lished (Tyson, Crane and Saslaw; *Astron. & Astrophys.*, **59** LIS, 1977) and a more definitive paper will be published in the *Astrophysical Journal* (see also ESO preprint No. 9).

The objects we have the most information about lie in the east radio lobe of 3C285, shown in Figure 1. The 15.5-magnitude galaxy in the centre has a redshift Z = 0.0797, putting it 320 Mpc away if the Hubble constant is 75 km s^{-1} Mpc. The galaxy is distorted, possibly by tidal interaction with nearby companions, and may even be of spiral type. It radiates about 3 x 10^{41} erg s^{-1} in the radio lobes, and the radio maps were made at 2.7 GHz with the Cambridge 5 km synthesis telescope.

In the centre of the radio lobe lies a 20.6-visual-magnitude optical object, which may be diffuse. Its optical emission is quite peculiar. The colours are very blue; using the 2.1 metre Kitt Peak telescope, we found photometric values B–V = 0.26 ± 0.4, U – B = –1.2 ± 0.5 magnitude. These colours are much more blue than normal Seyfert galaxies. They are the colours of quasars. Moreover, we also find that its radiation is 10 ± 5 % linearly polarized. This suggests it is optical synchrotron. Its power would be consistent with an extrapolation of the radio synchrotron emission into the optical regime. To produce optical synchrotron requires something on the radio lobe to generate highly relativistic electrons with $\gamma = (1-(v/c)^2)^{-0.5} \gtrsim 3 \times 10^6$.

There is another optical object in this radio lobe. It is of blue magnitude 23.6 and coincides with the region of peak radio emission to within one arcsecond. It is too faint to measure accurate colours or polarization with the KPNO 2.1 metre telescope, but we hope to find this information with the KPNO 4 metre. The probability of an optical object of 24th magnitude or brighter lying within one arcsecond of anywhere on our plate is about 3 x 10^{-3}.

The second radio galaxy we looked at, 3C265, is associated with a 20th-magnitude galaxy having redshift Z = 0.811. Figure 2 shows our plate with the Cambridge 2.7 GHz map superimposed. There is a remarkable choice of seven optical objects having about the same angular extent and position angle as the radio double. Again the strongest radio lobe coincides with an optical object, this time with B = 22.4 magnitude. We plan to measure its other optical properties in the near future.

The third radio galaxy, 3C390.3, is identified with a V = 15.4-mag N-type galaxy. One of the radio lobes, shown in Figure 3, is near a peculiar optical structure which points away from the central galaxy. An optical extension of this structure is seen to coincide with part of this radio lobe, which is itself double. A preliminary observation suggests the optical emission from this peculiar structure may also be polarized, but we want to repeat this measurement more sensitively.

The random probability of finding all these associations between optical objects and radio lobes is very small. But we plan to look at more radio galaxies to determine whether we have discovered the "tip of an iceberg" of information. If so, a new astronomical industry will soon arise, based upon radio, optical, and perhaps infrared, ultraviolet and x-ray emission from sources ejected by galaxies.

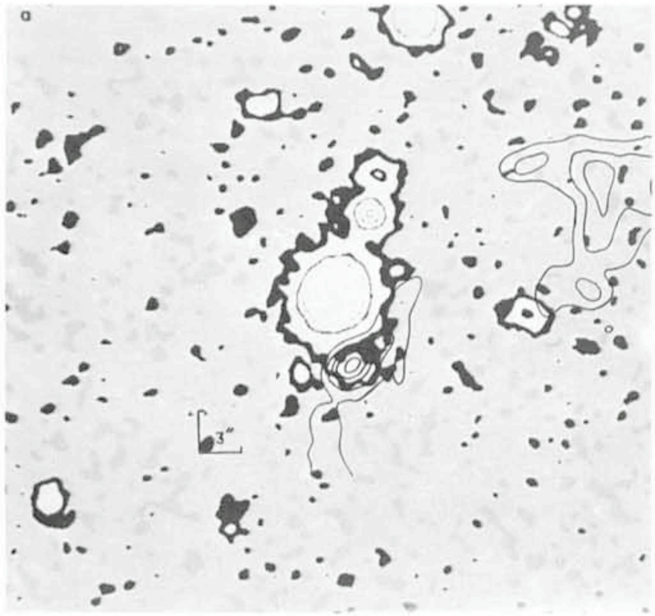

Fig. 3. — *This shows the north-west radio lobe of the radio galaxy 3C390.3. The galaxy itself is several minutes of arc away to the lower left. Several radio contours have been overlaid here to show a probable faint source just coincident with the radio peak. The bright object just above has V = 19.6 and the same redshift as the parent galaxy of 3C390.3. This picture is 45" across.*

Peculiar A-type Stars at ESO

H.-M. Maitzen and W. W. Weiss

The study of peculiar A stars is a fascinating chapter of modern astronomy. It combines measurements of light variability, variable spectral lines and magnetic fields. This review article by two Austrian astronomers, Drs. H.-Michael Maitzen and Werner W. Weiss from the Figl-Observatorium für Astrophysik (Vienna) discusses not only the observations, but also the attempts to explain theoretically the Ap phenomenon. It is probably true to say that the stellar models still are somewhat uncertain, but new and improved observational methods continuously refine the interpretation. The authors are frequent observers on La Silla.

Thirty years ago H. Babcock found for the first time a stellar magnetic field (78 Vir). Not quite as old is the history of Ap-star research at ESO. However, there exists already a long list of observational programmes in this field which were carried out at La Silla since ESO was founded. In what follows, we will try to give a very short historical background and our related contribution based on observations obtained at ESO.

Magnetic Fields

Babcock's observations for his famous catalogue of magnetic stars (1958) were made with a simple Zeeman analyzer in front of the slit of a coudé spectrograph which was designed by himself. This analyzer permits to separate left- and right-hand circular polarized components of stellar lines which are split by a magnetic field. Using the Landé g-factor and the measured shift between both components of a particular line, one can determine the longitudinal component of a stellar magnetic field averaged over the

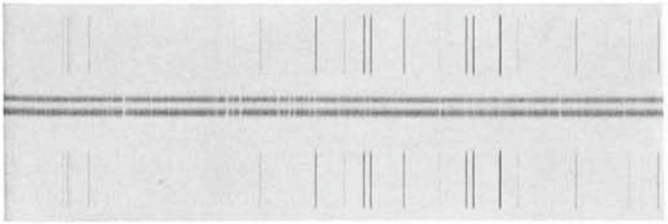

Fig. 1. — *HR 5049 Zeeman spectrogram (plate No. H348z, ESO 1.5 m coudé), IIa-O, 5^h31^m exposure time; observer H. J. Wood (March 26, 1971). Centre wavelength approx. 4200 Å, increasing wavelengths to the right.*

visible hemisphere. Typical Zeeman shifts for magnetic fields in the range of one kilogauss are of the order of a few microns if one observes with a Zeeman analyzer attached to the coudé spectrograph (3.32 Å/mm) of the 1.5 m telescope at La Silla. Exposures of about 6 hours are required for a star of 6^m. This Babcock technique was introduced at La Silla by Dr. H. J. Wood, while he was an ESO staff member. He started the first survey for southern magnetic stars in 1970. The excellent spectra which he obtained (fig. 1) require an adequate measuring and reduction technique. Both have been achieved meanwhile at the Vienna observatory. For a PDS-1000 microdensitometer controlled by a PDP-12 computer, software was developed (in cooperation with R. Albrecht, H. Jenkner and H. J. Wood) which enables us to measure line positions in photographic spectra with an accuracy of 0.2 micron and stellar magnetic fields (in the best cases) of the order of 50 gauss.

Those objects, where a magnetic field is measured (usually of the order of several hundred gauss up to several kilogauss), are nearly always identical with young stars of spectral type A. In addition, these stars show an unusual spectral behaviour. Especially Rare Earths, the Strontium and Iron group lines are enhanced and variable. Periods

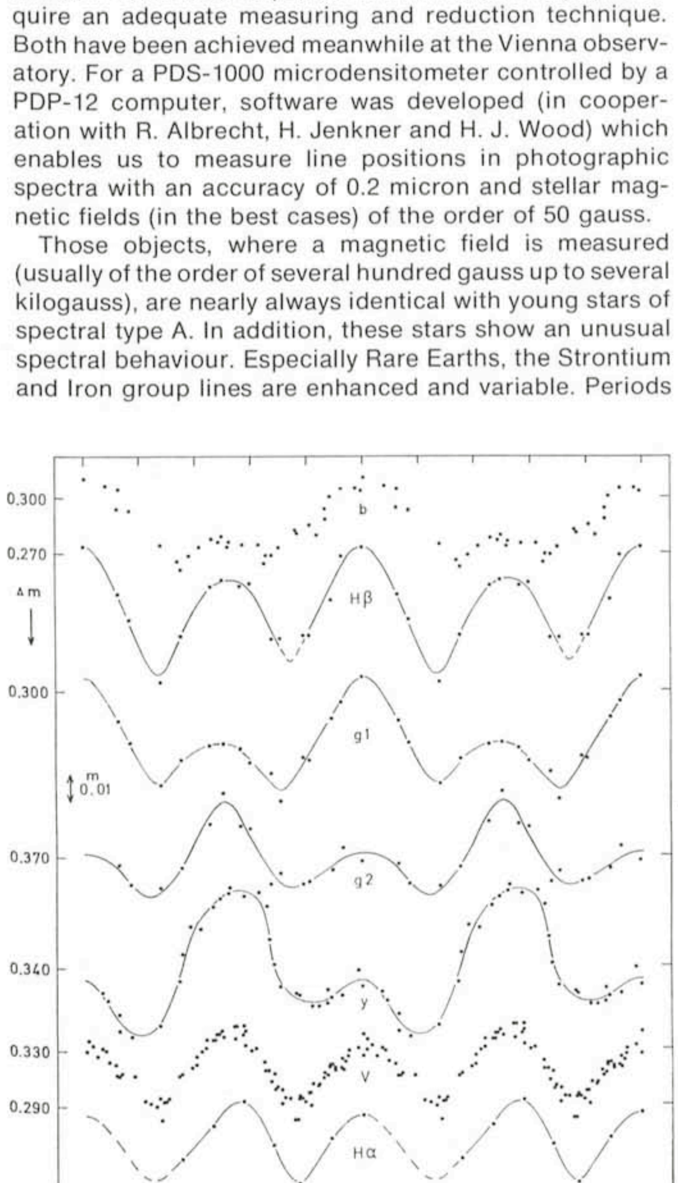

Fig. 2. — *Light curves of HD 125248 (Maitzen and Moffat, 1972).*

range from about one day up to hundred days. Parallel to the spectral variations the stars are also photometrically variable. The amplitudes of these light variations are of the order of several per cent. This is illustrated by measurements of the Ap star HD 125248, obtained at La Silla. Figure 2 shows the light curves in different colours. The characteristic features for the light curves are double waves, which also correspond to double variations in the spectra.

Astronomers already early found that the longitudinal magnetic field strengths are reversing in many cases and with the same period as the spectral and photometric variations. The maxima of the line variations were in phase with the maxima of the magnetic variations and also with those of the photometric light curves. Furthermore, an outstanding feature of Ap stars is the marked slow rotation, producing sharp spectral lines. All these phenomena justify to call these objects peculiar A stars.

The "Oblique Rotator"

In the early 1950s Stibbs and Deutsch created a simple model which to a large extent explains the phenomena just mentioned. This model, also referred to as "Oblique Rotator", is certainly one of the strongholds in the theoretical understanding of Ap stars up to now. It postulates the non-coincidence of the rotational and magnetic axes. Such a configuration causes a beacon effect and has also been used for treating the pulsar geometry. The magnetic poles and the associated patches of enhanced line intensities appear and disappear periodically. This results in radial velocity variations due to approaching and receeding spots. This oblique rotator model also allows us to understand very easily the double waves in light curves. These waves reflect the contribution of different parts of the stellar surface with different abundances, different temperature and effective gravity.

Using well-known mathematical techniques it is possible to calculate a map for the distribution of different elements in the atmosphere of Ap stars. Further spectroscopic analyses clearly demonstrate that the angle between the magnetic and rotational axes tends to be either 0° oder 90°.

The physical background for the photometric variations can be qualitatively explained by redistribution of the flux blocked in the UV by the presence of strong stellar lines. This mechanism explains why the observed brightness of Ap stars increases in the visible range although the spectral lines of elements typical for Ap-star atmospheres are also enhanced.

To be fair, we must stress the fact that quite a number of difficulties in the theoretical background have to be overcome for the oblique-rotator model, if one wants to explain all observational details. For example, in the case of non-sinusoidal magnetic field variations, decentred and sometimes non-aligned magnetic dipole fields are postulated. But how can such a field remain stable and be understood with our present knowledge of magnetohydrodynamics? In addition, there is hardly one effect described in this article which is *not* observed in some stars, even sometimes showing up in the *opposite* sense. More observations are needed!

Why are some A stars peculiar?

There remains the question why some 10 per cent of all A stars are peculiar. Related questions are:

- Why are magnetic fields almost exclusively found in A stars?

— Why do all these stars rotate slowly? Did a magnetic field brake the rotation already during star formation or is such a process going on during the main-sequence lifetime of the star?

There are two main theories to explain how A stars can become peculiar:

(1) Diffusion Theory

This theory is based on a selective effect of the radiation pressure relative to gravitation. Elements with more absorption lines will be lifted by the radiation pressure relative to other elements with few absorption lines, where gravitational forces prevail. This diffusion process requires a quiet atmosphere which implies slow rotation. Slow rotation is needed for this theory, diffusion does not explain it.

(2) Accretion Theory

Accretion works via a selective trapping of elements from the interstellar medium by a rotating magnetosphere. Roughly spoken, heavy elements penetrate deeper into the magnetosphere than light elements. This means that in the time scale of 10^8 years heavy elements will be found to be overabundant in the atmosphere. On the other hand, those light elements, which are not captured, are accelerated by the rotating magnetosphere, thus decelerating the stellar rotation.

Measuring "Peculiarity"

Generally spoken, observational evidence is required for the time span during which a peculiar atmosphere is being built up as well as for the evolutionary phase during which this mechanism is active. Hence, it is important to discuss the question whether old Ap stars do rotate more slowly than younger ones. It should be emphasized that more rotational periods are needed and also more data on the stellar ages, radius and v · sin i. Pioneering work in the field of period determination was done by K. D. Rakosch and for the southern hemisphere at ESO by observers from Bochum, Liège and Amsterdam. In addition, one needs sensitive criteria for the peculiarity of Ap stars. In this respect, the broad-band flux depression in the visual spectra of Ap stars can be used. Observations obtained at La Silla with photoelectric photometry demonstrate that there is a flux depression of about 300 Å width around 5200 Å with a depth of about 10 per cent depending on the peculiarity of the star. This flux depression is characteristic for Ap stars only. It enables us to survey even distant stellar clusters for Ap members and relate a degree of peculiarity to their age which can be determined by conventional techniques for clusters (figure 3).

Another aspect which we have investigated at ESO is the question of the stability of Ap-star atmospheres. There are two distinct groups of astronomers which have published different results for the photometric stability in the range of minutes up to several hours. One group found photometric and Balmer-line variations in a number of Ap stars which can be characterized as periodic, and where the mechanism might be pulsation, flickering or flare-like. Others found that in some cases the same Ap stars are stable and do not show any variations besides those due to rotation. Are these contradicting findings caused by an instrumental or extinction effect in our atmosphere, or do these stars switch on and off, or are only parts of their stellar atmosphere unstable, for example those around the magnetic poles?

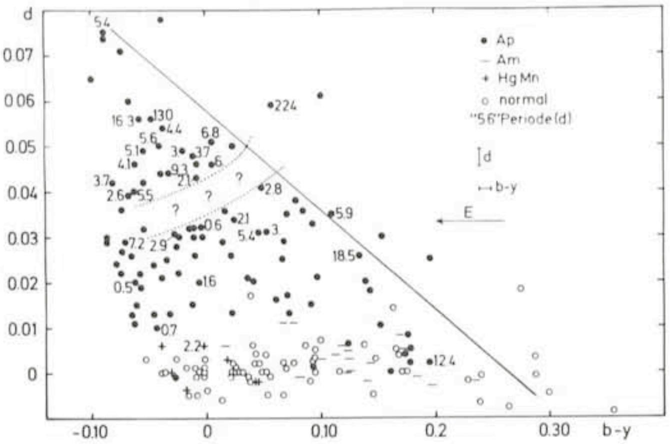

Fig. 3. — *Measurements (La Silla, 1973–74) of the peculiarity index Δd versus b-y. Error bars and the direction of the reddening vector are given, periods are in days (Physics of Ap-Stars, IAU-Coll. No. 32, Weiss et al., Eds.).*

However, if it is possible to demonstrate the existence of photometric variations in the time scale of up to some hours one can ask how diffusion is possible in such a dynamic atmosphere. In an observing run this summer, a sample of 21 Ap stars of different peculiarity has been observed and no variations larger than 0.004^m have been detected. As a by-product of this survey, two new bright δ Scuti type variables were discovered which originally were used as comparison stars.

The reader will find many question marks in this article. However, this is just the proof that Ap-star research is in a very active phase! Let us try harder!

NEWS and NOTES

The Sagittarius Dwarf Irregular Galaxy (SagDIG)

In the last issue of the *Messenger* we showed a picture of a new irregular galaxy in Sagittarius. Since then 21 cm hydrogen observations with the Nançay radio telescope have shown that it has a negative radial velocity, – 58 km s^{-1}. This is the same as the nearby member of the Local Group of Galaxies, NGC 6822, which is seen in almost the same direction. It is therefore likely that they have the same distance, 600 kpc (about 2 million light-years). In a letter to the journal *Astronomy & Astrophysics*, the Nançay and ESO astronomers Cesarsky, Laustsen, Lequeux Schuster and West write that SagDIG is "probably one of the smallest, faintest and less massive (irregular) galaxies known to date".

The Cluster of Galaxies STR 2232–380

In *Messenger* No. 10, Drs. A. Duus and B. Newell told about their new catalogue of southern clusters of galaxies. A photo of the cluster of galaxies STR 2232–380 accompanied their article. Dr. Duus asks us to mention that this cluster was discovered by MacGillivray and collaborators (1976, M.N.R.A.S., **176**, 649). We are happy to comply and would like to add that the photo of the cluster was reproduced (in October 1974) from ESO (B) Atlas plate No. 613, taken on August 20, 1974.

Planetary Nebula NGC 3132

In the same issue, Drs. Kohoutek and Laustsen showed photographs of the planetary nebula NGC 3132. We are sorry that the position was wrong: it should have been R. A. = $10^h\ 06^m$; Decl. = –40°, that is in the constellation of Vela (The Sail).