61 cm Bochum Telescope

Oct. 1982: Sterken Group.

Nov. 1982: Sterken Group.

Dec. 1982: Sterken Group.

Jan. 1983: Kohoutek, Sterken Group, Kohoutek, Pauls/Kohoutek, Sterken Group.

Feb. 1983: Sterken Group.

PERSONNEL MOVEMENTS

STAFF

Arrivals

Europe

KERK, Elizabeth (NL), Administrative Assistant (Personnel), 1. 9. 1982

STOFFER, Christina (CH), Secretary/Typist (Scientific Division), 1. 11. 1982

Chile

GILLIOTTE, Alain (F) Optical Technician (TRS), 13. 9. 1982

Departures

Europe

BUCHER, Beate (D), Secretary (Personnel), 30. 9. 1982

VERSCHUREN, Rita (B), Secretary (Scientific Division), 17. 9. 1982

Chile

SCHNUR, Gerhard (D), Astronomer 30. 9. 1982

LE SAUX, Paul (F), Systems Analyst/Programmer (TRS), 31. 10. 1982

FELLOWS

Arrivals

Europe

RICHTER, Otto-Georg (D), 1. 9. 1982

BANDIERA, Rino (I), 1. 10. 1982

OLIVA, Ernesto (I), 1. 10. 1982

Departures

FERLET, Roger (F), 30. 9. 1982

ASSOCIATES

Arrivals

Europe

FREDRICK, Laurence (USA), 6. 7. 1982

CHEN, Jian Sheng (Chinese), 12. 7. 1982

CHOUDRY, Amar (USA), 1. 9. 1982

LUCY, Leon (UK), 1. 9. 1982

SALVATI, Marco (I), 1. 11. 1982

Departures

Europe

MILLER, Richard (USA), 30. 9. 1982

Observations of Bipolar and Compact H II Regions

T. Neckel, Max Planck Institute for Astronomy, Heidelberg

Several investigations carried out during the last years at the Max Planck Institute for Astronomy in Heidelberg have dealt with the bipolar compact H II region S 106. The essential structural features of this object are: (i) There is only a single exciting star in the centre of the nebula, (ii) this star is surrounded by a disk of dust that we are seeing edge on. This disk of dust divides the nebula into two "lobes". It causes a visual extinction of the central star of about 20 magnitudes, for which reason it can be photographed only at infrared wavelengths (Eiroa, C., Elsässer, H., and Lahulla, J. F. 1979, *Astronomy and Astrophysics* **74,** 89), whereas the light of the central star can get through the disk in the perpendicular direction. A digitized near infrared photograph of S 106 taken by Elsässer and Birkle with the 1.23 m telescope of Calar Alto is shown in Fig. 1.

S 106 is associated with a massive molecular cloud containing OH and H_2O masers. From spectroscopic observations Solf (1980, *Astronomy and Astrophysics* **92,** 51) has shown that the ionized gas is flowing radially toward the polar lobes at supersonic speed. The kinematic age is about $5 \cdot 10^3$ yr. These observations and the structural properties support the idea that S 106 is an H II region in a very early stage of evolution excited by a star recently formed out of a disk-shaped cloud which is probably rotating around an axis perpendicular to it.

Among the H II regions compiled in the Sharpless catalogue there is no other object of the same kind. Only a few objects show some similarity to S 106, for example S 269 and S 270. The distance to S 106 is about 500 pc, and its angular diameter is approximately 2 arcmin; consequently more distant objects of comparable linear size are too small for recognition in available H II catalogues. In order to get—if possible—a more extensive sample of similar objects H. J. Staude and I have carefully searched the Palomar atlas for bipolar and related objects. Since the typical appearance of a bipolar nebula is found only if we are looking edge on onto the disk of dust, "monopolar" nebulae may also be bipolar. The best example is the R Monocerotis nebula, which looks like the southern lobe of S 106. Cantó, Rodriguez, Barral and Carral (1981, *Astrophysical Journal* **244,** 102) have shown that this nebula is bipolar, and that the second lobe is optically obscured by the disk of dust.

At present we have compiled a list of 40 possible bipolar nebulae found on the Palomar atlas. Some of them are very likely genuine bipolar nebulae. Others resemble the R Monocerotis nebula, probably they are halves of bipolar nebulae. During the last 3 years we have carried out several observing programmes in order to get information concerning the nature of these objects. We will now consider the first results for three of them shown in

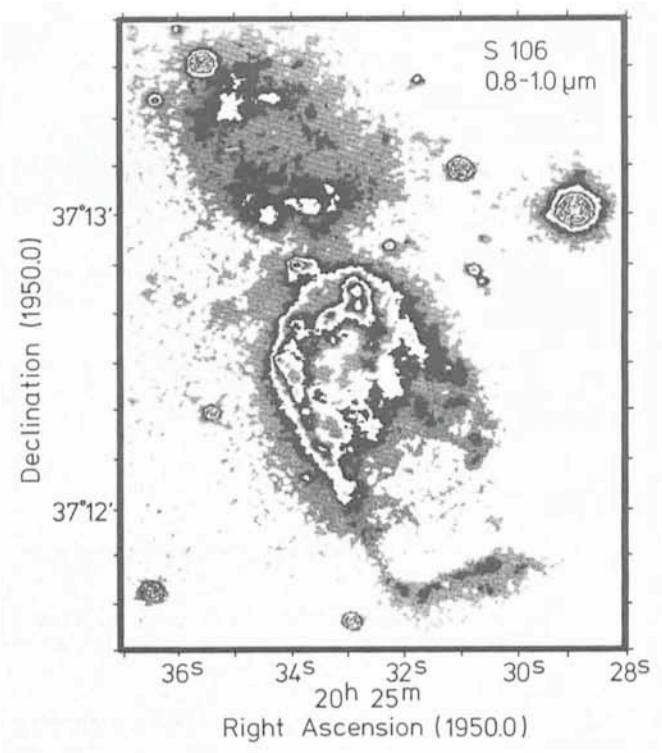

Fig. 1: *A digitized photograph of S 106 taken by H. Elsässer and K. Birkle at the 1.23 m telescope of Calar Alto.*

Fig. 2a – 2c (enlargements from the Palomar atlas). The most typical bipolar nebula in this sample is the first one, with the preliminary designation Anon 6^h56^m 7-4°. A digitized red photograph of this object, taken by K. Meisenheimer with an image-tube camera attached to the 2.2 m telescope of Calar Alto is shown in Fig. 3. The resemblance to S 106 (see also Staude, H. J., Lenzen, R., Dyck, H. M., and Schmidt, G. D., 1982, *Astrophysical Journal* **255,** 95) is very striking. At present we don't have an infrared photograph for this object and no image from the exciting star which is probably located within the central dust lane.

Early information concerning the hidden star was obtained from a spectrum taken in October 1980 at the ESO 1.5 m telescope, shown in Fig. 4a. This spectrum contains the Hα and Hβ lines, but not the forbidden lines of [O III] at 4959 Å and 5007 Å. From the known relationship between the ratio [O III] / Hβ and the spectral type of the exciting star (see for example Chopinet, M. and Lortet-Zuckermann, M. C. 1976, *Astronomy and Astrophysics, Supplement Series* **25,** 179), one infers a spectral type B0 or later for this star. Additional information was obtained with the 100 m radio telescope in Effelsberg in cooperation with Dr. Chini and Dr. Wink of the Max Planck Institute for Radio Astronomy. At 6 cm (4.8 GHz), a source was found exactly in the centre of the dust lane. The flux of this source is S (4.8 GHz) = 0.05 Jy. Since the 2.8 cm receiver at the 100 m telescope came out of order when we started to observe the nebula at 2.8 cm, we can't decide whether this nebula is optically thin or not. However, in the absence of these additional observations we *assume* the nebula to be optically thin so that we may apply the relation between the radio continuum flux S_ν and the number of Lyman continuum photons N_c' emitted by the exciting star as given by Mezger, Smith and Churchwell (1974, *Astronomy and Astrophysics* **32,** 269):

$$N_c' = 4.761\ 10^{48}\ a(\nu, T_e)^{-1} \left[\frac{\nu}{\mathrm{GHz}}\right]^{0.1} \left[\frac{T_e}{\mathrm{K}}\right]^{-0.45} \left[\frac{S_\nu}{\mathrm{f.\,u.}}\right] \left[\frac{d}{\mathrm{kpc}}\right]^2$$

For T_e we assume the quite common value 8,000 K. If we take the numbers for N_c' given by Panagia (1973, *Astronomical Journal* **78,** 929) for different spectral types, we find the distance d for a given spectral type.

We obtain an independent relation between spectral type and distance from infrared measurements carried out by R. Lenzen and myself at the 1.23 m telescope of Calar Alto. These observations are shown in Fig. 5a. Unfortunately it is not possible to get an unambiguous solution for spectral type, extinction and distance from these measurements. For nearly all spectral types one can find combinations of extinction and distance which allow a fit of the observations. One simultaneously determines the extinction A_V and distance modulus $a = 5 \log d - 5$ from a least square fit of the linear equation

$$\Delta_\lambda = a + A_V X_\lambda, \text{ where}$$

Δ_λ is the observed magnitude minus absolute magnitude corresponding to the chosen spectral type, and X_λ is the interstellar extinction law, for which we use Schild's curve (1977, *Astronomical Journal* **82,** 337).

In the case of our nebula Anon $6^h56.7^m$-4° we use only the J,H,K measurements to find these A_V, d combinations since an IR excess seems to be present in L, probably caused by radiation from hot dust. This relation between spectral type and distance is also shown in Fig. 6. It

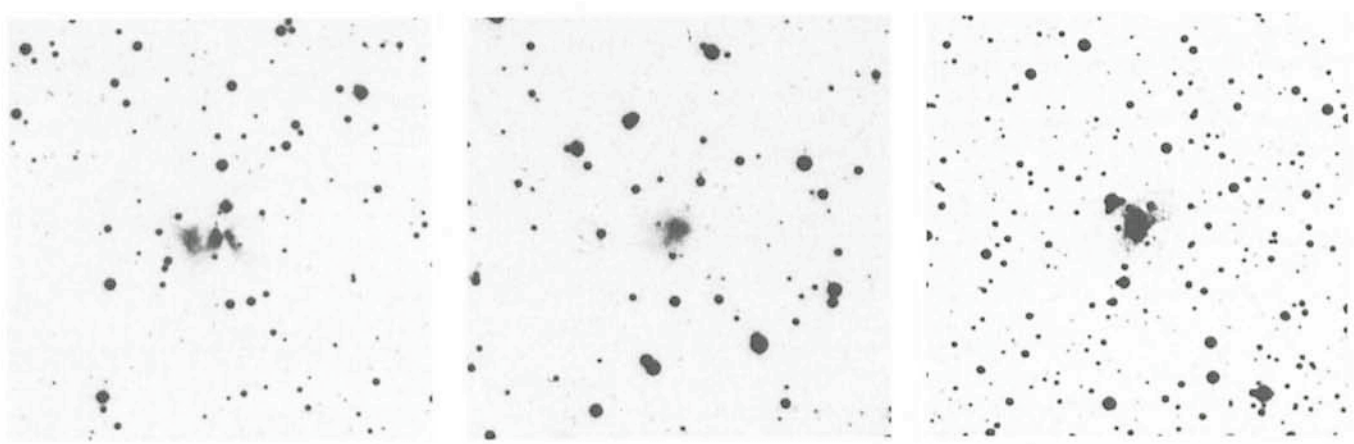

Fig. 2: *The objects Anon 6^h56^m7-4°, S 270 and Anon 6^h41^m3-1° (reproduced from the Palomar Sky Survey, 1 mm = 6.6 arcsec).*

Fig. 3: *A digitized photograph of the object Anon $6^h56^m.7-4°$ taken by K. Meisenheimer at the 2.2 m telescope of Calar Alto.*

intersects the $d(S_{4.8\ GHz})$ curve at spectral type B0.5 in agreement with the spectral type otained from the [O III] / Hβ ratio. The most probable values for the central star are therefore: spectral type B0.5 V, visual extinction $A_V = 13.7$ magnitudes, d = 1.4 kpc. From the apparent diameter of 50 arcsec results a linear diameter of 0.35 pc which is nearly the same as the diameter of S 106. A further similarity to S 106 is the low galactic latitude of $b = -0.1°$.

The next object is the very small H II region S 270. Its appearance on the Palomar atlas blue print is that of two diffuse spots of similar size (Fig. 2b). The spectrum (Fig. 4b) is that of a low excitation H II region. From the absence of the [O III] lines we conclude that the exciting star is of spectral type B0 – B2. The energy distribution of the object, again measured on Calar Alto, in the UBVRIJHKL passbands is shown in Fig. 5b. In L an IR excess is present again. However, it is also impossible to find a fit through UBVRIJHK alone. The best explanation seems to be the one illustrated in Fig. 5b, which corresponds to a B1 V star with $A_V = 12.2$ magnitudes and d = 1.7 kpc, resulting from J,H,K alone. The observed intensities in

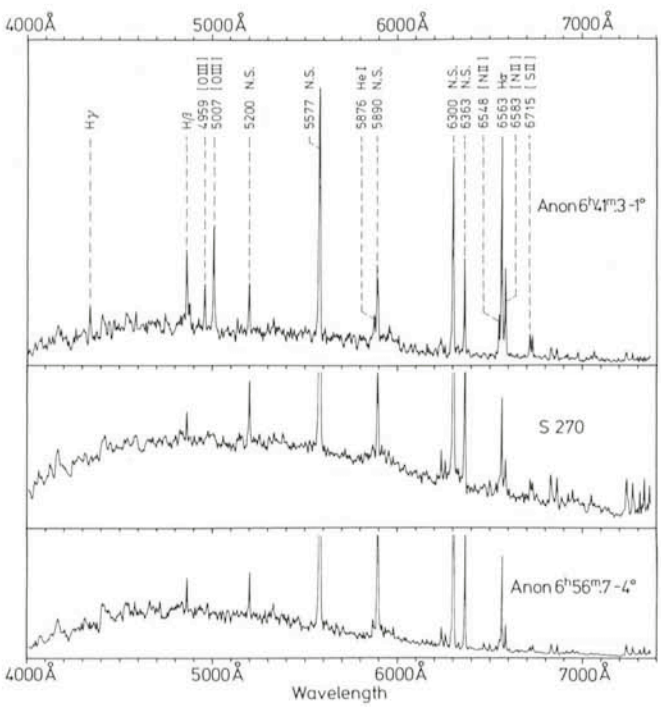

Fig. 4: *PDS spectral scans of the objects discussed in this paper taken with the Boller and Chivens spectrograph at the ESO 1.5 m telescope. The ordinates give log density.*

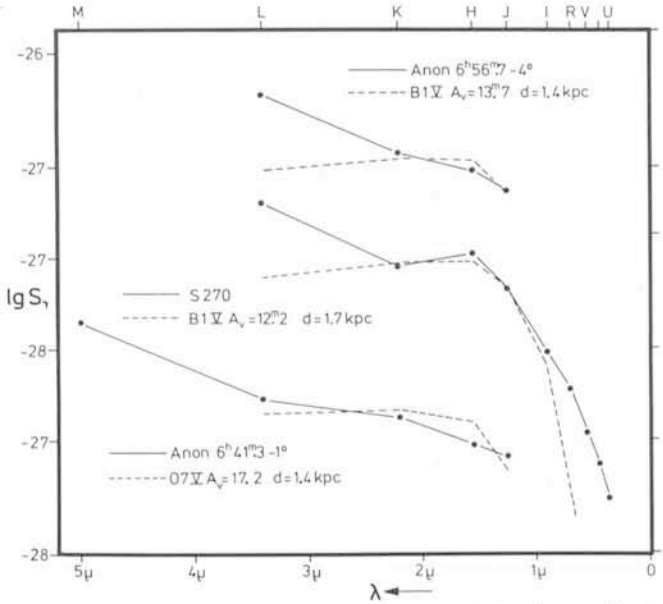

Fig. 5: *The observed energy distributions of the three objects (solid lines) and the computed fluxes for the stated combinations of spectral type, visual extinction and distance.*

UBVR are much higher than the computed values from the above combination of spectral type, extinction and distance. Possibly we see at these wavelengths predominantly scattered light from the central star; this assumption is strengthened by the fact that the spectrum shows a strong continuum in addition to the emission lines.

The spectrum of the third object, Anon $6^h41^m.3-1°$, shows strong [O III] lines. From the ratio [O III] / Hβ ~ 2 follows a spectral type of O7 for the exciting star, which is visible on the POSS infrared print. Its energy distribution in the range J,H,K,L is compatible with a star of spectral type O7 V, $A_V = 17.2$ magnitudes and a distance d = 1.4 kpc. An infrared excess appears in M only. The linear diameter of this nebula is also 0.4 pc, very similar to the diameters of S 106 and Anon $6^h56^m.7-4°$. Whether this nebula is half of a bipolar nebula or not must be clarified by further observations.

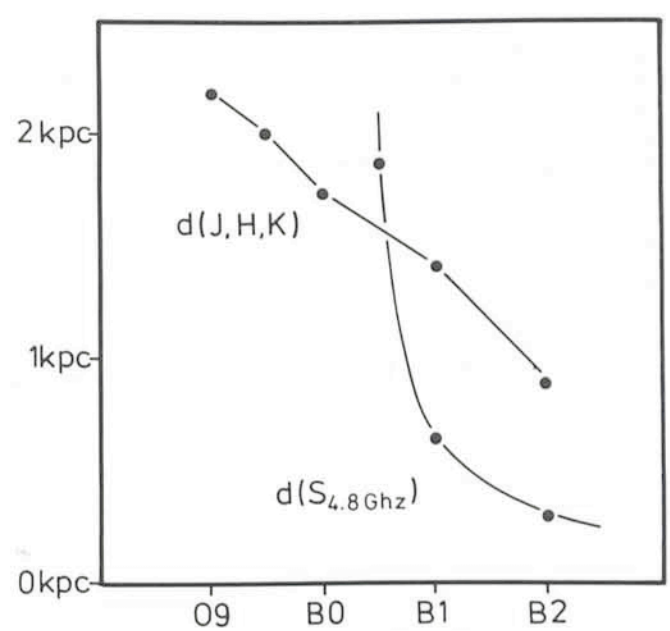

Fig. 6: *The relationship between the distance of the object Anon $6^h56^m.7-4°$ and the spectral type as derived from the J,H,K data and from the 4.8 GHz flux.*