Nordström, van Paradijs/van der Klis, Ilovaisky/Chevalier/Angebault/Mouchet/Pedersen.

50-cm Danish Telescope

November 1986: Kubiak/Seggewiss, Sterken/vander Linden.
December 1986: Sterken/vander Linden.
January 1987: Lodén K., Lindgren/Ardeberg/Maurice/Prévot/Lundström.

90-cm Dutch Telescope

October 1986: Gautschy, Schneider/Weiss.
November 1986: van Paradijs/Mayor/Verbunt/Zwaan, Trefzger/Pel/Blaauw.
December 1986: Trefzger/Pel/Blaauw, Lub/de Ruiter, de Loore/David/Blaauw/Verschueren/Hensberge.
January 1987: de Zeeuw/Lub/de Geus/Blaauw, v. Amerongen/v. Paradijs, Grenon/Lub.
February 1987: Grenon/Lub.
March 1987: Waelkens/Heynderickx.

61-cm Bochum Telescope

October 1986: Weiss/Schneider, Bianchi/Cerrato/Grewing/Scales.
November 1986: Bianchi/Cerrato/Grewing/Scales, Kohoutek/Steinbach.
December 1986: Kohoutek/Steinbach.

Hunting Halley's Comet

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Observers of bright comets have always been fascinated by the sight of these rare phenomena. However, it was as late as the 19th century that scientists started to make systematic observations of the appearance of comets and recorded them in the form of drawings and descriptions of comas and tails. Halley's comet in particular was observed intensively because the time of its return was well known. The first photographic observations of the comet were made during its 1910 perihelion. A large number of photographs were taken using astronomical instruments of all dimensions showing structures within the extended ion tail and the bright coma. Pictures from that time are well suited to be compared with recently obtained images of the 1986 appearance, although observing conditions were then much less favourable. Just when P/Halley was most active, at its brightest, and thus most interesting, namely during its perihelion passage, it was behind the Sun and unobservable. During the 2,000 years that observations of this comet have been recorded, there was only one appearance where the positions of Sun, Earth and comet were even worse for observations. In addition, the observing conditions in the northern hemisphere were extremely bad because at its best time the comet followed its path through the southern skies. Thus the only way to observe P/Halley successfully after its perihelion passage was to got to the southern hemisphere. At a latitude of 30 degrees south the comet culminated near the zenith.

Figure 1: *Comet P/Halley in the morning twilight of February 22, 1986, 9 : 01 UT from La Silla. Camera 1 : 2/110 mm, filter OG 530, IIIa–F hypersensitized, exposure time 3 minutes.*

The author and some colleagues from the Astronomical Institute of the Ruhr University in Bochum (FRG) were very interested in observations of P/Halley. Although solar system bodies are not the main field of work in our institute, a new small study group was set up to prepare, implement and evaluate observations of this comet. Collaborators are P. Koczet, Prof. W. Schlosser, R. Schulz, K. Weissbauer and the author. This was in February 1985, exactly 12 months before the approximation of P/Halley to the Sun. Thus time was short. A scientific observing programme demands extensive deliberation and preparation in order to produce new knowledge about the object. An important question was how to finance the campaign. Towards the end of June 1985 an application to the "Deutsche Forschungsgemeinschaft" was made for financial support of the project. This support was granted in September 1985. Now there was only little time left to acquire all the necessary instruments and equipment because we wanted to start the observations as early as possible after the perihelion which was on February 9, 1986. It was decided to restrict the campaign to photographic photometry and the investigation of structures in the coma and tail of P/Halley.

Determination of the brightness distribution across coma and tail is only valid if certain components of cometary matter are considered. Thus four wide-field cameras were used to take plates simultaneously in the light of the neutral CN molecule at 3880 Å wavelength using an interference filter of 50 Å bandwidth, in the light of the ionized CO^+ molecule at 4260 Å (filter bandwidth 100 Å), of the dust tail using a long-wave pass filter at 5300 Å, and of the ion tail with a filter combination resulting in a spectral range from 3750 to 4500 Å. To obtain a field of view of 30 degrees we used cameras of the format 6 × 6 cm and 6 × 6 objectives of the focal length 110 mm and a focal ratio of f/2. For the photographic emulsion we chose fine-grain hypersensitized IIIa–F. The optical filters for the wide-field images have a diameter of 65 mm and were set in front of the optics.

In order to study the structures within the cometary coma with high spatial resolution, we acquired a Flat-Field Camera 1 : 4/760 mm with a field of view of 1.8 × 2.7 degrees if 35 mm film is used. This instrument too was equipped with optical filters to obtain images in CN, CO^+ and of the dust coma. Photographs with this camera were taken with 103a–E, a–F and TP 2415 35 mm film, all hypersensitized.

From an amateur we bought a used but very stable parallactic mounting which is controlled by stepping motors in both right ascension and declination. Velocities in both directions were adjusted to follow the comet automatically as well as possible. A refractor with focal length 1,000 mm and f/10 served as a guiding telescope. It was modified to give an enlargement of 150–200 × and a field of view of 25 arcminutes.

The location of our observations was the ESO observatory at La Silla where our institute has a telescope of its own (diameter 61 cm, f/15) and where a complete infrastructure exists. There the comet could be observed optimally and multiple tail was a result of some isolated eruptions of gas and dust from the cometary nucleus. The maximum tail length visible to the naked eye was approximately 15 degrees; on the wide-field images the ion tail was sometimes longer than 25 degrees. One of the most interesting phenomena can be seen in the image of the CO^+ tail from March 10. It is a so-called disconnection event. Reasons for this event are still not completely understood. Perhaps the Bochum Halley campaign can help to solve this problem. At the beginning of April the comet moved along its path through the galactic disk – a very impressive sight but a handicap for the investigation. The surface brightness of the Milky Way in the background was partly higher than that of the comet tail and disturbs the interpretation of the images taken at that time. By mid-April, ion and dust tail of P/Halley had very well separated. They pointed to directions differing by approximately 90 degrees, a result of the altered geometry between Sun, Earth and comet.

During a total of 60 observing nights from February 17 to April 17, we were able to obtain more than 1,200 images of the comet in four different spectral ranges, most of them being of high quality. Exposure times lay between 10 seconds and 170 minutes. These images are now being analysed in Bochum with regard to two aspects: (1) investigation of the dynamics in coma and tail and the connections to the rotational period of

Figure 2: *Comet P/Halley on March 10, 1986, 8 : 26 UT from La Silla. Camera 1 : 2/110 mm, filter IF λ 4260, IIIa–F hypersensitized, exposure time 110 minutes.*

Figure 3: *Comet P/Halley on April 17, 1986, 2 : 00 UT from La Silla. Camera 1 : 2/110 mm, filter IF λ 4260, IIIa–F hypersensitized, exposure time 100 minutes.*

the Bochum telescope could be used for photometric parallel measurements. We are very grateful to ESO for granting us this possibility although our application for it was somewhat late. We thank especially the Director General, Prof. Woltjer, Mr. Schuster, Mr. Hofstadt, Mr. Bauersachs and Mr. Perez for their support.

On February 12 we arrived at La Silla coming from icy Europe; the temperature difference was 40 degrees. After setting up our equipment not far from the 61-cm telescope we observed P/Halley photographically for the first time on February 17 in the bright morning sky in the light of CN. Some days later the tail had developed so well that it could be observed easily with the naked eye. On February 22 we detected a double ion tail and six well-separated dust tails. The opening angle of the whole tail increased to more than 160 degrees. This

Figure. 4: *Comet P/Halley on March 16, 1986, 7 : 02 UT from La Silla. Flat-Field Camera 1 : 4/760 mm, filter OG 530, 103a–F hypersensitized, exposure time 15 minutes.*

Figure 5: *Comet P/Halley on March 16, 1986, 7:56 UT from La Silla. Flat-Field Camera 1:4/760 mm, filter IF λ 4260 (CO⁺), 103a–F hypersensitized, exposure time 60 minutes.*

Figure 6: *Comet P/Halley on March 16, 1986, 9:15 UT from La Silla. Flat-Field Camera 1:4/760 mm, filter IF λ 3880 (CN), 103a–F hypersensitized, exposure time 60 minutes.*

Figure 7: *Comet P/Halley near the radio galaxy NGC 5128 on April 15, 1986, 1:22 UT from La Silla. Flat-Field Camera 1:4/760 mm, filter GG 410, 103a–E hypersensitized, exposure time 20 minutes.*

the nucleus and the reactions with the solar wind, and (2) determination of abundances, production rates, and lifetimes of certain molecules as a function of the heliocentric distance of the comet. But these procedures are expected to take some time . . .

(Further information about the Bochum Halley campaign has been given in *Sterne und Weltraum* **25,** pages 221 (4/1986), 280 (5/1986) and 298 (7–8/1986).

Spectroscopy, Photometry and Direct Filter Imagery of Comet P/Halley

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The return of Comet P/Halley, as well as the related space missions, added to the intrinsic interest of comets and their importance in connection with the cosmogony of the Solar System, no doubt explain the high level of activity devoted to the study of these celestial bodies in recent years. While considerable progress has been achieved in this field, thanks to the use of new observational techniques and to numerous theoretical works, we are forced to admit that quite a long way remains ahead before a satisfactory understanding of the nature and origin of comets is to be reached. The unique opportunity offered by Comet Halley to gather an unprecedented wealth of original data of all kinds has given rise to a truly worldwide mobilization and we in Liège wanted very much to participate in this remarkable enterprise, in view of the continued interest shown by our institute in cometary physics and spectroscopy, ever since Professor Swings' pioneering work. When it was realized that our plans had so much in common with those of our colleagues from the Universities of Michigan, Texas, and Brussels, we decided all together to join our efforts.

The principal aim of our programme is to derive some information on the physical characteristics of the cometary atmosphere (distribution laws of densities, temperature and velocity as functions of the distance to the nucleus) by analyzing in detail the relative intensities of the molecular emissions, their variation with the position on the comet's image, as well as the evolution of these properties as the distance from the Sun, r, changes. The procedure followed to interpret the relative intensity distributions is to construct synthetic spectra integrating through the coma and taking into account radiative processes (resonance-fluorescence excitation by the solar radiation, sensitive to the radial velocity of the molecules relative to the Sun – the so-called "Swings effect") as well as collisional effects which may be