Radial Velocity Observations with the 36″ Telescope at Cerro San Cristobal, Santiago, Chile

C. Sterken, Astrophysical Institute, Brussels, and N. Vogt, Universitäts-Sternwarte, München

Around the end of last century there was an urgent need for systematic determinations of radial velocities of southern stars. W.W. Campbell at Lick Observatory therefore organized an astronomical expedition with the aim to install an observatory with a radial velocity telescope in Chile. D.O. Mills provided the funds to make a replica of the Lick Observatory 36″ telescope, and donated the dome and expedition costs.

A 850 m high hill in a chain near Santiago was selected as observatory site, mainly for the adequate location and the presence of logistic support from the town of Santiago. The expedition was initially planned for three years (1902–1905), but the interesting results prompted the initiators to keep the station functioning until 1928. The results were published in the famous radial velocity catalogues in the Lick Observatory Bulletins.

In 1928 Manuel Foster bought the observatory and donated the instruments and the building to the Universidad Católica de Chile. At that time, the 36″ telescope was still the largest one operating in the southern hemisphere, and the tenth all over the world. During the following two decades astronomers of the Catholic University (especially Dr. Erich Heilmeier) used the telescope for spectroscopy of β Cep stars and other variables. However, increasing technical and economic problems forced them to shut down the observatory in 1948, and for more than 30 years the telescope was not used for scientific purposes. In 1980 it was put again into operation with the original one-prism Cassegrain spectrograph mounted. Also telescope and dome are still in their original form of 1902, but perform satisfactorily (Fig. 1).

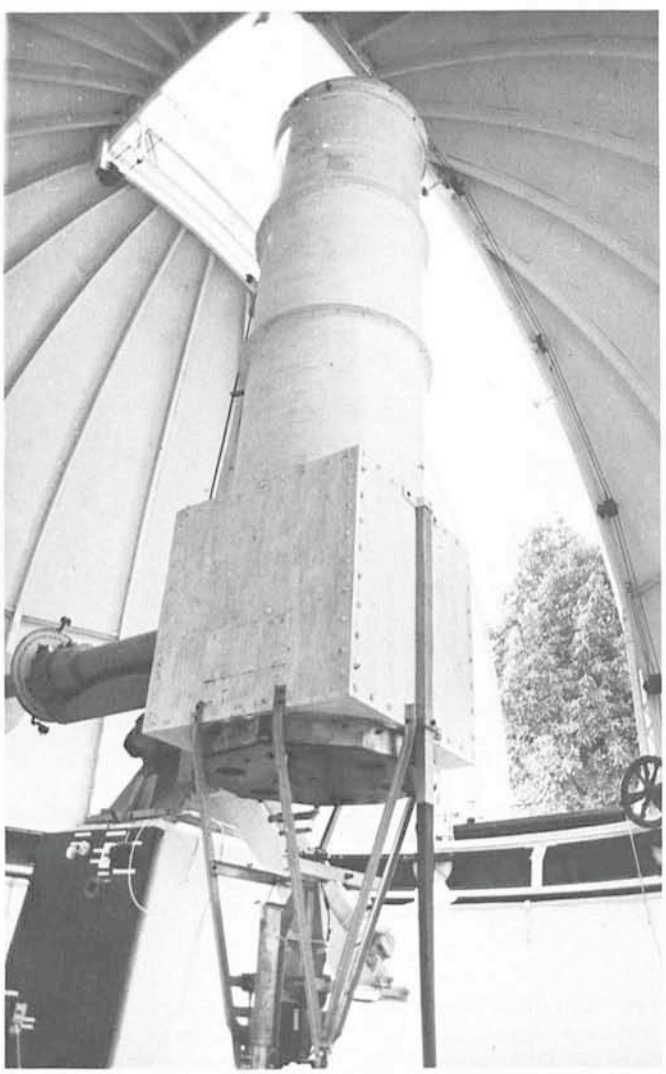

Fig. 1: *The 36″ Mills telescope at Cerro San Cristobal, Santiago, Chile. (Photograph by C.E. Le-Cerf.)*

The telescope has a main mirror of 92.9 cm diameter, and a focal ratio of f/18. On IIa–O plates a spectral range 3900–5000 Å can be covered. The dispersion at Hγ is 36 Å/mm. The exposure time for a 7^m star with 0.5 mm widening is typically of the order of 1 hour. Even for larger exposures up to 3 hours no influence of the city light of Santiago can be noticed in the spectrograms.

Several observing programmes are now executed in collaboration with the Instituto de Astrofísica at the Universidad Católica. The main subjects are observations of RS CVn stars, WR stars and β Cephei stars. The last programme consists of systematic observations of the brightest β Cephei stars and β Cephei candidates. During a photometric search for new β Cephei stars amongst the southern B stars listed in the Bright Star Catalogue (see i. e. the *Messenger,* No. 11, p. 5–7, 1977), M. Jerzykiewicz and C. Sterken found several new β Cephei stars. Some stars, however, are too bright to be observed photometrically (i. e. ζ CMa, α Pyx), or have a companion which is too close (HR 3142–3143, 17″ separation) to allow accurate differential photometry. Bright stars are excellent targets for the Mills telescope, because monitoring bright stars optimizes the ratio exposure time to pointing time. Until now hundreds of plates have been taken of objects such as ζ CMa, α Pyx, τ CMa, δ Cru, etc. All plates are secured by Gaston Le-Cerf Basulto and Esther-Maria Acunã, two technicians from the Universidad Católica.

The plates are sent to Garching monthly, and are measured on the Grant machine by one of the authors. Fig. 2 illustrates the radial velocity curve of α Pyxidis on the night of March 16/

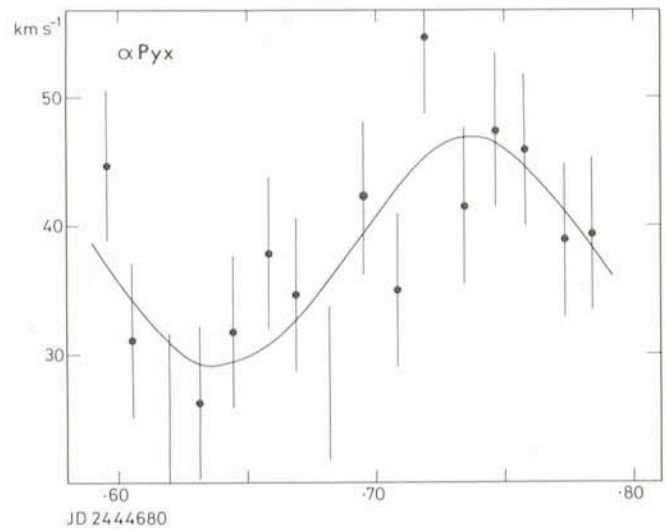

Fig. 2: *Radial velocity curve of α Pyx.*

17, 1981. The data points represent the mean value of the heliocentric velocity of the He 4143, 4388 and 4471 lines, and the solid line is the least squares sine curve fitted to the individual points. The mean error on each point is estimated to be of the order of 5–6 km s^{-1}. The range of radial velocity variation is about 20 km s^{-1}, and a probable period of .19 day (approximately 5 hours) is obtained from the fit. uvbyβ photometry of α Pyx yields a β-index β = 2.606 and a reddening corrected temperature index Co = .034, values very representative for a β Cephei star. The quasi-sinusoidal radial velocity variation found on JD 2444680 seems to support the suggestion that α Pyx is a reliable β Cephei candidate. The final evaluation of all available plates will probably give more indications concerning its nature. A detailed study of the star will be undertaken using the 1.5 m telescope at La Silla in 1983.

It is clear that the frequent use of an instrument like the Mills telescope may contribute enormously to increase the efficiency of searches and surveys and it may give important hints for planning observational research at larger telescopes. In addition, it offers the possibility of extended spectroscopic runs, allowing to follow the same star for several weeks or months. This kind of programme can never be executed at La Silla or similar observatories with a tight visitors schedule. Finally, simultaneous photoelectric (La Silla) and spectroscopic (San Cristobal) observations of brighter stars over relatively large time intervals would also be of great scientific interest, as shown above by means of the β Cephei candidates.

There is some hope that the actual one-prism spectrograph may be replaced by a modern fast instrument in the future. Such a development would surely encourage European observers to apply for observing time.

A New and Interesting Seyfert 2 Galaxy: NGC 5728

M.-P. Véron, P. Véron, M. Tarenghi and P. Grosbøl, ESO

NGC 5728 is an SBb galaxy; its galactocentric radial velocity is 2,710 km s^{-1} with H_0 = 50 km s^{-1} Mpc^{-1}, its distance is 54 Mpc and 1″ = 262 pc. The central structure of NGC 5728 is curiously asymmetric; a high luminosity nucleus sits within a high-surface brightness ring (dimensions 7″.5 × 10″.0 or 2.0 × 2.6 kpc); but the nucleus is displaced from the centre towards the east (Sandage and Brucato 1979, *Astronomical Journal* **84,** 472; Rubin 1980, *Astrophysical Journal* **238,** 808).

Within 2 arcsec of the nucleus, strong lines of Hα, [N II], [S II] and [O III] are observed, with [N II]λ6584 marginally stronger than Hα; weaker lines are also present ([O I]λλ6300, 6364 and [Ar III]λ7136); in the nuclear region, the Hα and [N II] emission lines are split into multiple components; the emissions continue beyond the nucleus through the region of the nuclear ring. Nuclear emission is intense; emission from the ring is weak. (Rubin 1980; Sandage 1978, *Astron. J.* **83,** 904).

According to Rubin, the velocity distribution in the ring can be fitted with a model with rotation plus axisymmetric expansion; this model implies a constant rotational velocity near V = 300 km s^{-1} and an expansion velocity decreasing from 275 to 150 km s^{-1} from r = 0.65 to r = 1.3 kpc and to zero at r = 2 kpc (r is the distance from the centre). Simple energetic considerations show that velocities radial from the nucleus with V ~ 250 km s^{-1}, decreasing to zero near 2 kpc imply a nuclear mass (r < 2 kpc) ~ 1×10^{10} $M_\odot$; this value agrees well with the mass deduced from the rotational velocities.

A spectrum exposed for 20 minutes, obtained on 12 August 1980, with the Image Dissector Scanner (IDS) and the Boller and Chivens spectrograph attached to the 1.5 m ESO telescope at La Silla, with a dispersion of 171 Å mm^{-1} (resolution ~ 10 Å FWHM) and a 4 × 4 arcsec aperture shows that the nucleus has the Seyfert 2 characteristics: [N II] λ 6584 ~ Hα and [O III] λ 5007 ≫ Hβ (Fig. 1).

The heliocentric radial velocity of the emission lines as measured on this spectrum is V = 2,760 km s^{-1}, close to the systemic velocity measured by Rubin, V_0 = 2,800 km s^{-1}.

Two spectra have been obtained with the IDS and the Boller and Chivens spectrograph at the ESO 3.6 m telescope, on 10 February and 5 August 1980, with a dispersion of 29 Å mm^{-1} (giving an instrumental profile of 1.6 Å FWHM), with a 2 × 4 arcsec aperture (with the large dimension in the EW direction), in the spectral range 4600–5100 Å. The emission lines (Hβ and [O III] λλ 4959, 5007) have a simple profile, with broad wings; their FWHM is 350 km s^{-1}. The radial velocity of the peak of these lines is V ~ 3,000 km s^{-1} (Véron 1981, *Astronomy and Astrophysics* **100,** 12).

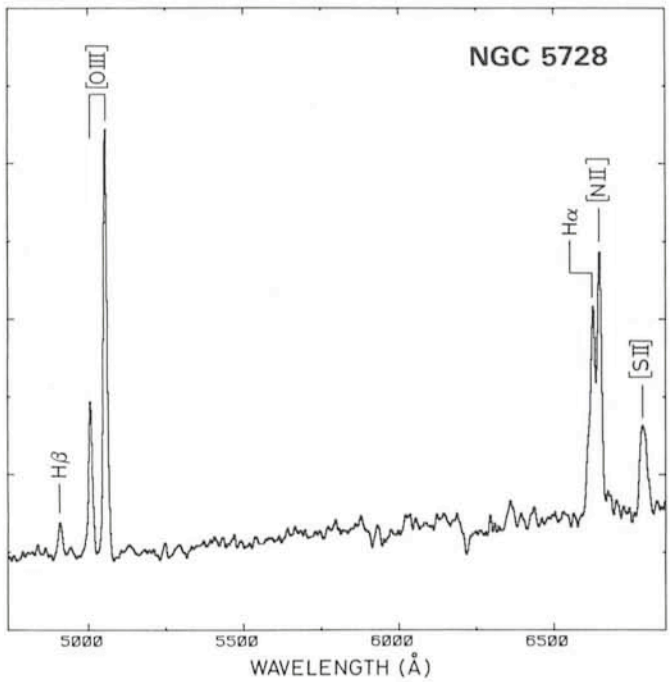

Fig. 1: *Spectrum of the nucleus of NGC 5728 obtained with the Image Dissector Scanner and the Boller and Chivens spectrograph attached to the 1.5 m ESO telescope. The resolution is about 10 Å. This spectrum shows that NGC 5728 has a Seyfert 2 nucleus.*

More recently, on 23 March 1982, we observed again this nucleus with the 3.6 m telescope, in the red. The dispersion was 60 Å mm^{-1}, the aperture 4 × 4 arcsec. On this spectrum, all lines are double with a separation of about 10 Å; the radial velocity of these two components is 2,520 and 3,000 km s^{-1} respectively (Fig. 2).

This seems to indicate that the gas in the nucleus has a radial velocity of 3,000 km s^{-1}, larger by 200 km s^{-1} than the systemic