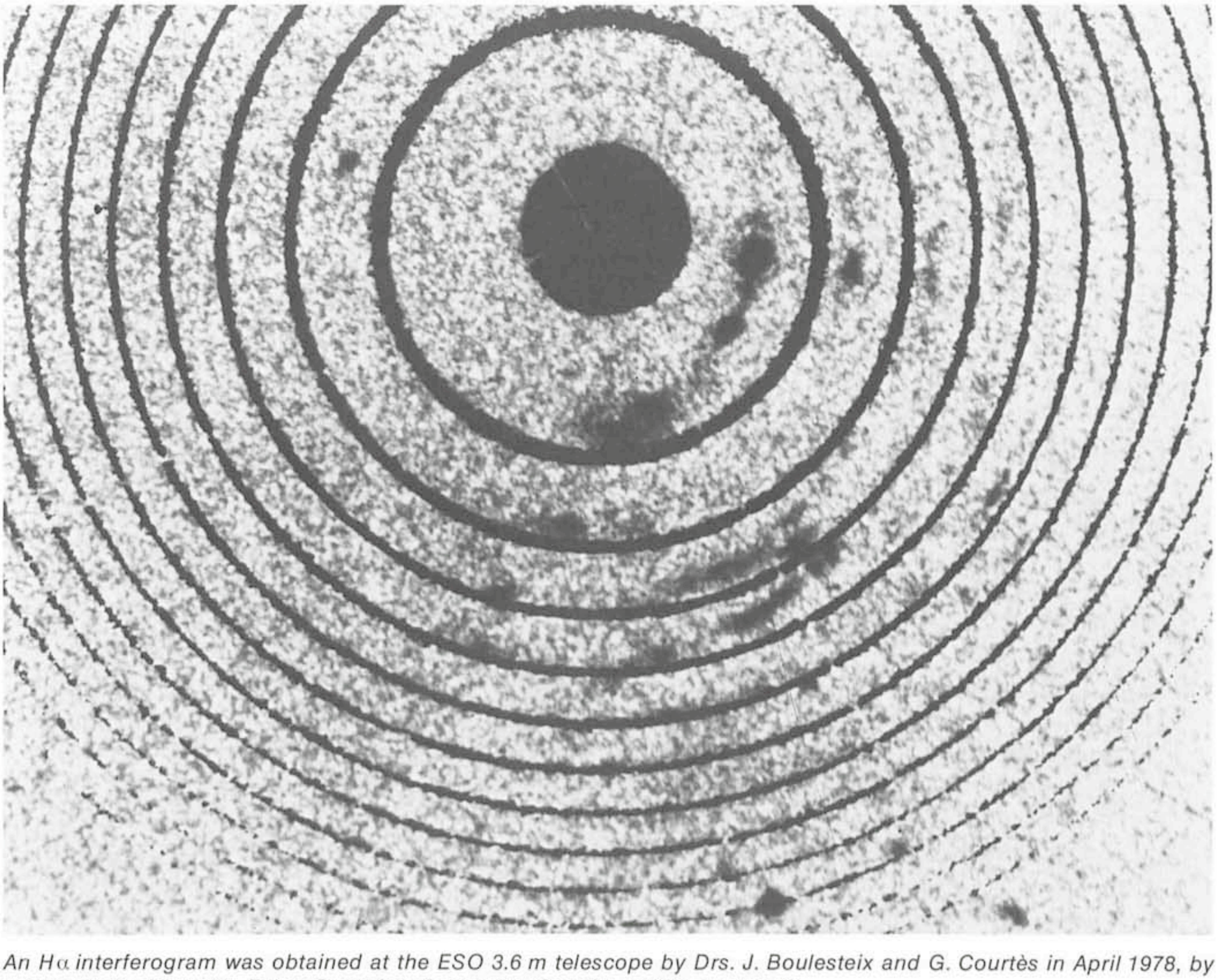
No. 14 – September 1978

Large-Scale Internal Motions in NGC 5128



An Hα interferogram was obtained at the ESO 3.6 m telescope by Drs. J. Boulesteix and G. Courtès in April 1978, by means of the Marseille Fabry-Perot interferometer. See the article on page 2.

Interstellar Hydrogen Observed in the Arms and Disks of the Nearest Southern Galaxies

J. Boulesteix and G. Courtès

French astronomers have been studying the kinematics of interstellar hydrogen for more than a decade, mainly by means of Fabry-Perot interferometers (cf. the article by M. Duval in Messenger *No. 9). Recently, Drs. J. Boulesteix and G. Courtès from Laboratoire d'Astronomie Spatiale in Marseille travelled to La Silla and obtained new and spectacular results about the hydrogen in some nearby southern galaxies.*

Our 3.6 m telescope observing programme on the kinematics of the nearest galaxies was continued during a recent run of 3 nights (April 3–5, 1978).

The main purpose of these observations is to obtain the highest possible space and spectral resolutions of the structure of the ionized hydrogen in the spiral arms as well as in the disk. During the reductions, particular attention is given to the velocity gradients of the gas at the edges of the morphologically well-determined spiral structures. Similar work has already been successfully done on M 33 (the Triangulum nebula) in the northern hemisphere in an attempt to verify the density-wave theory (see bibliography given by Courtès, invited review paper, IAU Grenoble, Symp. 1975 in Topics in Interstellar Matter, 209–242, Reidel Publishing Company, Dordrecht, Holland, Ed. Hugo van Woerden).

Some of the best southern candidates for this kind of studies are two Sc spiral galaxies, NGC 2997 and NGC 5236, with large apparent diameters.

The instrumentation was the Marseille focal reducer at the Cassegrain focus of the 3.6 m telescope. This instrument gives a final focal ratio of 0.95 when used with a photographic emulsion as detector and focal ratio 2 with an RCA image tube. The RCA image tube, in spite of a good cooling, is definitely too noisy for long exposures (over 75 min). Therefore, the faintest objects were observed with the 0.95 focal ratio and the IIIa–J photographic emulsion.

We obtained Fabry-Perot interferograms and f/0.95 and f/3 direct photographs. In figure 1, we show a direct photograph of the spiral galaxy NGC 2997 in Hα; 3-minute exposure through the RCA tube on a IIIa–J plate. We notice the interesting morphology of the gas around the nucleus. This complex structure was also pointed out by Sersic, but we see here an almost complete, central ring of hydrogen which is well defined thanks to the resolving power of the 3.6 m telescope.

In another part of our programme, we obtained high-resolution interferograms of the strong southern radio source Cen A, also known as NGC 5128, thereby improving upon the results of Carranza with the 1.5 m telescope at the Cordoba Observatory. On the front page is shown the interferogram of the central part of this galaxy with very strong internal motions. Note, for example, the shift of the Hα interference rings by comparison with the Hα calibration. The free spectral range between two successive rings corresponds to approximately 300 km s^{-1} in radial velocity.

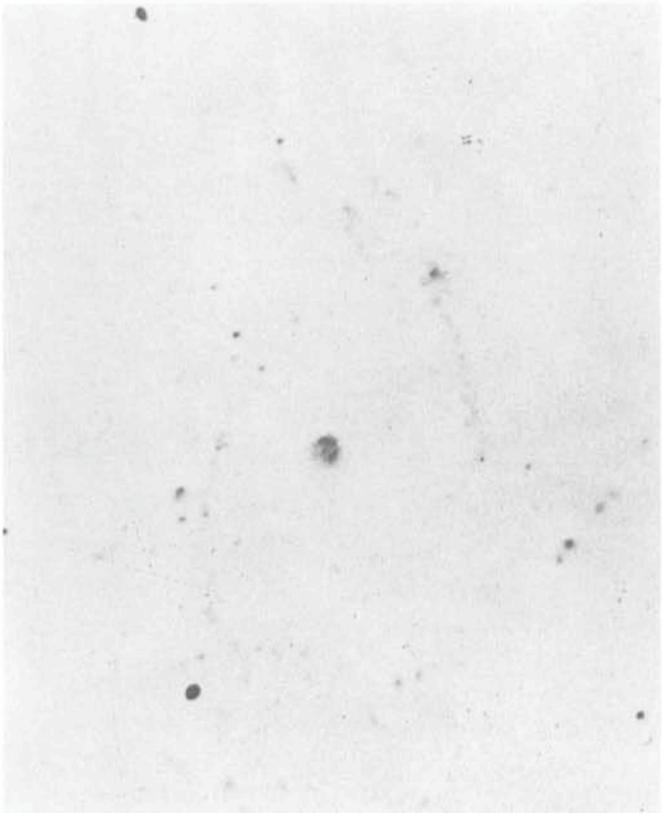


Figure 1: *Three-minute exposure of NGC 2997 in the light of Hα. Note in particular the central hydrogen ring.*

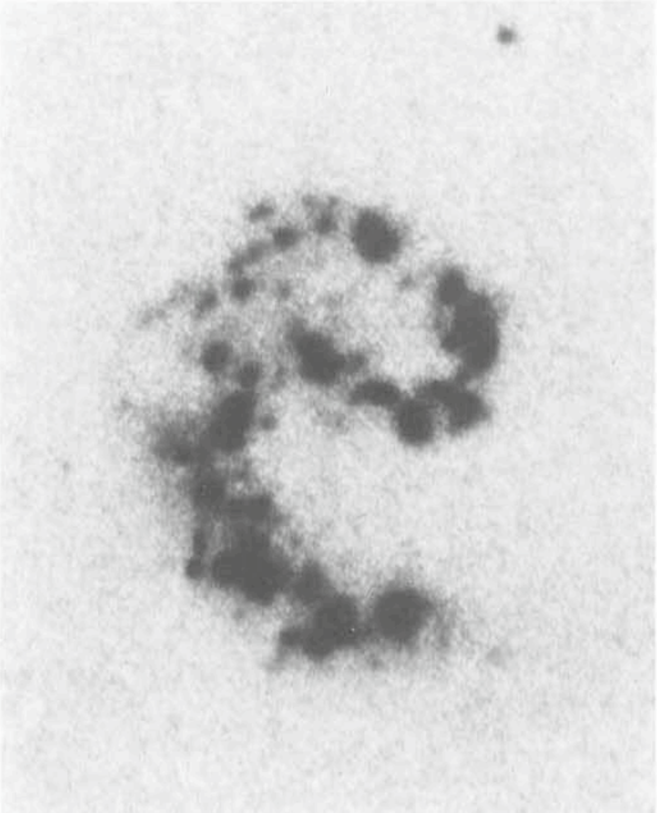


Figure 2: *H II regions in the peculiar interacting galaxies Arp 244 (NGC 4038-39).*

The broadening of the Hα line is certainly less than 1 Å as a combined effect of the electron temperature and the internal motions. This means that the gas behaves relatively quietly in spite of the very strong large-scale motions that have been observed in the interstellar medium of NGC 5128.

The peculiar, interacting galaxies Arp 244 (NGC 4038–39) were also observed in order to detect H II regions. Figure 2 shows that one of the components has many bright, condensed H II regions.

The excellent quality of the 3.6 m telescope permitted a very efficient use of the observing time, and the seeing and weather were also very good.

Visiting Astronomers

(October 1, 1978—April 1, 1979)

Observing time has now been allocated for period 22 (October 1, 1978 to April 1, 1979). The demand for telescope time was again much greater than the time actually available.

This abbreviated list gives the names of the visiting astronomers, by telescope and in chronological order. The complete list, with dates, equipment and programme titles, is available at request from ESO/Munich.

3.6 m Telescope

Oct. 1978:	West/Smith/Cannon/Schuster, Laustsen/Tammann, Lequeux/West/Schuster/Laustsen, Feitzinger, Crane, van den Heuvel/Hammerschlag/Henrichs, Crane, Materne, Tarenghi, Elvius.
Nov. 1978:	Elvius, Lindblad, van den Heuvel/Hammerschlag/Henrichs, Schoembs, Foy, Knoechel, Knoechel/Vogt, Borgman/Danks, Wamsteker, Schnur, Georgelin/Monnet.
Dec. 1978:	Georgelin/Monnet, Ardeberg/Lyngå, Hunger/Kudritzki, Weidemann, Lohmann/Weigelt, Alcaíno, Houziaux/Nandy, Surdej/Swings, Vogt.
Jan. 1979:	Vogt, Wlérick, Bouchet, Danks/Koornneef, Seitter/Duerbeck, Pakull, Lub, Melnick/Manfroid, Wlérick, Wamsteker.
Feb. 1979:	Wamsteker, Breysacher, Wlérick/Bouchet, Adam, Ritter/Schröder, Véron.
March 1979:	Véron, Danziger/Fosbury/Goss/Ekers/Wall, Courtin, Schultz/Kreysa, de Vries, Gyldenkerne, Schnur, Bergeron, Dennefeld, Kunth, Ulrich, Seggewiss.

1.52 m Spectrographic Telescope

Oct. 1978:	Breysacher/Azzopardi, Bouchet, Nordström/Andersen, Ahlin, van Dessel, Bareau, F. and M. Spite, Foy.
Nov. 1978:	Foy, Muratorio, Holweger, Bareau, Danks/Alcaíno, Feitzinger, Feitzinger/Kühn/Reinhardt/Schmidt-Kaler, Borgman/Danks, Bergvall/Ekman/Lauberts/Westerlund.
Dec. 1978:	Bergvall/Ekman/Lauberts/Westerlund, Monnet/Rosado, Wamsteker/Alcaíno, Lohmann/Weigelt, Breysacher, F. and M. Querci, Schnur.
Jan. 1979:	Schnur, Bastian/Mundt, Barbier/Swings, Bouchet, Renson, Baade, Swings, Hua/Doan, Gahm/Andrews.
Feb. 1979:	Gahm/Andrews, Danks, Bouchet, Dachs, Gerbaldi, Bastiaansen, Ritter/Schröder.
March 1979:	Ritter/Schröder, Mauder, Bouchet, Ahlin, Haug, de Vries, Haug, Mauder, Stenholm, Wramdemark, Schnur.

1 m Photometric Telescope

Oct. 1978:	Laustsen/Tammann, Danks/Alcaíno, Bouchet, Bensammar, Nguyen/Wamsteker/Bouchet, Olander, Westerlund/Lundgren, Schoembs.
Nov. 1978:	Schoembs, Vogt, Turon/Epchtein, Wamsteker, Knoechel, Bergvall/Ekman/Lauberts/Westerlund, Schnur/Mattila.
Dec. 1978:	Schnur/Mattila, Ardeberg/Lyngå, Shaver/Danks/Wamsteker, van Woerden/Danks, F. and M. Querci, Mianes/LMC Group.
Jan. 1979:	Mianes/LMC Group, Pakull, Wamsteker, Bouchet, Lodén, Wlérick/Bouchet, Melnick.
Feb. 1979:	Melnick, Salinari/Tanzi/Tarenghi, Dachs, Moorwood, Thé, Adam.
March 1979:	Adam, Mauder, Schultz/Costa, Wamsteker, Haug, Wlérick/Bouchet.

50 cm ESO Photometric Telescope

Oct. 1978:	Bouchet, F. and M. Spite, Bouchet.
Nov. 1978:	Bouchet, Schöffel, Bouchet, Renson.
Dec. 1978:	Renson, Mianes/LMC Group.
Jan. 1979:	Bouchet, Wramdemark, Bastiaansen, Tinbergen, Lodén.
Feb. 1979:	Lodén, Bastiaansen, Tinbergen, Bouchet.
March 1979:	Bouchet, Haug, Lagerkvist.

40 cm GPO Astrograph

Oct. 1978:	Bensammar, Vogt.
Nov. 1978:	Vogt, Gieseking, Azzopardi.
Dec. 1978:	Azzopardi, Gieseking.
Jan. 1979:	Gieseking, Gahm/Andrews.
Feb. 1979:	Gahm/Andrews, Gieseking.
March 1979:	Vogt.

50 cm Danish Telescope

Jan. 1979:	Gahm.
Feb. 1979:	Gahm, Gerbaldi.

61 cm Bochum Telescope

Oct. 1978:	Danziger/Brunt/Whelan, Walter.
Nov. 1978:	Isserstedt.
Dec. 1978:	Isserstedt, Pakull.
Jan. 1979:	Pakull, Bastian/Mundt, Lodén, Elst.
Feb. 1979:	Elst.

Tentative Meeting Schedule

The following dates and locations have been reserved for meetings of the ESO Council and Committees:

November 14/15	Finance Committee, Geneva
November 16	Committee of Council, Geneva
November 22/23/24	Observing Programmes Committee, Paris
December 7/8	Council, Munich

Spectroscopic Observations of YY Orionis Stars at La Silla

C. Bertout and B. Wolf

Trailblazing observations of stars in late stages of their initial formation were carried out some months ago by two astronomers from the Landessternwarte Heidelberg-Königstuhl, FRG, Drs. C. Bertout and B. Wolf. Spectroscopy with the ESO 1.5 m telescope on La Silla during twelve consecutive nights revealed dramatic spectral changes, and simultaneous photometric observations at the new observatory near San Pedro Martir, Baja California, Mexico, are now being reduced.

What are the YY Orionis Stars?

Back in 1961, M. F. Walker noticed that the T Tauri-like variable YY Orionis showed displaced absorption components located at the red edges of certain emission lines. At that time, ideas about the pre-main-sequence stellar evolution were still mostly of a qualitative nature, and no particular attention was paid to his discovery. In 1969, however, R. B. Larson published the first calculations of protostellar collapse, which indicated that the protostar grew by accretion of matter from the surrounding interstellar cloud. The model predicted that the new-born star would be imbedded in a free-falling envelope for as long as a million years (in the case of a 1 $M_\odot$ star). It also predicted that the star should be optically visible during a major part of this time.

In 1972, Walker suggested that YY Orionis was indeed such a protostar at the end of its hydrodynamic evolution. He based this supposition on the redward displacement of the absorption components of the Balmer emission lines, which indicate that the absorbing material has a recession velocity of at least 300 km s^{-1} with respect to the observer. This velocity is in good agreement with the end velocities of the infalling matter computed in theoretical collapse models for a 1 $M_\odot$ protostar. In the same paper, Walker reported the discovery of several other T Tauri-like stars showing line profiles similar to YY Orionis, and introduced the term "YY Orionis stars".

Like most of the T Tauri stars, each of the YY Ori stars has its own peculiarities, thus making it difficult to define clear-cut class characteristics. However, the basic properties of the YY Ori stars can be summarized as follows. They are T Tauri variables, and most of them possess a strong ultraviolet excess, defined by $U-B \lesssim 0$. Certain emission lines, in particular the hydrogen Balmer lines, sometimes exhibit a displaced absorption component at the red edge of the emission. Such line profiles are called YY Orionis profiles, or inverse P-Cygni profiles. In their other properties, YY Ori stars resemble T Tauri stars: their spectrum is often "veiled" by continuous emission in the blue and visual spectral ranges, so that it is often difficult to discern their photospheric late-type spectrum. Also, most YY Ori stars exhibit strong IR excess. YY Ori stars, like other T Tau stars, are aperiodic fast variables; large variations of the Balmer line profiles are recorded on time scales of hours to days, and variations of the continuum level and UV excess are indicated by photometric measurements. Examples of observed profile variations are given in the following sections.

One can easily understand the fascination that these stars exert on us. In the menagerie of young stellar objects, most of which show some evidence of mass loss rather than mass infall, and whose properties are still largely unexplained, the YY Ori stars are the only link between the observed pre-main-sequence evolution and today's pre-main-sequence evolutionary models. Detailed studies of these objects cannot only help us to gain insight into the early phases of stellar evolution, but can also be used to test the validity of proposed theoretical models.

A Search for "Bright" YY Ori Stars

The YY Ori stars listed by Walker (1972) are rather faint, with m_v between the 13th and 15th magnitude. Detailed spectroscopic investigations of these stars are therefore very difficult. In order to find additional and possibly brighter YY Ori stars, a spectroscopic survey is being carried out by several observers of the Heidelberg Observatory. Slit spectrograms of young emission-line stars suspected to belong to the YY Ori class are being taken.

The brightest YY Ori star so far, S Coronae Australis, was found by Appenzeller during his May 1976 observing run at the ESO 1.5 m spectroscopic telescope. This star was

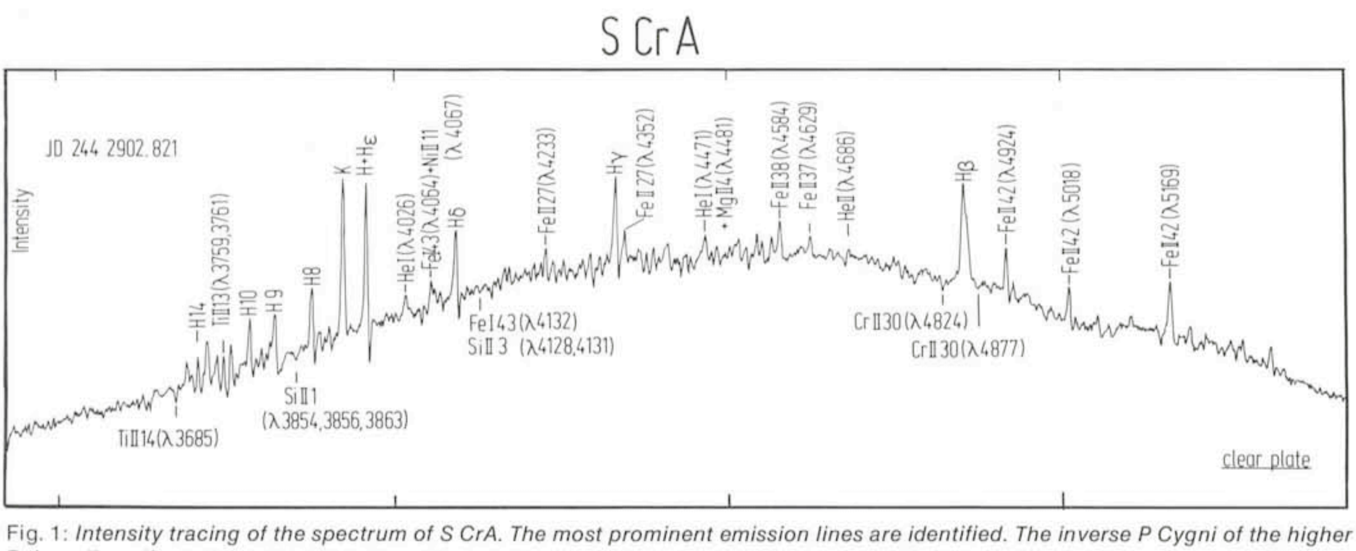


Fig. 1: *Intensity tracing of the spectrum of S CrA. The most prominent emission lines are identified. The inverse P Cygni of the higher Balmer lines (from Hγ on) and the strong Fe II lines are clearly discernible.*

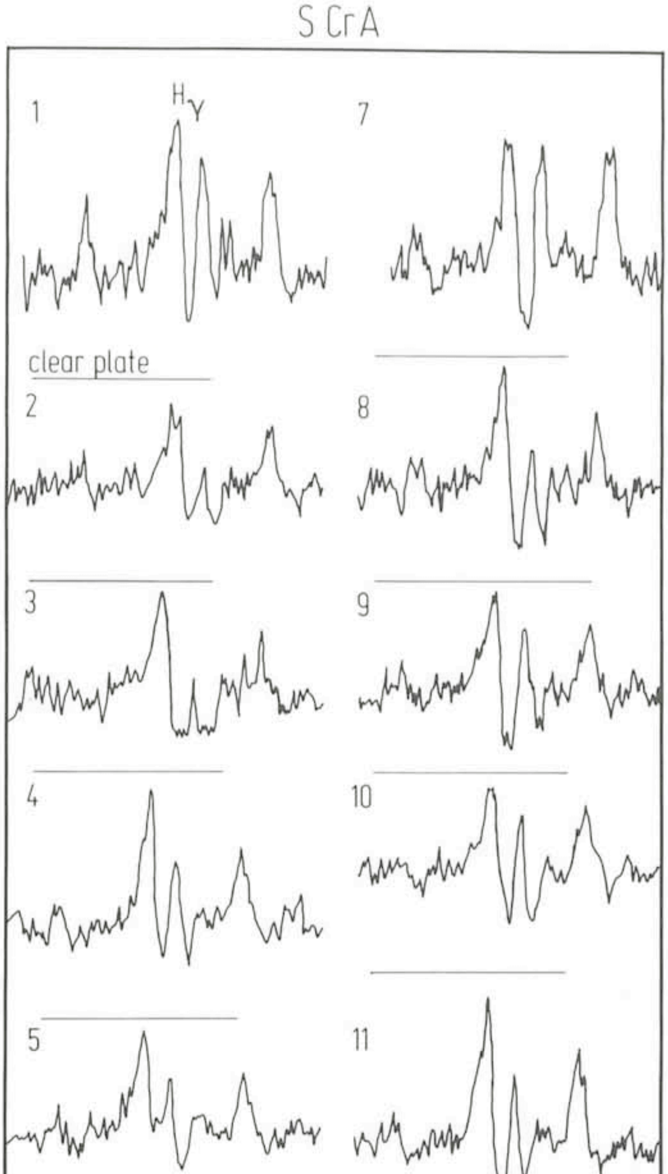


Fig. 2: *Intensity tracings of the Hγ profiles of high-dispersion (20 Å/mm) spectrograms of the YY Ori star S CrA. The coudé plates 1 to 12 were taken during twelve consecutive nights (one per night) between April 15, 1978 and April 27, 1978.*

known as a T Tauri-like variable, but apparently its prominent inverse P Cygni-line profiles had never been detected in earlier spectroscopic observations. S CrA, which is associated with the molecular cloud NGC 6729, has a mean visual magnitude of $11^{m}.5$; and its range of variations is $\Delta m_v \simeq 0.8$.

The spectrum of S CrA is described in detail in two papers (*Astron. Astrophys.* **54,** 713, and **58,** 163). In figure 1, we show the intensity tracing of an image-tube spectrogram of this star. In spite of the rather moderate resolution (about 3 Å), the inverse P Cygni profiles of the Balmer lines (except Hβ) and of the strongest Fe II lines are readily recognized. Besides the hydrogen Balmer series and the Fe II lines, prominent He I (λλ 4026, 4471) and He II (λ 4686) emission lines are present in the spectrum. The helium lines are undisplaced and never exhibit absorption com-

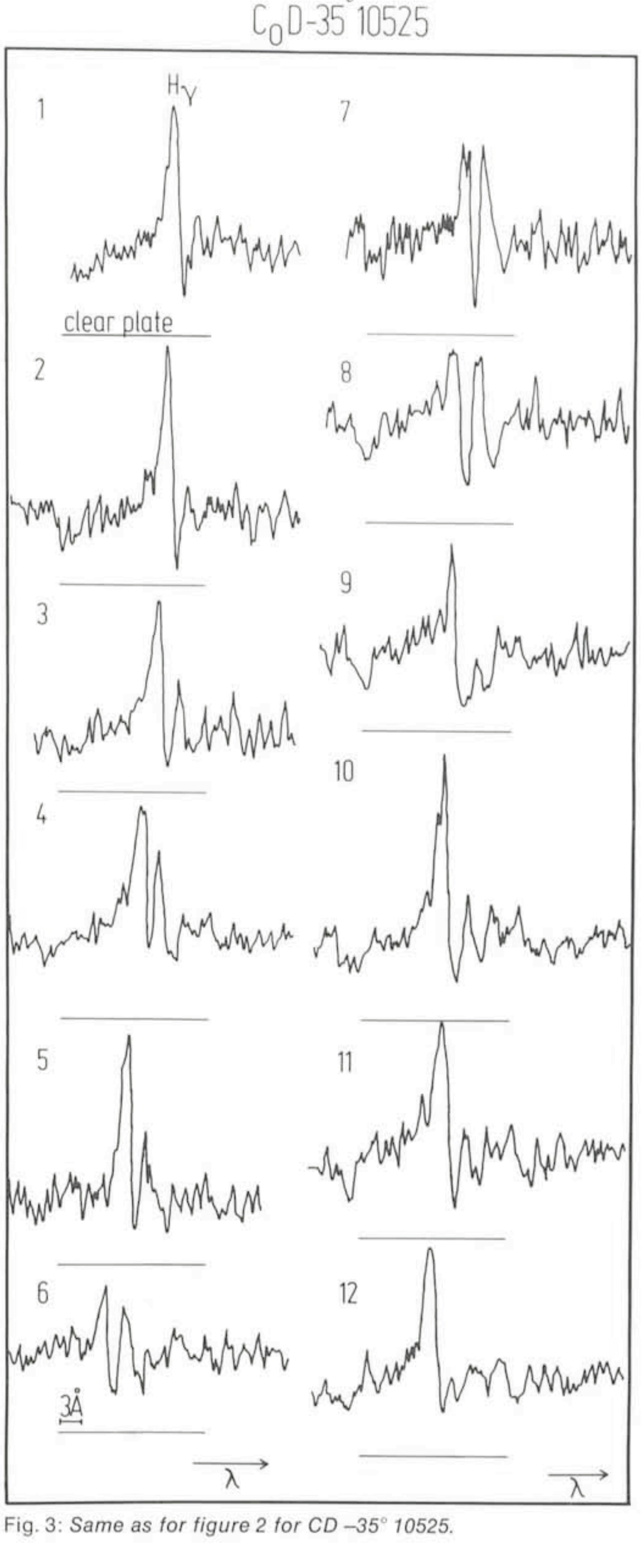


Fig. 3: *Same as for figure 2 for CD –35° 10525.*

ponents. Their occurrence is typical of YY Ori stars and requires excitation and ionization temperatures of about 30,000 to 50,000 °K.

The second in brightness among the YY Ori stars reported so far is CD −35° 10525, with an average brightness $V = 11\overset{\mathrm{m}}{.}6$. This star is associated with the elongated interstellar dust cloud Barnard 228 in Lupus. The membership of CD −35° 10525 to the YY Ori subclass of the T Tauri variables was first established by Mundt and Wolf during an observing run in July 1977 at La Silla. The spectrum of CD −35° 10525, described in *Astron. Astrophys.* **63.** 289, is again characterized by inverse P Cygni-line profiles, especially of the Balmer lines. However, this star shows fewer emission lines in the blue spectral range than S CrA. For example, Fe II does not show up in emission. Also in contrast to S CrA, CD −35° 10525 exhibits absorption features characteristic of an underlying late-type spectrum of spectral type around M0.

Coudé Observations and Balmer Line Profile Variations

The apparent brightness of the newly-discovered YY Orionis stars described above allows for high dispersion spectroscopic observations even with medium-sized telescopes. Highly-resolved spectrograms are very desirable because they allow a detailed comparison of the observed line profiles with profiles calculated using theoretical protostar models. To our knowledge, the first coudé observations in the blue spectral range of a YY Ori star were carried out in August 1976 at La Silla, using the 1.5 m ESO spectroscopic telescope. These observations revealed the rather complex structure of the S CrA Balmer line profiles with (besides the red-displaced absorption at 300 km s^{-1}) two emission peaks separated by a slightly blue-shifted (about −30 km s^{-1}) central absorption. A comparison of these profiles with theoretical line calculations allowed Wolf, Appenzeller and Bertout to present a possible configuration of the outer layers of S CrA (*Astron. Astrophys.* **58,** 163).

In order to study the full range of profile variations of the Balmer lines and to relate these variations to the continuum variability, one needs high dispersion spectroscopy and simultaneous photometry. Since the broad photometric bands are contaminated by the emission lines, standard UBV photometry is not suitable to determine the continuum level exactly. What one needs here is narrow-band photometry. We therefore applied for observing time at the coudé ESO spectrograph at La Silla, and at the 1.5 m photometric telescope of the Mexican National Observatory located at San Pedro Martir, Baja California, in a joint programme with Dr. Luis Carrasco. The 13-colour medium narrow-band photometric system developed by Johnson and available at San Pedro Martir is well suited to our purposes.

Simultaneous Observations in Chile and in Mexico

Twelve half nights were allotted to our project by ESO. Thanks to the flexibility of the Mexican organization, Dr. Carrasco was able to obtain observing time during the same period. The spectroscopic coudé observations of S CrA and CD −35° 10525 were carried out by Wolf and the simultaneous photometric observations, extending from 3300 Å to 1 μ, were made by Bertout and Carrasco, from April 15 to 27, 1978. Due to the catastrophic floodings which occurred in Baja California last winter, the San Pedro Martir Observatory had to be closed from February until our arrival. We are very much indebted to the technical team whose efforts kept the station in working order during our run.

Thanks to the excellent weather and seeing conditions at La Silla, we could take the best advantage of the allotted observing time. We could take one camera I spectrogram of each of our two programme stars each night, i. e. we obtained a complete series of 24 spectrograms with a dispersion of 20 Å/mm. Due to the unusual climatic conditions, the weather in Baja California was not as good as in Chile. However, six and a half of our twelve nights were photometric, so that we also obtained extensive data for our programme stars.

A first glance at the intensity tracings of the spectrograms gained during this last observing run readily shows the existence of strong spectral variations. The complex structure of the Balmer line profiles and the profile variations are illustrated by the intensity tracings of Hγ shown in figures 2 and 3 for S CrA and CD −35° 10525. Especially the red-shifted emission component shows dramatic changes even within two consecutive nights. In fact, it can be seen from these tracings that we never observed the same profile shape twice. Unfortunately, the simultaneous photometric observations are not yet completely reduced, so that we cannot say much about possible correlations between profile strengths and continuum level. However, it is already apparent that spectacular changes in the energy distribution occur.

Now the most difficult part of the work remains to be done. That is, we must try to understand what physical mechanism might be responsible for these variations. Doing that will probably require even more luck than we had in coordinating the simultaneous observations in Mexico and Chile without a telephone connection!

FIRST ANNOUNCEMENT OF A EUROPEAN WORKSHOP ON

"Astronomical Uses of the Space Telescope"

The European Space Agency (ESA) and the European Southern Observatory (ESO) are jointly organizing a Workshop on "Astronomical Uses of the Space Telescope". It will be held in Geneva, on the premises of CERN, on February 12–14, 1979. The purpose of the Workshop is to give the European astronomical community an occasion to discuss in depth possible scientific programmes in various astronomical areas. A preliminary list of topics includes: Star Formation, Globular Clusters, Magellanic Clouds, External Galaxies, Active Nuclei of Galaxies, Clusters of Galaxies, Cosmology. Attention will also be given to the problem of ground-based observations required before the launch in order to optimize the use of the ST.

Scientists wishing to participate and possibly present a short contribution related to the use of the ST for performing specific programmes should write as soon as possible to the following address:

Dr. M. Tarenghi
ESO-CERN
1211 Geneva 23
Switzerland

The maximum number of participants will be about 120 persons.

The ESO Workshop on Infrared Astronomy

About 60 astronomers attended the workshop on IR astronomy jointly organized by the Stockholm Observatory and ESO on the island of Utö on June 20–22, 1978. The number of participants, significantly larger than originally planned, was in itself a sign of the increasing interest among the European astronomers in the scientific and observational aspects of ground-based IR astronomy.

The first day was devoted to the presentation of a number of review talks on the contribution of infrared observations to the understanding of various astrophysical problems in the fields of extragalactic, galactic and solar-system astronomy.

The instrumental techniques were the topic of the second day, integrated by communications by European groups active in the field and by reports on various projects for airborne and ground-based facilities for IR astronomy.

An extended discussion on which should be the priorities for ESO in the development of infrared instrumentation for the observatory at La Silla took place in the morning of the last day.

Among the numerous suggestions and proposals, two obtained wider support: the first was that of concentrating the effort on intermediate-resolution spectroscopy after completion of the presently developed IR spectrophotometers, and the second was to modify for optimal IR performances, in addition to the 3.6 m telescope, also a telescope of smaller size to be used in the infrared for a prevailing fraction of time.

Piero Salinari

The ESO Measuring Machines in Geneva

The ESO S-3000 plate-scanner and Grant machine are now fully operational and are available for use by visiting astronomers for the reduction of direct plates and photographic spectra.

The S-3000 microdensitometer can accommodate plates up to 14 x 14 inches in suitable plate-holders and much larger plates taped on top of the stage. The accuracy of this machine is better than one micron for positional work and comparable to that of a PDS machine for density measurements up to 3.0 D. The data are stored on magnetic tapes and can be processed with the ESO Interactive Image Processing Package (cf. *Messenger* No. 10, p. 16).

The ESO computer-controlled Grant machine can be used either in the conventional mode for manual measurements of radial velocities or as a one-dimensional microdensitometer for scanning of photographic spectra which can be reduced with the Image Processing Package mentioned above.

For further information and in order to apply for time on these machines, please write to Jorge Melnick, ESO c/o CERN, CH-1211 Geneva 23, Switzerland, specifying the dates when you wish to use a given machine and enclose a short description of the proposed measurement programme.

ESO Astronomer Honoured!

The following announcement can be read in Minor Planet Circular No. 4358, which was published by the Center in Cincinnati on April 30, 1978:

New name of minor planet

(2018) SCHUSTER = 1931 UC

Discovered 1931 Oct. 17 by K. Reinmuth at Heidelberg.

Named in honour of Hans-Emil Schuster, astronomer at the European Southern Observatory, who is active as an observer and discoverer of minor planets and comets.

PERSONNEL MOVEMENTS

(A) Staff

ARRIVALS

Garching

Ursula LIESE (German), shorthand-typist (telephone and telex operations), 1.11.1978

Geneva

Peter SCHABEL (Austrian), senior electronics engineer, 1.9.1978

Alan F. M. MOORWOOD (British), infrared astronomer, 1.10.1978

La Silla

Patrick HALLEGUEN (French), electronics technician, 1.8.1978

Günter G. SCHUBA (German), electronics technician, 1.11.1978

DEPARTURES

Geneva

Norbert RODGERS (British), administrative officer, 31.8.1978

Susan KAY (British), secretary, 31.8.1978

Peter SCHARNWEBER (German), electronics engineer, 31.8.1978

Dietmar PLATHNER (German), mechanical engineer, 31.8.1978

Bernard PILLET (French), laboratory assistant (photography), 15.9.1978

La Silla

Christopher SMITH (Canadian), resident astronomer, 15.9.1978

(B) Paid Associates – Fellows – Coopérants

ARRIVALS

Geneva (Scientific Group)

Peter A. SHAVER (Canadian), paid associate, 1.9.1978

Danielle M. ALLOIN (French), fellow, September 1978

Guillermo TENORIO-TAGLE (Mexican), fellow, 14.9.1978

Hans R. DE RUITER (Dutch), fellow, 1.10.1978

Eduardus J. ZUIDERWIJK (Dutch), fellow, 1.10.1978

Per Olof LINDBLAD (Swedish), paid associate, 1.11.1978

La Silla

Holger PEDERSEN (Danish), paid associate, 1.9.1978

Christian PERRIER (French), coopérant, October 1978

DEPARTURES

Geneva (Scientific Group)

Jean MANFROID (Belgian), fellow, 30.9.1978

Irena J. SEMENIUK (Polish), paid associate, 30.9.1978

Marco SALVATI (Italian), paid associate, 7.8.1978

Svend LAUSTSEN (Danish), scientific associate, 4.7.1978

Franco PACINI (Italian), paid associate, 31.10.1978

The X-ray Binary 4U 1700-37/HD 153919

G. Hammerschlag-Hensberge and E. van den Heuvel

New satellite data have provided ground-based optical astronomers with a large amount of extremely interesting work in connection with X-ray binary stars. Spectroscopic and photometric observations are urgently needed to further unravel the nature of these strange objects. The present report by Drs. Godelieve Hammerschlag-Hensberge and Edward P.J. van den Heuvel of the Astronomical Institute of the University of Amsterdam, the Netherlands, summarizes four years of painstaking observations of one of the brightest stars identified with an X-ray source. Their thorough study has already revealed some very interesting details about this binary system.

Since the discovery of the first X-ray binaries by the Uhuru satellite, our group in Amsterdam, in collaboration with the Astrophysical Institute of the Vrije Universiteit of Brussels, has put much effort in analysing the optical behaviour of these systems. For our observations we made primarily use of the ESO telescopes and of the 92 cm light collector of the Leiden Southern Station in South Africa.

In this note we will describe some recent results for HD 153919, the optical component of the 3.41 day period X-ray binary 4U 1700–37. HD 153919 is one of the brightest stars identified with an X-ray source (only the supergiant binary V 861 Sco, recently identified with the X-ray source OAO 1653-40, is brighter). Its spectral type is O 6.5f. The X-rays are eclipsed during 0.9 day of the 3.41 day orbital cycle.

Spectroscopy

Between 1973 and 1977 we collected 75 blue spectrograms of this star with the coudé spectrograph of the 1.5 m ESO telescope. The spectra were taken by van den Heuvel, De Loore (Brussels) and Hammerschlag-Hensberge. The spectral lines in this Of star are very broad, which makes measurements of radial velocities difficult. But thanks to our large number of excellent plates, we were able to determine a rather accurate radial velocity orbit. Figure 1 shows the result of these radial velocity measurements. We put a lot of effort in correcting the measurements for different kinds of systematic errors. One of the most important corrections is the following one: Due to the steady outflow of the atmosphere of the Of star, lines which are formed at different levels in the stellar atmosphere, show different velocities. Before calculating the mean velocity of all observed lines on a plate, corrections for this systematic deviation therefore had to be made. If the outflow of the atmosphere is spherically symmetric, one would expect that this radial velocity deviation of a spectral line remains constant through the binary cycle. But figure 2 shows that this is not the case! The radial velocity deviation of Hγ, for instance, shows two peaks per orbital cycle, of which the largest coincides with the phase where we see the side of the star which is turned toward the X-ray companion. At this phase (0.5) the velocity is more negative than average.

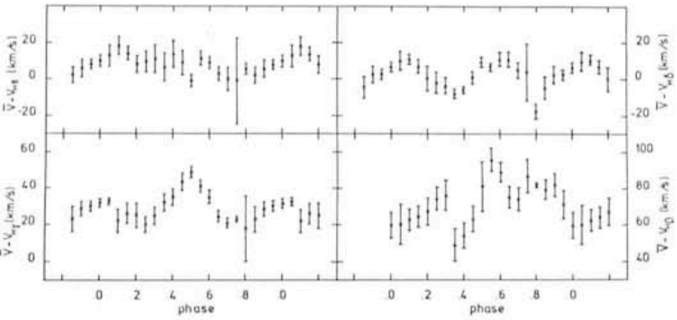


Figure 2: *The radial-velocity deviations from the mean for some of the Balmer lines, plotted against X-ray phase.*

This is also clearly demonstrated in figure 3: the radial velocity of Hγ deviates strongly from the mean velocity curve near binary phase 0.5 and becomes more negative, which is indicative for a stronger outflow of material. This asymmetry in the stellar wind influences the radial velocities of most stellar lines and hence the derived masses of both components.

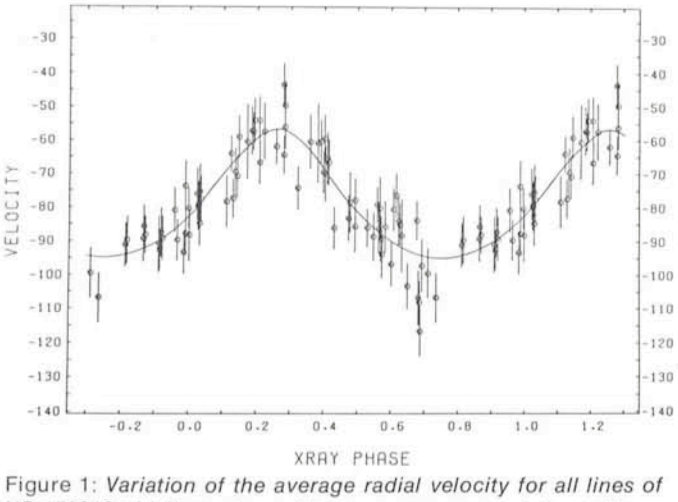


Figure 1: *Variation of the average radial velocity for all lines of HD 153919 with X-ray phase. Phase zero corresponds to mid X-ray eclipse time. Each point represents the average radial velocity for one ESO coudé plate. The curve drawn through the points represents the best-fit solution to the data.*

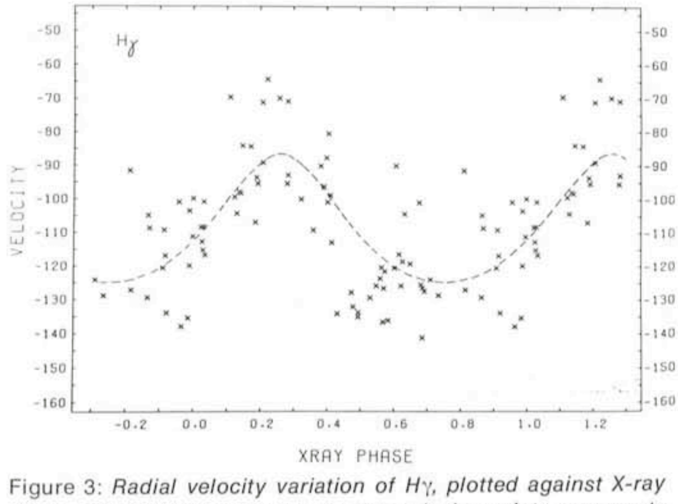


Figure 3: *Radial velocity variation of Hγ, plotted against X-ray phase. The dashed curve drawn through the points represents the best-fit orbital solution for the mean velocities of all lines together.*

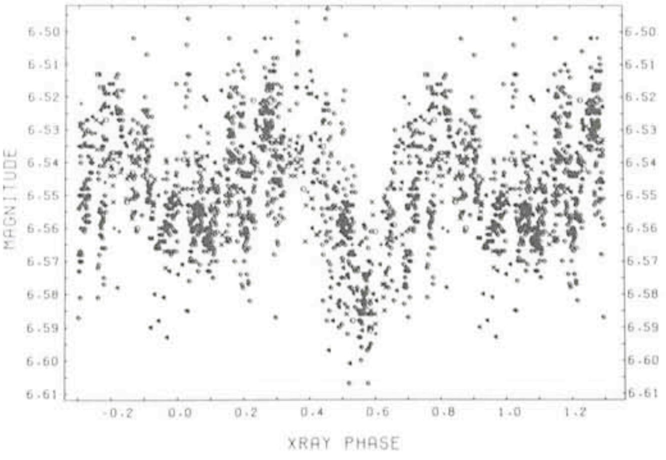


Figure 4: *V-light curve of HD 153919. The symbols denote observations by the different observers, viz.:*
- *Penny, Olowin, Penfold and Warren, 1973*
- *de Freitas Pacheco, Steiner and Quast, 1974*
- *van Genderen, 1976*
- *van Paradijs, Hammerschlag-Hensberge and Zuiderwijk, 1978*
- *Hammerschlag-Hensberge and Zuiderwijk, 1976.*

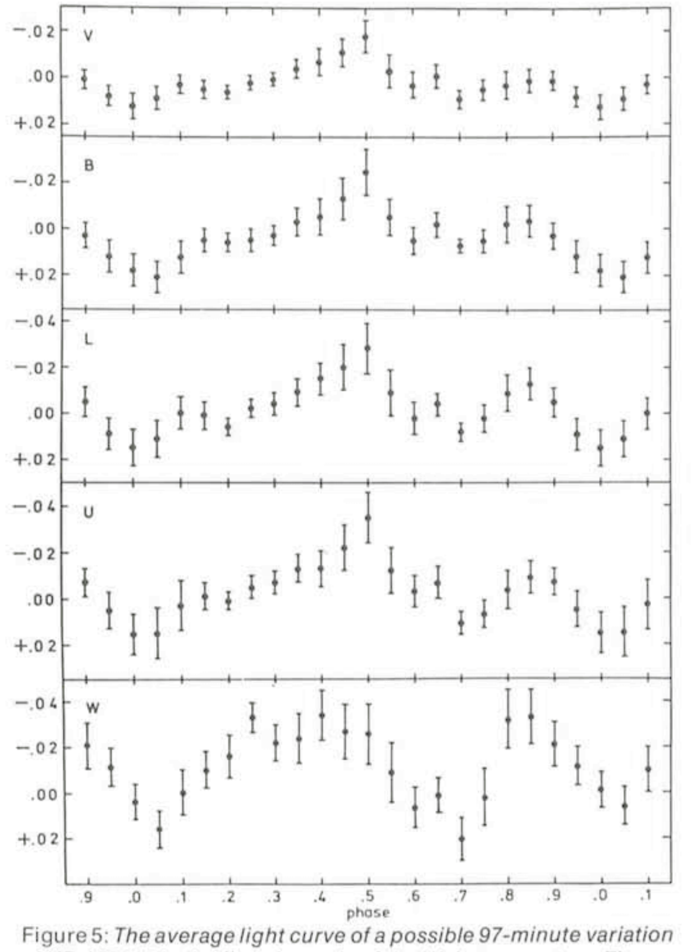


Figure 5: *The average light curve of a possible 97-minute variation of HD 153919 in the five channels of the Walraven system. The results were obtained from observations between orbital phases 0.44 and 0.59 when the X-ray source is in front of the Of star.*

Photometry: A Possible 97-Minute Periodicity

At the same time we also studied this star photometrically. Together with Ed Zuiderwijk (Amsterdam), one of us (G.H.–H.) observed it in the uvby system with the Danish 50 cm telescope at ESO in 1975. One year later, van Paradijs (Amsterdam) observed the star during one month with the Walraven 5-colour photometer in South Africa. At that time, we collected all existing photometry of this star and plotted it in the 3.41-day orbital period. The result is shown in figure 4. The double wave variation typical for massive X-ray binaries is clearly visible although there is much intrinsic scatter in the points.

In April 1978 Dr. T. Matilsky of Rutgers University and Dr. J. Jessen of the Massachusetts Institute of Technology reported the discovery of X-ray pulsations in 4U 1700-37 with a 97-minute periodicity from observations with the SAS-C satellite. This is the longest reported period for any X-ray pulsar. Most other X-ray pulsars have periods between 0.7 sec. and 12 minutes. Although such long periods may also be produced by rotating white dwarfs, there is a variety of reasons why these pulsars—including 4U 1700-37—are most likely to be neutron stars. The main reason is the X-ray spectrum: all the pulsating sources, including 4U 1700–37, appear to have very hard X-ray spectra, strongly suggesting that we are dealing with accreting neutron stars. Some of the previously reported X-ray pulsars in binaries showed optical pulses with the same period as the X-ray pulses. For 4U 1700–37 our optical photometry comprised the largest available material, so that it was natural to use our data to search for possible optical variability. Dr. A. Kruszewski from Warsaw University Observatory searched for 97-min optical pulsations in the yellow-filter photometry obtained by van Paradijs and reported evidence for the presence of this 97-minute variability. According to him, the variability appears strongest around orbital phases 0.4 – 0.6 and it disappears at X-ray eclipse time. We studied the variability not only in the V channel but in all the five available spectral regions of the Walraven system. The 97-minute variability is probably present in all these channels and becomes stronger towards the ultraviolet as is shown in figure 5. Similar plots for other periods did not produce positive results. More observations in the Walraven 5-colour system (by A. van Genderen) and in Hβ-photometry (by H. Henrichs at ESO) are being analysed at this moment to try to examine whether this variability remains present over longer time intervals than one month. Although the present data seem very suggestive, we feel that still more data are required to definitely confirm the presence of this periodicity.

What is very mysterious about this pulsar is why its pulse period is so long. No theoretician has so far come up with a satisfactory answer to this question.

About the "Messenger"

We regret that this issue is somewhat delayed due to summer holidays. The next issue will appear as planned on December 1, 1978.

The *Messenger* is printed in approximately 2,200 copies and distributed to all major observatories in the world. It is also sent to the IAU members in the ESO countries and to many other friends of astronomy, including science journalists and amateurs. We shall always be happy to review the application for a free copy from others who are interested in ESO and in European astronomy.

Most of the authors are professional astronomers who work in Europe and many of them describe their observations at the ESO La Silla observatory. We try to bring the latests news and to inform the readers about what is going on in astronomy *now*. It is therefore unavoidable that some of the articles have a "preliminary" look and that statements therein are often expressed with some caution. We certainly do not attempt to compete with the professional journals.

Readers, who have suggestions or would like to propose changes and improvements over the present form are welcome to write to us—the address is on the last page.

The editors

NEWS and NOTES

Computer Catalogue of ESO Schmidt Plates

Visiting astronomers to the ESO 1.52 m telescope are used to receive, soon after their observing runs, a computer list of the plates they obtained. The lists include all the plate data, from the exposure time and the celestial coordinates to the slit width and the quality of the plate.

No such service has until now been available for direct plates taken with the ESO telescopes. But during the past months, ESO programmer *Klaus Teschner* has implemented a very efficient system for storage and retrieval of Schmidt plate data. The system works so well that it will soon be enlarged to include plates from other telescopes as well, in particular the GPO and the 3.6 m telescopes.

The programmes were written and tested with the ESO HP system on La Silla, but a regular exchange with ESO/Geneva will ensure that all the information is available in both places. At the moment the more than 3,000 plates that were obtained with the Schmidt telescope are being put into the Catalogue, a task that will take some time. Thereafter, future plates will be entered as soon as they have been taken.

The Teschner system consists of one input and two retrieval programmes. The input programme is only of interest to the night assistants on La Silla who enter the new plates, but the two other programmes will be extremely useful for the astronomers. One programme will search for all plates with a certain characteristic or combinations of these: e.g. which plates were taken in March 1976 with filter GG 385 in seeing better than 1.″5? The second programme will find all the plates that show a certain position. In this way, anyone who is interested in a given celestial object will immediately learn which plates are available at which epochs.

Further about ESO 113-IG45

The readers of the *Messenger* may remember ESO 113-IG45, the quasar-galaxy that was described in issue No. 11 on page 24. Further observations were obtained of this remarkable object at other southern observatories at about the same time as the initial ESO observations. It has also been investigated in some detail from La Silla.

Drs. A. C. Danks, W. Wamsteker, N. Vogt, P. Salinari and M. Tarenghi (ESO), together with Dr. H. W. Duerbeck from the Hoher List Observatory near Bonn, FRG, observed 113–IG45 by means of visible (UBV) and infrared (JHKLM) photometry. They find a strong infrared excess, as often seen in Seyfert 1 galaxies. They also notice that the object is very variable; a decrease of more than one magnitude in the L-band and somewhat less in the K-band was seen between November 1977 and January 1978. This sets an upper limit to the size of the infrared emitting region and helps chosing between the possible models.

The ESO velocity (13,600 km/s) has been confirmed by observers with the Tololo and AAT 4 m telescopes and Dr. A. P. Fairall, who called attention to this object in August 1977, has recently obtained a spectrum of the elliptical companion galaxy to ESO 113-IG45 (see the *Messenger* photo). Although the spectrum showed few lines, he was able to measure the velocity and found that it was the same as that of the main galaxy. They are therefore most likely at the same distance and are physically connected.

Dr. Charles C. Wu of NASA obtained ultraviolet spectra of ESO 113-IG45 with the International Ultraviolet Explorer (IUE) satellite in late June 1978. He is now reducing these observations together with Drs. A. Boggess and T. Gull and the preliminary results are very interesting.

Objects of the ESO 113-IG45 class are few—but they tell us more about what is going on in the nuclei of Seyfert galaxies and in quasars. Observations over the widest possible spectral range, from X-rays to radio, are continuing.

Spectra of the Brightest Stars in a Very Distant Globular Cluster

Among the vast number of new and exciting objects that have been found on the ESO Quick Blue Survey plates, some have been shown in the *Messenger*. One of these (No. 10, p. 13) has now been observed in more detail with the ESO 3.6 m telescope.

The object, a globular cluster in the southern constellation Eridanus, is rather faint. The brightest stars have an apparent magnitude fainter than 19, and the integrated magnitude of the entire cluster is about 15.8 in V, according to Dr. G. Wlérick, who obtained this measurement with the ESO 1 m telescope.

Spectra of the three brightest stars were obtained by ESO astronomer R. M. West with the Boller and Chivens spectrograph in the Cassegrain focus of the 3.6 m telescope. During a period of very good seeing and thanks to the excellent performance of the telescope and spectrograph, it was possible to obtain well-exposed 123 Å/mm spectra (3900–7000 Å) with a widening of 0.1 mm. The spectral resolution is slightly lower (about 4 Å) than what is needed to perform MK-classification, but enough to make a rough analysis of the stars.

Together with Dr. R. A. Bartaya from the Abastumani Observatory, Dr. West finds that the spectral types of the three stars are in the range G8–K2 III and that they all are severely metal-deficient. This is a common feature of stars in the halo (Population II). However, there are plenty of lines visible in the spectrum of the brightest star, many of which are of metallic origin, and the star cannot be completely deficient in metals. This confirms the conclusion by Cowley, Hartwick and Sargent (*Ap. J.* 220, **453**) and Canterna and Schommer (*Ap. J.* **219,** L 119) that there are metals even in the most distant clusters and that so far, there is no observational indication of a possible Population III (no metals).

From the apparent magnitudes of the brightest stars in the present cluster and their absolute magnitudes (from the spectral types), it is possible to estimate that the distance is probably well over 100 kpc, thus making it one of the most distant known in the neighbourhood of the Milky Way system. It may even be questioned whether it really "belongs" to our galaxy, or whether it is an intergalactic "tramp". The only clue we have is the radial velocity. From more than ten unblended spectral lines, a mean value of –42 ± 12 km/s is found (heliocentric, i.e. relative to the Sun); the cluster is approaching. Adding the component of the solar motion in the Galaxy, the measured velocity becomes even more negative. So who knows, may be this interesting cluster is really one of "ours"?

New Publications from ESO

Preprints: May–August 1978

23. J. LUB, J. VAN PARADIJS, J. W. PEL, P. R. WESSELIUS: Ultraviolet Photometry of the Cepheid B Doradus from the A.N.S. Satellite. May 1978. Submitted to: *Astronomy and Astrophysics,* Main Journal.
24. A. C. DANKS, L. HOUZIAUX: Spectroscopic Observations of 27 C Ma from 0.14 to 4.7 Microns. May 1978. Submitted to: *Astronomy and Astrophysics.*
25. WILLEM WAMSTEKER: The Continuous Energy Distribution of Nova Cygni 1975. May 1978. Submitted to: *Astronomy and Astrophysics.*
26. G. CONTOPOULOS, L. GALGANI, A. GIORGILLI: On the Number of Isolating Integrals in Hamiltonian Systems. June 1978. Submitted to: *Physical Review* – A.
27. I. R. KING: Astrometric Accuracy with Large Reflectors. June 1978. Colloquium on European Satellite Astrometry, Padova, 5–7 June 1978.
28. E. B. HOLMBERG, A. LAUBERTS, H.-E. SCHUSTER, R. M. WEST: The ESO/Uppsala Survey of the ESO (B) Atlas of the Southern Sky – VI. June 1978. Submitted to: *Astronomy and Astrophysics.*
29. G. CONTOPOULOS: The Dynamics of the Spiral Structure in Galaxies. August 1978. Presented at the "Strömgren Symposium" in Copenhagen, May 1978.
30. D. KUNTH, W. L. W. SARGENT: Spectrophotometry of Six Seyfert Galaxies from the Zwicky Lists. August 1978. Submitted to: *Astronomy and Astrophysics.*

Annual Report 1977.

Modern Techniques in Astronomical Photography. Proceedings of ESO Colloquium. Editors R. M. West and J. L. Heudier, 304 p.

Be Stars Observed at La Silla

L. Divan, D. Briot and J. Zorec

Be stars are hot stars with emission lines, but where are these lines formed? Simultaneous spectroscopic observations at La Silla in June 1978 by Drs. L. Divan, D. Briot and J. Zorec from Institut d'Astrophysique (CNRS) in Paris throw new light on the Be phenomenon.

Be stars have been known for a very long time and, as their emission lines could not be formed in the photosphere, these objects were supposed to be surrounded by a thin hydrogen envelope extending to several stellar radii, the emission lines originating from the part of this atmosphere not projected on the central star. This picture explained also the presence in some Be stars of the so-called *shell spectrum* as due to the part of the extended atmosphere projected on the disk of the central star. Moreover, the rapid rotation of most Be stars could at first sight render plausible the formation of this envelope.

But when the details are considered, so many difficulties are encountered that even the reality of the extended atmosphere in which we have believed during more than forty years, now appears questionable. In fact, there is no real correlation between the rotational velocity and the size of the envelope. Difficulties arise also because in the same star, the emission lines and/or the *shell spectrum* can disappear in a few weeks or months and reappear again, more or less rapidly; in the extended-atmosphere picture this is not easy to explain.

On the other hand, the theoretical models for extended atmospheres depend on so many parameters (optically thin or not, dimensions, static or with any form of velocity gradient . . .) that it is impossible to decide if they are or are not in contradiction with the too few observed parameters.

We thought that this bad situation could be somewhat improved if

(1) more parameters were observed,

(2) observations were made of the same stars at the same time,

and this is why simultaneous observations were done at La Silla, by D. Briot with the 152 cm telescope and coudé spectrograph, and by L. Divan and J. Zorec with the 50 cm ESO telescope and Chalonge spectrograph.

Simultaneous Spectroscopic Observations on La Silla

The parameters observed by D. Briot are the equivalent width and profiles of Balmer lines (Hα included); the reduction is made by classical methods but with improved spectral types and effective temperatures thanks to (λ_1, D)-classification obtained for the programme stars with the Chalonge spectrograph.

The Chalonge spectrograph gives interesting and practically never observed parameters in Be stars. The Balmer region is particularly rich in information; in many cases Be stars have quite a normal Balmer Jump but sometimes, as Barbier and Chalonge announced long ago (*Ap. J.* 1939, **90**, p. 627) for ζ Tau, *two* Balmer Jumps occur at wavelengths differing by about 50 Å. The first one is situated like in a normal star and the second one, at shorter wavelengths near the theoretical Balmer limit, like in supergiant stars. Barbier and Chalonge concluded that hydrogen was present in the photosphere of the star and in an envelope at a very low pressure.

The Two Balmer Jumps

Following this idea we assume that the long-wavelength Balmer Jump ($D_\star$ on figure 1) is the Balmer Jump of the central star and that, together with the corresponding λ_1 it gives the λ_1D spectral type (this had been done long ago, by D. Chalonge and L. Divan, *Ann. d'Astroph.* **15**, 1952, 201, to classify four stars with emission in the Balmer continuum: 1 H Cam, 59 Cyg, υ Cyg and 11 Cam) and the effective temperature (the λ_1D spectral type has been calibrated in effective temperature). This assumption is justified by observations made in stars with variable emission (see below).

The second Balmer Jump (d on figure 1) can be either in emission, like in α Ara ($d < o$), or in absorption like in 48 Lib ($d > o$). In all cases the resultant Balmer Jump D is equal to ($D_\star + d$).

These stars are often variable, but the most interesting point is that the variations occur *only* in the short-wavelength Balmer Jump d due to the envelope which may even disappear entirely (1 H Cam, figure 2 or 59 Cyg, figure 3) and reappear again. The long-wavelength Balmer Jump is *constant* and then really defines the spectral type

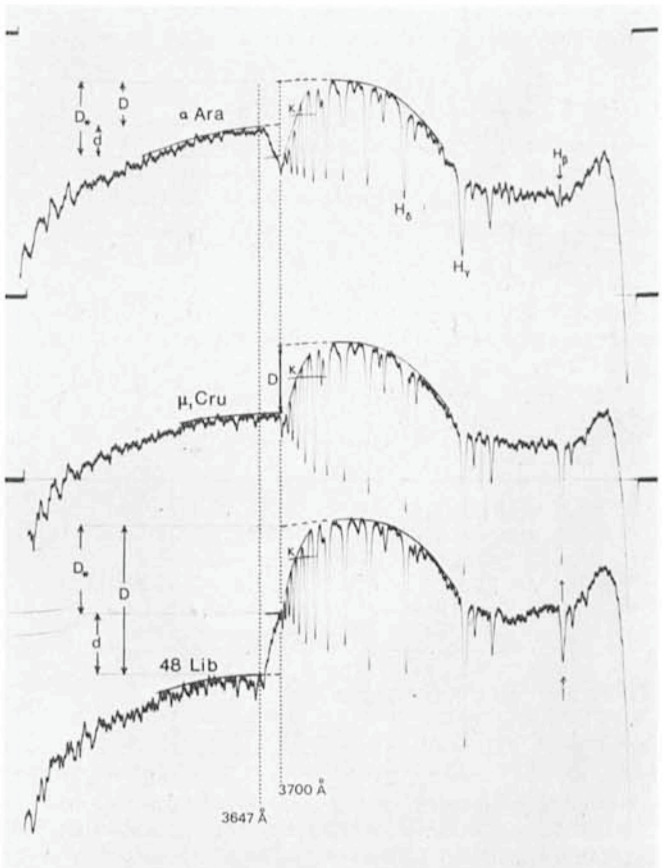


Fig. 1: *Microphotometer tracings of α Ara, μ_1 Cru and 48 Lib. μ_1 Cru is a normal B star showing a unique Balmer discontinuity, D. In α Ara and 48 Lib two Balmer discontinuities can be seen, a long-wavelength one, $D_\star$, which is due to the central star, and a short-wavelength one, d, corresponding to the envelope.*

d is in emission for α Ara ($d < o$) and in absorption for 48 Lib ($d > o$). In the two cases $D = D_\star + d$.

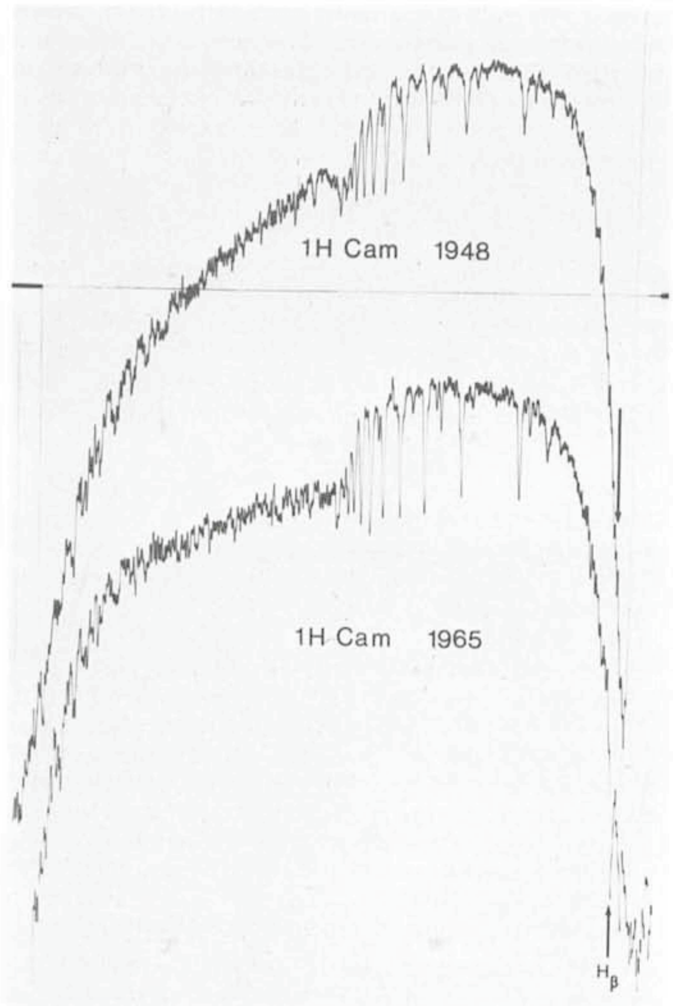


Fig. 2: *Emission in the Balmer continuum which was clearly visible on the 1948 spectrum has disappeared in 1965. Note also the Hβ line, absent in 1948 (filled in by emission) and normal in 1965.*

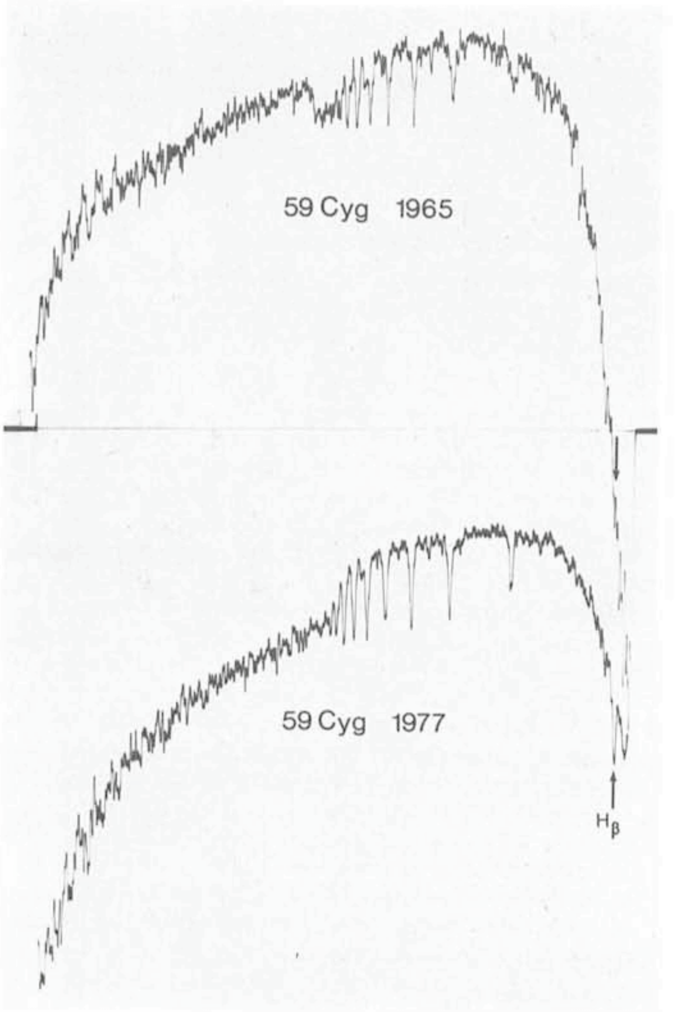


Fig. 3: *Cf. figure 2.*

(and luminosity class) of the central star as was supposed above.

Spectral Variations

Naturally, variations in d are accompanied by variations of the emission in the Balmer lines (Hβ in figures 2 and 3). What is less known (but was discovered by Barbier and Chalonge for γ Cas during its great burst in 1936–37) is that variations in d and Balmer emission lines are accompanied by changes in the colour temperature of the star, on both sides of the Balmer discontinuity. Figure 4 shows the results obtained for HD 24534 (= X Per) by L. Divan at the Haute-Provence and Jungfraujoch Observatories with the Chalonge spectrograph: there is a close relation between the colour of the *star + envelope* and the discontinuity d (D_* being constant) both on the red side (φ_{rb}) and on the ultraviolet side (φ_{uv}) of the Balmer Jump, showing that in this

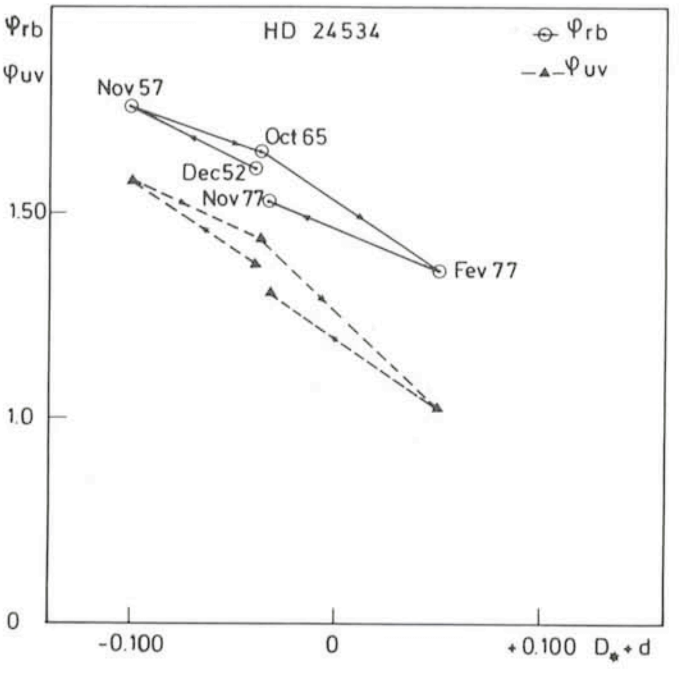


Fig. 4: *Spectrophotometric gradients φ_{rb} (spectral range 6200–4000 Å) and φ_{uv} (3700–3150 Å) for HD 24534 (= X Per) as a function of $D = D_* + d$.*

The emission d in the Balmer continuum of X Per is variable and we can see here that the colour temperatures on both sides of the Balmer Jump are strongly correlated with d.

The normal colour of X Per (spectral type B0) is $\varphi_{orb} = 0.73$. In February 1977, the colour of the star is $\varphi_{rb} = 1.36$ and its spectrum shows practically no emission ($d = O$, $D = D_*$); thus the colour excess $\varphi_{rb} - \varphi_{orb} = 0.63$ is entirely interstellar. In all other cases the colour excess is the sum of two terms, the interstellar colour excess and a colour excess due to the presence of the envelope. Observations of this type permit a clear separation of these two terms. ▶

case the envelope cannot be considered as optically thin in the continuum. Note that the extrapolation of this relation to d =0 (in fact to the immediate vicinity of the point *Fev 77* for which the emissions have almost disappeared) gives the interstellar colour excess of the star; this interstellar colour excess is the same in all phases and can then be subtracted, to obtain the colour excess due to the envelope alone.

Future Observations

All these observations will be extended to many stars. The fact that the discontinuity D_* as it has been defined on figure 1, is constant, justifies the picture of an *unvariable* central star. But the variable part of the spectrum is still a mystery: extended atmosphere or perhaps a chromosphere? A tentative representation of the Be phenomena by non-thermal phenomena in the stellar atmosphere is in progress (R. N. Thomas and J. Zorec) at the Institut d'Astrophysique in Paris and the present simultaneous observations done by us at La Silla (high dispersion to measure the emission in Balmer lines, low dispersion to measure all the parameters of the continuum: D_*, λ_1, d, φ_{rb}, φ_{uv}) will serve to test new models. Of particular interest are the correlations:

(1) between d and emission in Balmer lines ($W\alpha$, $W\beta$ . . . and Balmer decrements),
(2) between d and the colour temperatures on both sides of the Balmer Jump.

We hope that the large set of new data obtained in June 78 at La Silla together with theoretical efforts will throw some new light on the Be phenomenon!

The Environments of Active Galactic Nuclei

R.A.E. Fosbury

It is becoming increasingly clear that strange things happen in many galaxy nuclei and that their study is of extreme importance for our understanding of the behaviour of matter. Observations from satellites and with large telescopes have yielded new and often unexpected results and the possibility of the existence of black holes (or even more exotic objects) in the centres of active galaxies is now taken seriously by most astronomers. Dr. Robert Fosbury, who joined the ESO Scientific Group in Geneva in 1977, has been pursuing for a long time the study of galaxy nuclei with some of the world's largest telescopes. He gives some examples of recent work with the ESO 3.6 m telescope.

Small regions of intensely energetic activity are known to exist in the nuclei of many galaxies and there are a number of arguments which, taken together, provide rather convincing evidence that QSOs are distant, luminous examples of the same type of phenomenon. Understanding the nature of these energy sources is important because the extreme conditions encountered in them stretch our knowledge of basic physics. Also it would be possible to use the QSOs as cosmological probes with much more confidence if there was a better knowledge of what they were and whether their redshifts were entirely due to the universal expansion.

Aside from the cosmological information implicit in the study of QSOs, by moving a little nearer home and looking at activity in galactic nuclei, we are immediately presented with a number of observational and interpretative advantages. Not least of these is the chance to investigate the relationship between the nucleus and its galactic environment. The interaction between the central energy source (10^{15} cm from variability and other arguments) and its surroundings occurs on a very wide range of spatial scales and, depending on the nature of these surroundings, produces widely different manifestations of what are probably similar phenomena. This range of scales demands the application of a wide range of observational techniques. The radio band does not in general contain a large fraction of the luminosity of active nuclei, radio continuum observations do however provide a means of tracing events from the smallest to the largest angular scales. Optical and ultraviolet spectrophotometry are powerful techniques for studying the continuum radiation emitted from very close to the energy source and also, from the emission lines, the state of the ionized gas which is excited by the activity. Recently obtained X- and γ- ray results are putting very severe constraints on models of the energy source itself.

These are some interesting general correlations between the outward appearance of the nuclear activity we observe and the morphological type of the associated galaxy. For example, classical double radio sources seem only to be found straddling elliptical galaxies, while class 1 Seyfert nuclei (blue continuum, broad permitted emission lines, narrow forbidden lines) exist predominantly in spiral galaxies and are usually not strong radio sources. While correlations of this kind do not have the status of absolute rules, they do provide a starting point for a study of the link between events in the nucleus and the evolution of the galaxy as a whole.

As part of a larger programme studying the morphologies of radio galaxies in the Parkes Catalogue using the SRC IIIa-J sky survey, I obtained in April direct plates of some selected galaxies using the 3.6 m telescope at prime focus. Figure 1 shows the galaxy identified with the inverted-spectrum radio source PKS 1934–63. The radio source itself is worthy of note since it was among the first discovered to show the characteristic low-frequency cut-off due to synchrotron self-absorption (Bolton, Gardner and Mackey, 1963, *Nature*, **199**, 682). It is also extraordinarily powerful as a compact source associated with a galaxy rather than a QSO. Optical spectrophotometry has been published by Penston and Fosbury (1978, *M.N.R.A.S.*, **183**, 479), and figure 1 is a significant improvement over previously published photographs. Rather than being a "double" galaxy it is possibly a giant elliptical girded by a dust belt reminiscent of our nearest radio galaxy NGC 5128 (Centaurus A). As in Cen A, the radio structure, which is known to be a very close double from VLBI observations, would be aligned perpendicular to the dust belt. It is even possible that the dust is hiding a quasar-like nucleus, an idea which could be checked by infrared observations.

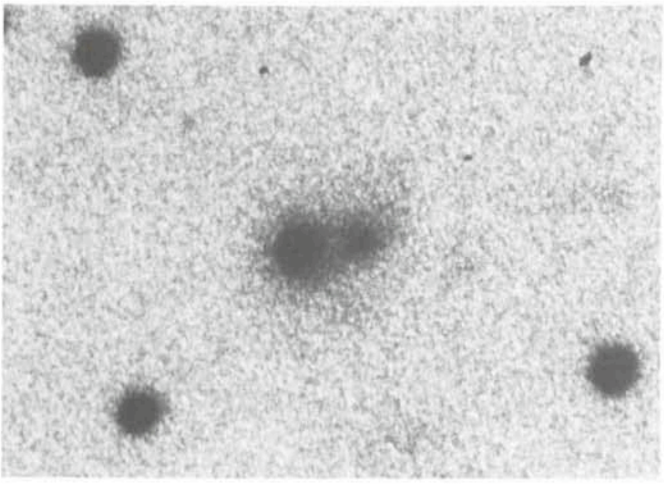


Fig. 1: *From a 3.6 m prime focus plate (60-min exposure on sensitized IIIa-J with GG 385 filter) of the galaxy associated with the powerful compact radio source PKS 1934–63. This may be a giant elliptical crossed by a dust belt like Centaurus A.*

Another topic receiving much attention in the current literature is the 21-cm detection of the neutral hydrogen gas in some elliptical galaxies. From the limited sample available it has been noted that those ellipticals with detectable amounts of H I have some form of nuclear activity, evidenced by optical emission lines and/or a compact nuclear radio source, and also occur in small groups with half a dozen or so member galaxies. This has led to the notion that the elliptical has not always contained the neutral gas (most ellipticals contain embarrassingly little) but that it is currently being accreted from gas left over in the group and perhaps finding its way down to the nuclear regions to power the activity there.

The galaxy associated with the flat-spectrum radio source PKS 1718-649 may have some relevance to this problem. It was originally classified as D-type (elliptical with extended halo) from the ESO (B) survey. The SRC IIIa-J survey however showed that this halo was not smooth but was in fact a pair of diffuse, very low surface-brightness spiral arms. (Fosbury, Mebold, Goss & van Woerden, 1977, *M.N.R.A.S.*, **179**, 89) showed that the system contains a large mass ($3 \times 10^{10} M_\odot$) of neutral hydrogen and that the nucleus has an emission-line spectrum reminiscent of the active ellipticals. The new 3.6 m photograph (fig. 2) shows the spiral structure in much more detail (a) than seen previously and also (b) the tidal interaction between the main galaxy and the companion spiral. Several fainter galaxies are visible in the viscinity which may be members of the same small group.

The IIIa-J survey from the Schmidt telescope in Australia is giving us a much clearer view of galaxies than the previous surveys. There is still, however, no substitute for the plates taken with a big reflector in a good site, and these plates, coupled with the radio observations of H I, are providing new insights into the galaxies around the nuclei.

I am happy to acknowledge that the prints reproduced in figure 2 were made by David Malin at the Anglo-Australian Observatory.

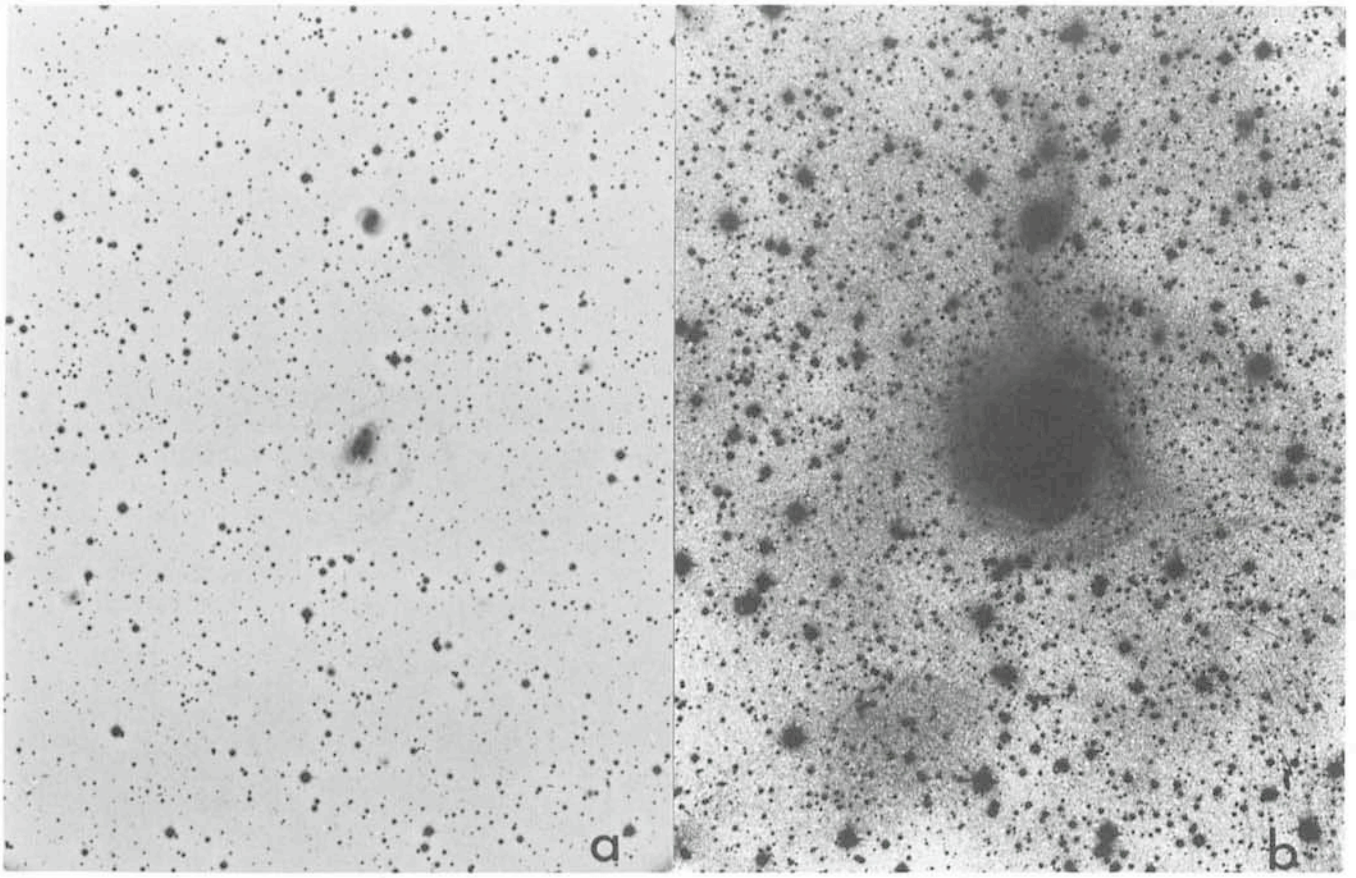


Fig. 2: *The flat spectrum radio source PKS 1718–649 is in the nucleus of the big spiral galaxy with low surface-brightness arms. Both prints are derived from the same 90-min exposure on sensitized IIIa-J emulsion with the 3.6 m telescope. (a) is made using an unsharp mask (Malin, 1977.* AAS photobull. *No. 16, 10) to filter out the low spatial frequencies and show the fine detail from the densely exposed original plate. (b) is a high-contrast derivative (Malin, 1978,* Modern Techniques in Astronomical Photography, *Geneva. Ed. R.M. West and J.L. Heudier) which shows the very faint tidal extension through the companion spiral.*

SU Ursae Majoris-type Stars—The Most Interesting Dwarf Novae

I. Semeniuk

Dr. Irena Semeniuk is a senior lecturer at the Astronomical Observatory of the Warsaw University, Poland, and joined the ESO Scientific Group in October 1977 with a one-year fellowship. She is interested in extragalactic astronomy (distribution of galaxies in clusters) as well as in cataclysmic variables. She recently observed at La Silla and was very happy to catch one of these stars in a "superburst".

Among the large variety of cataclysmic variables there is a subgroup called SU Ursae Majoris-type stars. Although this group of variables owes its name to a star in the northern sky, our contemporary knowledge about these stars results mainly from observations of southern members of this class. Similar to the U Geminorum-type stars—with which the reader is probably more familiar, as they attracted the attention of observers much earlier than the SU UMa-type stars—the SU UMa-type stars also show quasi-periodic recurrent rapid outbursts during which the stars' brightness increases by a few magnitudes during a night. The rapid rise to maximum is then followed by a slower decline to minimum light. But the SU UMa-type stars differ from the ordinary U Gem stars in demonstrating two essentially different types of maxima. The first type of maxima, so-called *normal* maxima, occur most frequently and are characterized by rather steep rise and quick decline to minimum light. The second kind of maxima are so-called *flat* maxima or supermaxima. They are on average 1 magnitude brighter than normal maxima and they last 4–5 times longer than normal ones. Like the normal maxima they also occur quasi regularly with the recurrence periods much longer than those between the normal maxima.

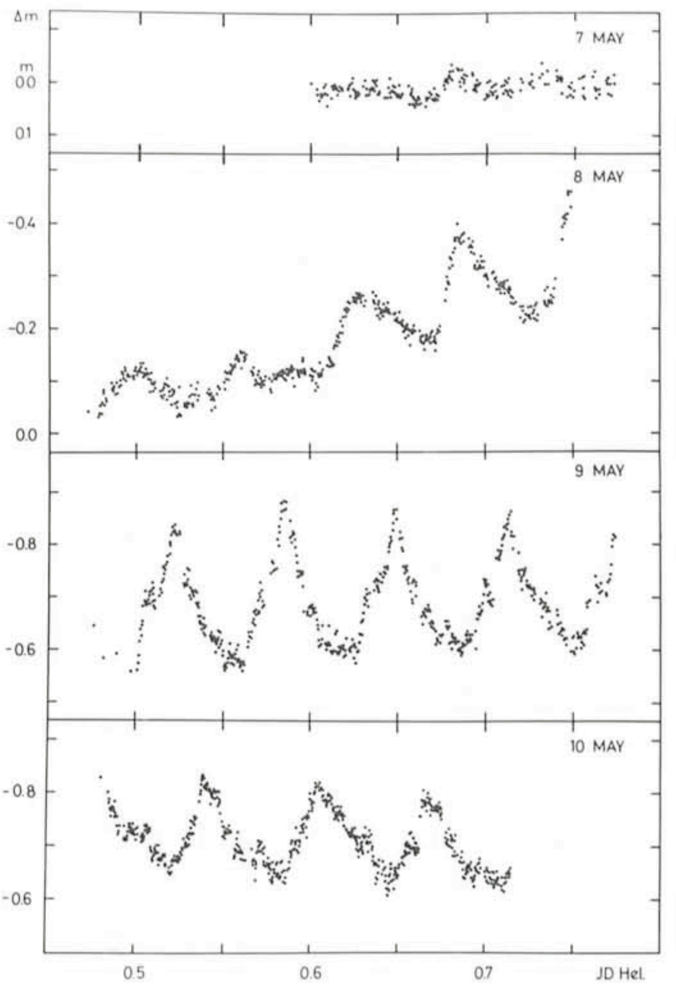
The members of the Variable Stars Section of the R.A.S. of New Zealand, directed by F. Bateson, play an important role in observing SU UMa stars. Their extensive visual observations make it possible to distinguish between the types of observed maxima, to classify a star of the SU UMa type, and to determine the mean recurrence period of outbursts or superoutbursts. Sometimes they alert astronomers having better observational facilities at their disposal that a superoutburst has begun and thus make it possible to obtain precise photometry or spectroscopy during this interesting phase.

VW Hyi

One of the brightest and the most investigated SU UMa stars is VW Hyi. It was observed by N. Vogt and B. Warner during minimum and during outbursts and it is the best example to demonstrate the behaviour of the SU UMa stars. The light curve of the star during minimum light shows a hump of amplitude between 0.4–0.9 mag which repeats periodically with a period equal to 107 min ($0\overset{\mathrm{d}}{.}07427$). This is the orbital period of the binary system. As is generally known, all dwarf novae are binary systems of which one component is a white dwarf and the second is a late-type star filling its Roche lobe and losing mass through the inner Lagrangian point. This stream of matter is responsible for an accretion disc surrounding the white dwarf component of the system. This stream impacts onto the disc creating a hot spot on its outer edge. Under advantageous orbital inclination conditions this hot spot manifests itself as a hump on the light curve seen during half the orbital period of the system. As a result of inhomogeneities in the impacting stream of matter the hot spot changes its luminosity and this exhibits itself as a rapid and irregular flickering observed in the light curves of dwarf novae. Observations seem to indicate that the origin of outbursts is connected either with the outer layers of the white dwarf or with the central region of the disc.

In the case of VW Hyi, normal eruptions occur in 80 per cent of all observed cases. During the normal maxima the system increases its brightness by 3.9 magnitude on average. The duration of normal maxima is about 4 days and they repeat with a mean interval between them of 29 days. During the normal maxima no hump is observed. This is not surprising, since one can easily imagine that during the outburst the system brightens so much that the source of radiation responsible for the periodically repeated hump is negligible.

The supermaxima occur in VW Hyi with an average interval between them of 179 days. Their mean duration is 17 days, i. e. they last about 4 times longer than the normal



Observations of V 436 Cen in blue light during the superoutburst in May, 1978. A star of magnitude B = 12.4 was used as comparison.

maxima and their mean amplitude is 4.8 magnitude, i.e. about 1 magnitude greater than that of the normal maxima. A naïve expectation would predict that no hump should be observed during supermaxima as it is not observed during the normal maxima. But in spite of this naïve expectation—and it is the most curious thing—not only a hump but even a *superhump* is observed during the supermaxima of VW Hyi. It is called the superhump because its amplitude in intensity units is much greater than what is observed at minimum light. Moreover, what makes the phenomenon still more curious is that the mean period of the superhump of VW Hyi is 110 min (0ᵈ07676), i.e. it is by about 3 per cent larger than the orbital period observed at minimum light, and even more, the superhump period is decreasing during the supermaxima. The same behaviour was observed with WX Hyi, another southern star of SU UMa type. In its case the mean period of superhump is also greater by about 4 per cent than the orbital period of the system as obtained from humps at minimum light.

Interpretation?

What is the real nature of such behaviour of SU UMa-type stars? Are the superhumps connected with appearance of a "superspot" on the disc surrounding the white dwarfs? Is the observed superhump period change related to the period change observed in Nova V 1500 Cyg? Is it indeed so that with all SU UMa stars no hump is observed during the normal maxima, but only during the supermaxima? Are the physical processes responsible for the two types of outbursts completely different?

Observations on La Silla

All these questions motivated the author to place some SU UMa stars in her observational programme for La Silla. Most of these stars at minimum light are below the threshold of visibility of the 60 cm Bochum telescope which was available. But every night the author started her observations by checking whether or not any of the stars had exploded. The chance was rather small during the author's short stay at La Silla. Thus she was very pleasantly surprised when on the night of May 7, while making her nightly survey, she perceived a star in one of the previously empty fields. It was V 436 Cen which had just exploded and was by then about 3 magnitudes brighter than the limiting magnitude of the Bochum telescope. The author's excitement was so great that she could not believe that this was the correct star. Only after measuring colours of the star she was sure there was no misidentification. The star showed a great ultraviolet excess as is usually observed with dwarf novae. The star was then monitored in blue light almost until the moment it was on the horizon.

It was not obvious after the observations of the first night whether or not the star was in a normal maximum or in one of the rare supermaxima. According to the New Zealand observers it was known that the normal maxima of V 436 Cen last only about 2 days. On the following night the star increased again in brightness and as it kept this high brightness during the next two nights it became clear that it was a *supermaximum!* In the course of the observations a hump which only started to develop on the first night increased its amplitude to the value of 0.3 magnitude so that it was clearly seen from the counts displayed on the monitor screen.

Unfortunately cirrus clouds which often cover the sky above La Silla at this time of the year interrupted these exciting observations. But when after an 8-day break, the author again began the observations (due to the kindness of N. Vogt and J. Breysacher who offered her their nights), the star was only about 1 magnitude fainter, and the hump was still visible although its amplitude had decreased. On the following night the hump merged into a rapid flickering. But the star was visible in the telescope even 16 days after the beginning of the outburst, giving strong evidence that it was indeed a long-lasting supermaximum. The reader may see some of the observations of the star in the figure. The observations are not yet fully reduced. Perhaps their further careful analysis will make some contribution to the better understanding of the most interesting dwarf novae.

Observation of the M87 Jet with the International Ultraviolet Explorer

M. Tarenghi, ESO, Geneva
G.C. Perola, Istituto di Fisica, Milano, Italy

During the past months, astronomers have been busy at the IUE ground station near Madrid. Dr. Massimo Tarenghi was the first ESO astronomer to use this unique ultraviolet satellite to observe extragalactic objects. This is the first, brief report about his exciting observations, together with Dr. Perola from Milan. We expect to bring further news about the IUE in the next issue of the Messenger.

The International Ultraviolet Explorer (IUE), a joint project of NASA, the United Kingdom, and the European Space Agency, is the first satellite designed for use by the general astronomical community which does not require a special knowledge of space techniques on the part of the observer. IUE is a geosynchronous satellite equipped with a 45 cm Cassegrain telescope for spectroscopic studies in the wavelength range 1000–3000 Å. It is kept under control at two operation centres, one located at the Goddard Space Flight Center in Greenbelt, Maryland, USA, the other at the ESA Tracking Station in Villafranca del Castillo near Madrid, Spain.

The telescope field of view is seen by a television camera in the satellite and can be displayed on a TV screen at the ground station to allow the observer to identify his target. The situation is like with a normal ground telescope: just imagine to observe with the ESO 3.6 m telescope, where the astronomer sits in the control room. With IUE the control room for the European astronomers is at the Villafranca station, the telescope is only a bit further than the other side of the window . . . !

The telescope is a Ritchey Chrétien of 45 cm aperture, with focal ratio f/15, an image quality of 1 arcsec and an acquisition field of 10 arcmin in diameter. At the focal plane there is an echelle spectrograph with two SEC vidicon cameras, one for the range 1150–2000 Å, the other for the range 1800–3200 Å. One can choose between a high-dispersion mode (resolving power $\sim 10^4$) and a low-dispersion mode (resolution ~ 6 Å).

The scientific aims of the IUE mission can be summarized as follows:

- to obtain high-resolution spectra of stars of all spectral types,
- to study gas streams within binary star systems,
- to observe at low resolution faint stars, galaxies and quasars,
- to obtain spectra of planets and comets,
- to improve the knowledge of the physical conditions in the interstellar matter by measuring its effect on the stellar spectra.

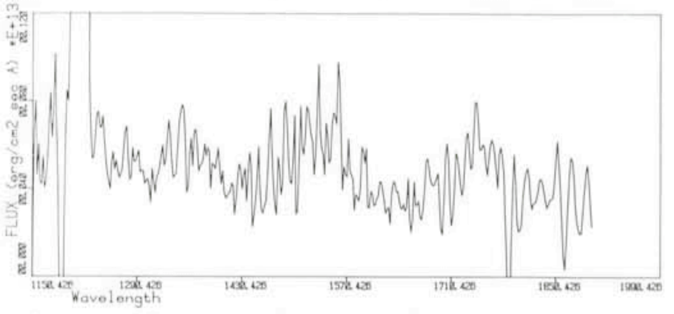
After the first few months of observations an exciting body of data has already accumulated on a large number of objects, from planets to QSOs. At the end of September, a full issue of *Nature* will be devoted to the data obtained in the very first period of observations.

Here we would like to present the preliminary results of an observation of the jet in M87, which represents a case of this instrument used at the limits of its technical possibilities. The radio galaxy Virgo A (NGC 4486, M87) is a bright elliptical in the Virgo cluster. It is known since 1918 to contain a very peculiar feature near its centre, which looks like a jet emerging from the nucleus. The total magnitude of this feature is $m_B = 15.8$, but it consists of several bright spots, among which the brightest has $m_B = 16.77$. The optical spectrum is a featureless continuum which follows a power law with a spectral index $n = 1.7$ ($F(\nu) \alpha \nu^{-n}$) and is highly polarized.

The soviet astrophysicist L. Shklovski suggested in 1956 that the optical radiation is produced via the synchrotron process by relativistic electrons and positrons in a magnetic field. It was the first extragalactic source with spectral and polarization properties similar to those of the Crab nebula continuum. One of the main problems it poses is how the electrons get continuously accelerated to catch up with the synchrotron losses, which become more and more severe as the emission frequency increases. The first aim of our measurement with IUE was therefore to measure how the continuum extends into the far UV.

On July 24, 1978, we pointed the IUE telescope in the direction of M87, whose nucleus is bright enough to appear as a diffuse spot on the TV screen. The jet itself is too faint to be seen in the picture, so, in order to position the entrance slot of the spectrograph on it, we made use of the possibility offered by IUE to guide an observation in the "blind" offset mode. We therefore moved the telescope off by 12″ from the centre of the galaxy in the appropriate direction and then selected a bright star in the field of view for the automatic guide. After 6^h30^m of exposure time with the short-wavelength camera we saw on the screen the spectrum of the brightest knot of the M87 jet. Unfortunately, some fairly wide sections of the spectrogram were disturbed by a comparatively strong microphonic noise produced during the read-out of the camera. (This happens rather rarely.)

A preliminary version (there are still problems with the calibration of the IUE camera) of the spectrum after the subtraction of the background is presented in the figure. It



tells us two important things: the first is that the optical continuum appears to extend into the far UV without changing the slope of the power law. The second is that, despite of the noise, there is one emission feature in the spectrum which looks undoubtedly real (we have carefully inspected the raw image of the spectrogram to make sure that it is not a fake). This feature sits at 1556 Å, which corrected for the redshift of M87 corresponds to the line CIV λ1549, the most prominent line after Lyα found in this range of wavelengths in high redshift QSOs and also in the spectra of 3C 273, NGC 4151 and NGC 1068 obtained with IUE. (Because of the large aperture of the slot, the strong Lyα line at 1216 Å is due to geocoronal light.)

This result is particularly important, because it immediately implies that the brightest knot at least cannot be moving at a large speed (say greater than a few hundred km sec^{-1}) relative to the galactic nucleus. This represents a strong constraint for dynamical models of the jet involving ejection of matter from the nucleus of the galaxy.

Optical Pulsations from 4U 1626–67 Discovered with the ESO 3.6 m Telescope

S.A. Ilovaisky, C. Motch and C. Chevalier

A little over a year ago, Drs. Claude Chevalier and Sergio Ilovaisky reported the optical identification of the X-ray source LMC X-4 (cf. Messenger *No. 9, p. 4). Now, together with Dr. Christian Motch, also from Observatoire de Meudon, France, they have succeeded in measuring optical pulses in a 19^m star with the same period as the southern X-ray source 4U 1626-67, and therefore identical with this source. To obtain a high time-resolution, $0\overset{s}{.}8$, it was necessary to use the 3.6 m telescope. Contrary to other X-ray sources, no Doppler shift has yet been detected in 4U 1626-67.*

Much excitement has been generated in the astronomical community by the publication of more than 50 accurate positions (± 20″ to 30″) of galactic X-ray sources obtained with the Rotation Modulation Collimator (RMC) experiment on the SAS-3 satellite. Even more numerous and accurate X-ray positions are expected as a result of the sky survey being carried out at this moment by the giant HEAO-1 satellite. With this improved positional information, *optical identifications* can now be attempted with a high degree of confidence inside the small X-ray error circles.

Preliminary photometric detective work carried out by Jeffrey McClintock and colleagues at Cerro Tololo last year singled out two sources for further study: the X-ray burster MXB 1735-44 and the X-ray pulsar 4U 1626-67. In both error circles faint blue stars with unusual colours ($V = 17.5$, $B\text{-}V = +0.2$, $U\text{-}B = -0.8$ and $V = 18.6$, $B\text{-}V = +0.1$, $U\text{-}B = -1.2$, respectively) were found. These two suggested optical counterparts have been scrutinized in detail

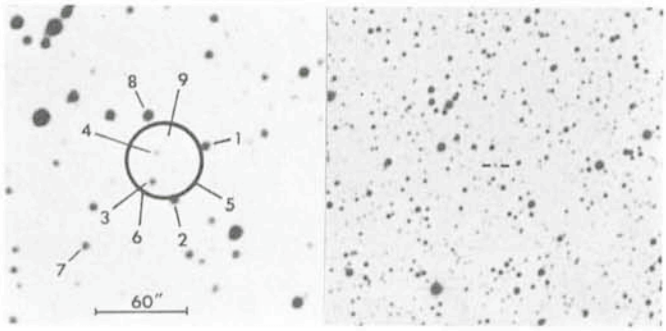


Fig. 1: *Optical identification of 4U 1626-67. To the left the SAS-3 RMC position with a 50" diameter 90 per cent confidence circle. Pulsations were detected from star No. 4, which is also indicated in the right hand figure, reproduced from the ESO QBS Atlas.*

this season: MXB 1735-44 from Cerro Tololo in June 1978 and 4U 1626-67 from La Silla in May, and in both cases the optical observations have successfully shown that the suggested stars are indeed the correct ones: precisely the same *time-signature* known in X-rays has been discovered in each star. For 4U 1626-67 we found optical pulsations at exactly the X-ray period (7.68 seconds) and for MXB 1735-44 three sharp optical bursts identical in shape and duration (0.1 sec rise and 10 sec decay) to the X-ray bursts were observed by a joint Harvard-MIT group, one being exactly simultaneous with an X-ray burst observed with SAS-3.

Optical Observations

During our observing run at the 3.6 m in May 1978—our first at this telescope—the weather was particularly bad with cirrus clouds and 100 km/h winds and it really looked as if we would not observe much, if at all. But on the second half of the night of 2/3 May we decided to attempt high-speed photometry of the 4U 1626-67 candidate for about 1 h—through thin cirrus and with some wind—using our own special equipment brought from Meudon. Observing conditions on the Cassegrain cage were not ideal, due to a severely inclined cage floor (more than 40° with respect to the horizontal!), but we managed to locate the almost nineteenth-magnitude star and put it in the photometer aperture.

Fourier analysis of the data was done back home in Meudon a few weeks later, and how pleasant was our surprise when the computer print-out showed a huge spike in the power spectrum at 7^{s}6805, almost exactly the predicted geocentric X-ray period at the date of the observations! A portion of the spectrum is shown in figure 2 and

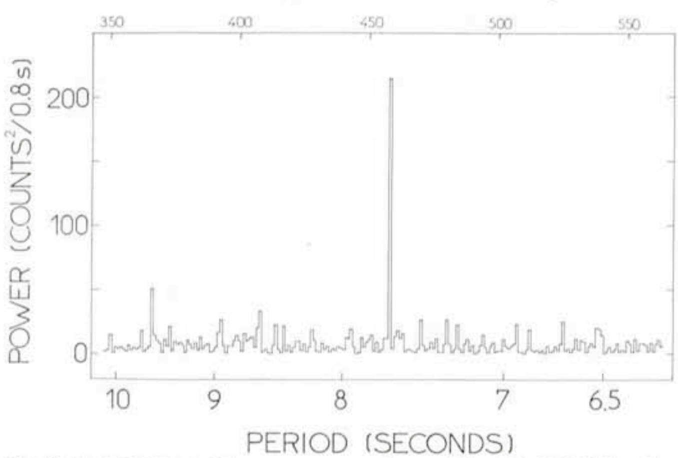


Fig. 2: *A small part of the power spectrum of the 4U 1626-67 optical counterpart. The strong peak corresponds to a period of 7.6805 sec.*

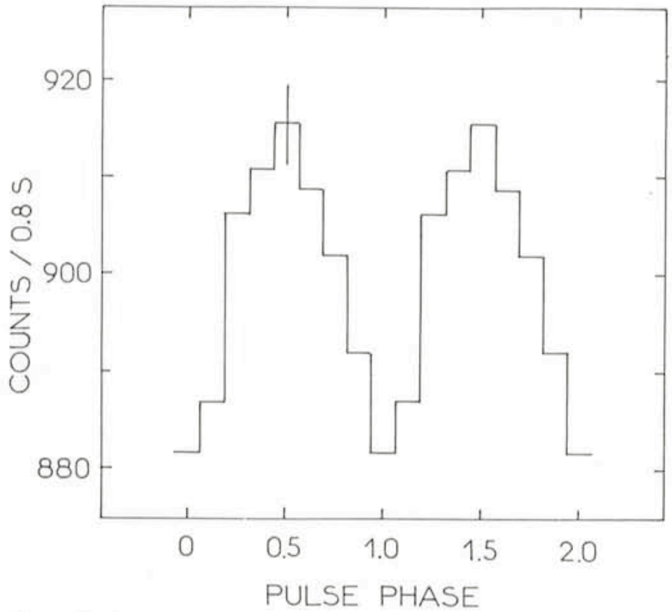


Fig. 3: *The light-curve of 4U 1626-67. Note the relatively sharp rise and gradual decrease.*

the light curve—the data folded modulo the best period—in figure 3, where the pulse is repeated for clarity. Our observations were made in white light using an S-13, low-noise, uncooled photomultiplier. The time resolution was 0^{s}9 with counts being actually accumulated only for 0^{s}8. A highly stable quartz-crystal oscillator integrated into our microprocessor-controlled photometer gave us strictly equi-spaced integrations—a must for Fourier analysis. The high signal-to-noise ratio obtained for this faint object with our system (a net star-sky signal of 1100 counts/sec with a sky count of 3800 c/s using a 10" aperture) has encouraged us to plan re-observing the star next season with better time resolution (0^{s}1). We are already re-programming the microprocessor and hope for improved weather conditions!

The Nature of 4U 1626-67

With an amplitude of 4 per cent this source turns out to be the one showing the largest optical modulation of the optically identified X-ray pulsars in binary systems (Her X-1, Vela X-1, 3U 1700-37 and 3U 1223-62). However, and this is where the 4U 1626-67 system is really mysterious, there is no trace in the X-ray data of any Doppler effect. This effect, normally seen in other X-ray pulsars, is due to orbital motion of the compact X-ray source around the centre of mass of a binary system in which the optical primary is the more massive component—and the one we *see*—and where orbital periods range from 2 to 40 days. The optical pulsations detected in these systems are thought to be due to X-ray heating of the material close to the X-ray source, where X-ray photons are absorbed and quickly re-emitted as optical photons.

The absence of a Doppler effect on the 4U 1626-67 system led theoreticians to conclude that the orbital period was most likely very short ($P \leq 0.3$ day) in order to have escaped detection and that the companion optical star was a low-mass, low-luminosity object, actually of lower mass than the X-ray source! In such a highly compact binary system, it was argued, X-ray heating of the companion would dominate and strong optical pulses might be detected. This prompted our observations, which indeed revealed strong pulses, but not even half as strong as predicted. Our data show no Doppler effect within one hour. Perhaps future observations might reveal this effect and thereby determine the orbital period—or are we in for more surprises?

A Search for High-Inclination Minor Planets

L.D. Schmadel and J. Schubart

There is a renewed interest in the Solar System and its planets. Incredible photos are transmitted back from distant space probes and on-site physical investigations have become possible. An increasing number of new planets are being discovered with large, ground-based telescopes. However, most of the known objects lie in or near the plane of the Earth's orbit, the Ecliptic. Little is known about the objects that presumably exist high above or far below this plane. How many are there and how did they get there? Drs. Lutz Schmadel and Joachim Schubart from Astronomisches Recheninstitut in Heidelberg, Fed. Rep. of Germany, describe a search programme with the ESO Schmidt telescope that aims at the discovery of out-of-the-Ecliptic minor planets.

Most searches for faint minor planets have been based on photographic plates of fields close to the Ecliptic. However, Schubart recently indicated the possible existence of faint, resonant asteroids of Hilda und Thule types at high inclination and predicted favourable conditions for discovery of such objects at rather high ecliptical latitudes (35 to 60 degrees). We have therefore carried out two pilot surveys with the ESO 1 m Schmidt in order to discover highly-inclined asteroidal orbits. The ESO astronomers H.E. Schuster and R.M. West participated in this programme.

Earlier surveys that aimed at the detection of faint minor planets clearly favoured objects with a small orbital inclination relative to the plane of the Ecliptic. This is particularly true for the now famous Palomar-Leiden Survey which was based on plates taken with the 48-inch Palomar Schmidt telescope in September-October 1960, since all the observed fields were comparatively close to the Ecliptic. Only a few attempts have so far been made in order to detect objects with high inclinations; e.g. the search by Schubart in 1960 with the 40 cm astrograph at the Sonneberg Observatory. By the way, the recently numbered minor planet (2000) HERSCHEL is a result of this work. It is of the so-called *Phocaea-type* (the elements of the prototype, (25) PHOCAEA, are a = 2.4 AU, e = 0.25 and i = 22°).

Orbital resonances

Asteroids with a resonance between their orbital periods and that of Jupiter have been known for many decades. Typical cases are the *Trojan* asteroids (1:1 resonance, that means that the respective periods are nearly equal) and the *Hilda* group planets (3:2 resonance). However, other theoretically possible resonances show no or only very few examples in nature. There are for instance only three numbered objects corresponding to the 2:1 or *Hecuba* case. These three objects are characterized by rather high orbital inclinations (20° to 35°). In this connection it is also interesting to note the recent ESO discovery of the Trojan-type planet 1976 UQ (see *Messenger* No. 8) which has a very large inclination, 39°.

Schubart has called attention to the possibility of the existence of different kinds of resonant motions in orbits with high inclinations. This refers to the *Hilda* (3:2) and *Thule* (4:3) resonance types. Theoretical considerations show a certain analogy to the resonance between the major planets Neptune and Pluto. The orbital periods of these planets are approximately characterized by a 2:3 ratio, and the orbit of Pluto is highly inclined with respect to that of Neptune so that close encounters cannot occur. In the same way the possible asteroids of Hilda and Thule type can avoid close approaches to Jupiter, both because of the resonance and because of a high inclination. Especially, the parts of the orbits with the largest heliocentric distances are always far above or below the orbital plane of Jupiter.

A Search with the ESO Schmidt

Minor planet surveys require telescopes of considerable aperture and with sufficiently wide field. The Palomar Schmidt and the ESO Schmidt are very well suited for this purpose. In a cooperation between the Astronomisches Recheninstitut and ESO we have started a small-scale survey for high-inclination asteroids. Two such searches took place during September/October and December 1977. The first one was aimed at the discovery of Thule-type objects, the second one especially at Hilda's. No objects with the predicted resonant periods were found in either of the investigations. This is not too surprising in first attempts since the objects are certainly very rare if they exist at all. Otherwise they would already have been detected by chance on plates taken for other purposes. Further attempts to discover such objects are scheduled for the near future.

Even if the whole project should not lead to the discovery of the expected types, it will make a valuable contribution to our knowledge about the statistics of highly-inclined minor planets, as seen from the by-products of the first survey. The most surprising event was the discovery of Comet Schuster 1977o (see *Messenger* No. 11). Besides this, Schuster found the fast-moving planet 1977 RC, a *Pallas*-type planet with a = 2.7 AU, e = 0.46, and i = 30°. This asteroid headed further south from the discovery field at latitude –40° and reached –50° in October 1977. While it was followed to this latitude, two further planets appeared on the plates. They are probably of the so-called *Hungaria* group which is characterized by a small semi-major axis and a high inclination. Together with 1977 RC, we discovered six additional minor planets on the very first plates including another Hungaria asteroid and a new Phocaea-type object.

The December 1977 search comprised two fields centered at ecliptical latitudes of –58° and –51°. We discovered no moving objects. Nevertheless, this result is statistically important since the observed field is larger than the field of our first attempt. By-products at such very high latitudes may sometimes occur, as was demonstrated by the above-mentioned 1977 RC or, for instance, by Object Lovas, which was discovered late in 1977 at a northern declination of about 80 degrees. This object was first believed to be a comet (1977 t) but was later found to be a minor planet of Pallas type.

Our next survey is scheduled for September 1978 and will be under way when this note appears in print. We shall again look for Hilda's but at the more moderate latitude of about –42°. Hopefully, there will at least be some interesting Phocaea or Pallas objects this time.

ESO, the European Southern Observatory, was created in 1962 to . . . establish and operate an astronomical observatory in the southern hemisphere, equipped with powerful instruments, with the aim of furthering and organizing collaboration in astronomy . . . It is supported by six countries: Belgium, Denmark, France, the Federal Republic of Germany, the Netherlands and Sweden. It now operates the La Silla observatory in the Atacama desert, 600 km north of Santiago de Chile, at 2,400 m altitude, where nine telescopes with apertures up to 3.6 m are presently in operation. The astronomical observations on La Silla are carried out by visiting astronomers—mainly from the member countries—and, to some extent, by ESO staff astronomers, often in collaboration with the former.

The ESO Headquarters in Europe will be located in Garching, near Munich, where in 1980 all European activities will be centralized. The Office of the Director-General (mainly the ESO Administration) is already in Garching, whereas the Scientific-Technical Group is still in Geneva, at CERN (European Organization for Nuclear Research), which since 1970 has been the host Organization of ESO's 3.6-m Telescope Project Division.

ESO has about 120 international staff members in Europe and Chile and about 150 local staff members in Santiago and on La Silla. In addition, there are a number of fellows and scientific associates.

The ESO MESSENGER is published in English four times a year: in March, June, September and December. It is distributed free to ESO employees and others interested in astronomy.

Editor: Richard M. West
Technical editor: Kurt Kjär

EUROPEAN
SOUTHERN OBSERVATORY
Schleißheimer Straße 17
D-8046 Garching b. München
Fed. Rep. of Germany
Tel. (089) 3204041-45
Telex 05215915 eso d

Printed by Universitätsdruckerei
Dr. C. Wolf & Sohn
Heidemannstraße 166
8000 München 45
Fed. Rep. of Germany

ALGUNOS RESUMENES

Fue honrado astrónomo de ESO

En la publicación *Minor Planet Circular* No. 4358, publicada por el Centro en Cincinnati el 30 de abril de 1978, se puede leer el siguiente aviso:

Nuevo nombre para planeta menor

(2018) SCHUSTER = 1931 UC
Descubierto el 17 de octubre de 1931 por K. Reinmuth de Heidelberg.

Nombrado en honor de Hans-Emil Schuster, astrónomo del Observatorio Europeo Austral, quien observa activamente y ha descubierto planetas menores y cometas.

Investigación de Planetas Menores de inclinación elevada

La mayoría de los nuevos planetas que se descubren con los grandes telescopios se encuentran dentro o cerca del plano de la órbita terrestre, la eclíptica. En realidad sabemos poco sobre los objetos que presuntivamente existan muy por encima o muy por debajo de este plano.

Por esta razón, los Drs. Lutz Schmadel y Joachim Schubart del Astronomisches Recheninstitut en Heidelberg, República Federal de Alemania, han recientemente hecho una investigación de los asteroides débiles, resonantes del tipo *Hilda* y *Thule* en inclinación elevada con el telescopio Schmidt de 1 m de ESO en La Silla. Los astrónomos de ESO, Sres. Schuster y West, participaron en este programa.

Por largo tiempo ya se conocían asteroides con una resonancia entre sus períodos orbitales y aquel de Júpiter. Un caso típico son los asteroides del tipo *Troya* con una resonancia de 1:1 (lo que significa que los respectivos períodos son casi iguales).

Schubart ha llamado la atención sobre la posible existencia de diferentes tipos de movimientos resonantes en órbitas de inclinación elevada. Esto se refiere a los tipos de resonancia de *Hilda* (3:2) y *Thule* (4:3).

Se hicieron dos investigaciones, durante septiembre/octubre y en diciembre de 1977. La primera fue dedicada al descubrimiento de objetos del tipo *Thule* y la segunda especialmente a aquellos del tipo *Hilda*. En ninguna de las dos investigaciones fueron encontrados objetos con los períodos de resonancia anunciados. Esto no es sorprendente, ya que los objetos, en caso de existir, son sumamente escasos. Se han planeado más ensayos en un futuro cercano.

Sin embargo, aunque el proyecto no lleve al descubrimiento de los objetos esperados, contribuirá altamente a nuestros conocimientos sobre las estadísticas de planetas menores de inclinación elevada. Como sub-producto de esta primera investigación fueron descubiertos el Cometa Schuster 1977 o y seis nuevos planetas menores.

Fuentes de rayos X

Identificaciones ópticas de fuentes de rayos X

Nuevos datos de satélites han proporcionado una gran cantidad de trabajo altamente interesante en conexión con estrellas de rayos X a astrónomos ópticos. Un buen ejemplo es la investigación llevada a cabo por el satélite SAS-3 que obtuvo más de 50 posiciones precisas de fuentes de rayos X galácticas.

El trabajo fotométrico preliminar efectuado el año pasado por Jeffrey McClintock y colegas en el Cerro Tololo, seleccionó dos fuentes para un futuro estudio. En ambos casos se encontraron estrellas azules débiles con colores no usuales. Uno de estos ejemplares ópticos sugeridos, 4U 1626-67, fue investigado detenidamente por los Drs. Claude Chevalier, Sergio Ilovaisky y Christian Motch del Observatorio de Meudon, Francia, durante el mes de mayo del año en curso con el telescopio de 3,6 m de ESO. El otro, MXB 1735-44, fue estudiado en el Cerro Tololo. En ambos casos las observaciones ópticas mostraron que las estrellas propuestas eran efectivamente correctas: Para 4U 1626–67 una pulsación óptica exactamente en el período de los rayos X (7,68 segundos) y para MXB 1735–44 se observaron tres nítidas erupciones ópticas idénticas en tamaño y duración a las erupciones de rayos X, una de éstas sucediendo en exacta simultaneidad con una erupción de rayos X observada con el SAS-3.

La estrella doble de rayos X 4U 1700-37/HD 153919

Otra estrella, HD 153919, el duplicado óptico de la estrella doble de rayos X 4U 1700-37 con un período de 3,41 días, fue observada durante cuatro años por los Drs. Hammerschlag-Hensberge, E.P.J. van den Heuvel y sus colaboradores con los telescopios de ESO. HD 153919 es una de las estrellas más luminosas identificadas con una fuente de rayos X y el estudio de este objeto ya ha revelado algunos detalles interesantes con respecto a este sistema de estrellas dobles.

LATEST NEWS

The "Hilda-Thule" minor planet programme that is presently (September 1978) being carried out in collaboration between Heidelberg and ESO has yielded several new asteroids with peculiar motions (see page 19). Further news in the next issue.