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Comets – Distant and Nearby

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Comet P/Halley Observed at ESO

With the recovery of Comet Halley on October 16, 1982, the interest in comets has received a new impetus. Everybody knows this famous comet and when the predicted orbit for its current return was published in 1977, several astronomers started a systematic search to recover the object.

Apart from the honour of being the first to see P/Halley (P/ is used for *periodic* comets with periods of less than 200 years), there was also a very practical aspect. No less than four spacecraft are planned to intercept Comet Halley in 1986, and it was of obvious necessity to learn, as early as possible, the exact orbit of the comet upon its return.

Following the recovery 5 m Palomar observations, teams of astronomers at the Kitt Peak 4 m and the Canada-France-Hawaii 3.5 m telescopes were immediately successful in detecting P/Halley. At ESO, the first (unsuccessful) attempts were already made in 1980, with the ESO 3.6 m telescope on photographic plates and with the Danish 1.5 m telescope by means of the electronographic McMullan camera. These attempts were heroic but since at that time, as we know now, the comet's magnitude was certainly much fainter than 25, they were doomed from the beginning.

With the installation of a CCD camera at the Danish 1.5 m telescope, it became possible, during the past year, to observe extremely faint objects. It was, however, still somewhat doubtful whether it would be possible to observe P/Halley which according to the American and French observations would have a magnitude of approximately 24.5. The main problem was that extremely accurate tracking of the comet would be necessary to keep the few photons received from it falling on the same pixels of the CCD camera throughout the exposure. Since it was impossible to "see" the comet, *blind tracking* was necessary, that is letting the telescope follow the predicted motion of the comet, but without any possibility of checking that it actually does so.

Through a combination of very good seeing, exceedingly accurate tracking and admittedly a bit of good luck, Holger Pedersen was finally able to obtain the first ESO picture of Comet Halley on 10 December 1982. Near the centre of a 45-minute exposure through a broad-band filter (3700–7800 Å) there was a very weak spot which could barely be seen on the

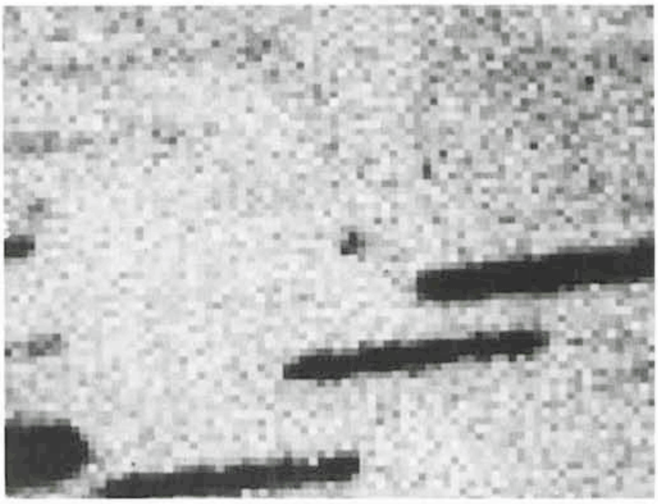

Fig. 1: *P/Halley as seen on 45-min broad-band (3700–7800 Å) frame, obtained with a CCD on the Danish 1.5 m telescope, January 14, 1983. 1 pixel = 0.47 arcseconds.*

Prof. Otto Heckmann, 1901–1983

It is with deep regret that we have to announce the death of Professor Otto Heckmann on 14 May 1983. Professor Heckmann was Director General of ESO from 1962 to 1969. An obituary will follow in the next issue of the *Messenger*.

cleaned and field-corrected picture. He brought the frame to ESO, Garching, where we were able to measure the exact position of the "spot", and we were happy to learn that, since the measured position coincided exactly with that predicted from the orbital motion, it was indeed P/Halley which could be seen in the frame.

H. Pedersen was again successful on 14 January 1983 when he obtained the picture shown here. Now there was no doubt about the reality of the object and, again, the position was correct. Indeed, the residuals from the expected motion are less than 1 arcsecond, and the ESO observations were a good contribution to the exact determination of the orbit and were therefore of some help to the planned spacecraft experiments.

Is Halley Active?

On the first picture the measured magnitude was 24.5 ± 0.3. It is indeed impressive that such a faint object can now be observed with a 1.5 m telescope! However, the measured magnitude on the January 14 picture was 23.5 ± 0.2, or 1 magnitude brighter! Even with the expected uncertainties it thus appears that P/Halley underwent a definite brightening during a few weeks. This could be due to the onset of nuclear activity, that is vaporization of the ices in the comet nucleus or, perhaps, rotation of the nucleus.

Nobody knows for sure what the nucleus of the comet looks like, and the ESO observations cannot alone give any answer to that. Still, with the addition of further observations at other telescopes, it may perhaps become possible to learn at which distance the activity of the nucleus first sets in and also whether the tiny object (estimated at 6 km diameter by the French group) rotates, or not.

H. Pedersen and I expect to carry through a long series of observations of P/Halley during its next opposition in early 1984. We hope, by obtaining several frames every night during a period of two weeks, to learn whether regular light variations are present and to measure the rotation period, if possible.

International Halley Watch

In order to coordinate observations of Comet Halley, the International Halley Watch has been set up. This group of astronomers will take care of the planning of observations and the subsequent archiving of all data obtained during this Comet Halley apparition, so that future generations of astronomers can better profit from all the efforts. Anybody interested in performing observations of P/Halley should therefore contact one of the lead centers. He will then receive further information.

Please write to: Dr. Ray L. Newburn – IHW Lead Center, Western Hemisphere, Jet Propulsion Laboratory, 4800 Oak Grove Drive, Pasadena, CA 91103, USA; or Prof. J. Rahe – IHW Lead Center, Eastern Hemisphere, Astronomical Institute, Sternwartstraße 7, D-8600 Bamberg, FRG.

Comet 1983 d Passes the Earth

When Comet Halley was first observed at ESO, it was still at a distance of 10.5 AU or roughly 1,600 million km, or beyond the orbit of Saturn.

At the opposite range of distances, a newly discovered comet, IRAS-ARAKI-ALCOCK (1983d), passed only 4.5 million km from the earth on 11 May 1983. The European Southern Observatory was also involved in observations of this object, but in a somewhat unusual way.

When the IRAS satellite detected an infrared source in the sky towards the end of April 1983, it was not immediately

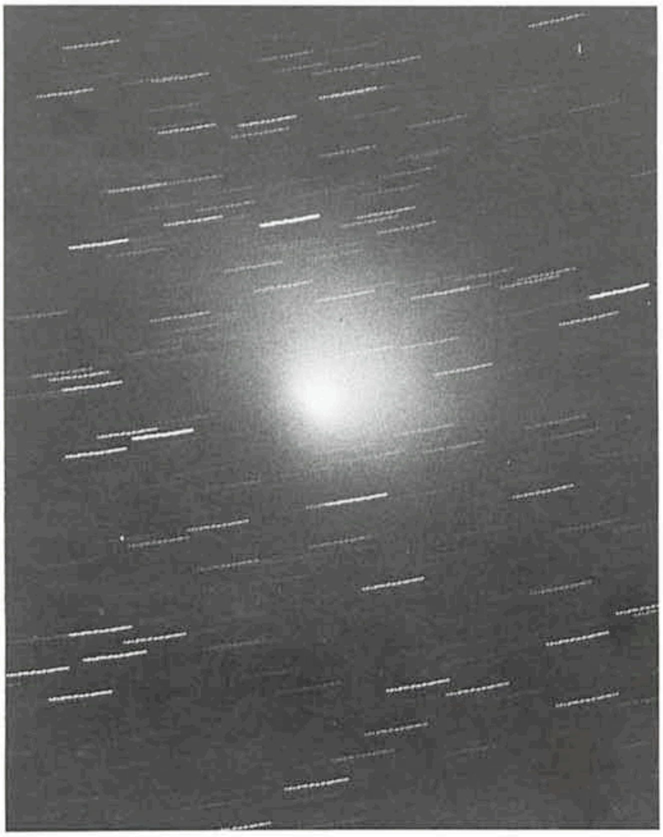

Fig. 2: *Comet IRAS-ARAKI-ALCOCK (1983d) observed by Mr. P. Stättmayer at Herrsching near Munich, on May 9.8 1983; exposure time 12 minutes on 103-aE emulsion.*

known what kind of object it was. However, two amateur astronomers independently discovered 1983d, and by connecting the positions given by IRAS, Araki (Japan), and Alcock (UK), Dr. Brian Marsden of the IAU Central Telegram Bureau was able to calculate a preliminary orbit. It immediately became clear that 1983d would pass very close to the earth and that the object could become of exceptional interest. A telegram went out from the Bureau stressing the paramount importance of obtaining accurate positions in order to improve the precision of the orbit, so that observations could be made with large radio and optical telescopes at the closest passage.

Upon reading the telegram in the ESO library at Garching, I wondered whether it would be possible in some way to obtain observations from Munich. Not being at La Silla, I felt that it would be useful to see whether any means were available, near the ESO headquarters, of obtaining these crucial positional measurements. I therefore contacted Mr. Peter Stättmayer of the Munich Volkssternwarte who runs an amateur observatory in Herrsching near the beautiful Ammersee, just south of Munich, and was happy to learn that he was willing to try to make photographic exposures of the object. Although the weather was not very cooperative, Mr. Stättmayer made a series of short exposures during the night between May 9 and 10, when the comet was moving rapidly across the sky at a distance of only 8 million km. We measured the 35 mm Tri-X frames in the same way as the large ESO Schmidt plates by means of the OPTRONICS measuring machine at ESO, Garching, and although the plate scale was only 3.5 microns per arcsecond (roughly 4 times smaller than that of the ESO Schmidt), it was possible to obtain an accuracy of approximately ± 2 arcsec. The principal error source was the diffuseness of the comet coma. We transmitted the positions to Dr.

Marsden about 12 hours after the observations and were quite happy to learn that they contributed significantly to the improvement of the orbit and thereby directly to the success of e.g. the radar experiments with the Arecibo and Goldstone antennas.

Late in the evening of 11 May, just after the closest approach to the earth, it was again possible to observe through a hole in the clouds over Munich, and this time Dr. Marsden received the positions only 4 hours later. (It should here be noted that this was only possible because there is no speed limit on the German highways!)

The above story is a nice illustration of how amateur astronomers can contribute significantly to our science. Without the dedication of Mr. Stättmayer, it would not have been possible to obtain these crucial observations and thus to help the professional astronomers pointing their telescopes in the correct direction.

Absolute Photometry of HII Regions

J. Caplan and L. Deharveng, Observatoire de Marseille

Today it is possible to observe HII regions not only in the visible part of the spectrum, but also in the radio, millimetre, infrared, and ultraviolet ranges. Combining photometric data from several of these wavelengths helps us to understand the properties of HII regions and of their exciting star clusters. But often, rather surprisingly, the measurements are quite good at these "exotic" wavelengths but only qualitative, or of low accuracy, in the optical region.

A few years ago we decided to try to remedy this lack of accurate absolute surface photometry of emission nebulae by constructing a special photoelectric photometer, which was modified in 1981 by the addition of a scanning Fabry-Perot interferometer. We have since used it at the Observatoire de Haute Provence in France and at the 50 cm and 1.52 m ESO telescopes at La Silla.

Choosing the Instrument

A grating instrument was immediately rejected. This kind of device is good for measuring accurate relative intensities of lines, but it uses an entrance *slit,* which has an inconvenient shape for comparison with radio maps and with photographs; also, total flux measurements are difficult. We chose photoelectric photometry with interference filters (and, later, a Fabry-Perot) because it is sensitive, accurate, can be put on an absolute scale using standard stars, and works with a circular diaphragm of much larger area than a slit. This makes it fairly easy to calibrate photographs, and we can generally arrange to have a diaphragm comparable in diameter to the beam of a radio telescope so as to facilitate radio/optical comparisons.

Nebular photometry requires accurate knowledge of the transmission curves of the filters used. Unfortunately, interference filters are often rather non-uniform in their transmission characteristics, especially near the edges. Therefore we place

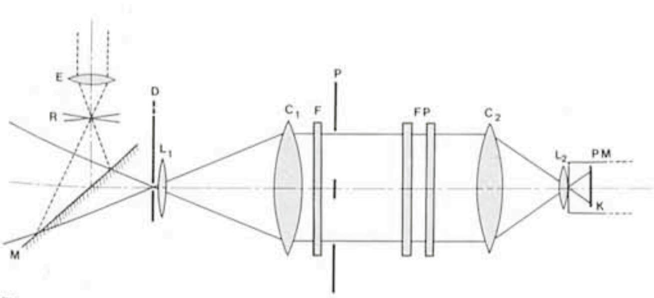

Fig. 1: *Basic optical design of the spectrophotometer, showing principal components. E: eyepiece; R: reticle; M: mirror; D: diaphragm; L_1: field lens; C_1: collimating lens; F: filter; P: mask (image of telescope entrance pupil); FP: scanning Fabry-Perot; C_2: imaging lens; L_2: Fabry lens; PM: RCA C31034 photomultiplier; K: cathode.*

our filters in a collimated beam, near the image of the entrance pupil, rather than near the focal plane of the telescope as we do for less critical applications. Furthermore, we calibrate our filters *in situ:* we leave them in our instrument and illuminate the entrance aperture with light from a monochromator. Exactly the same part of each filter is used during calibration and during the observations, thanks to a mask placed at the image of the entrance pupil and adjusted at the telescope.

Another requirement is high-accuracy pointing. Unlike stellar photometry, in general not *all* of the light from our emission region falls within the diaphragm. Thus interpretation of the observations requires accurate knowledge of the diaphragm's position. There is not always a star visible at the desired coordinates, so offset pointing is necessary. At the ESO 50 cm telescope, pointing of the telescope itself is sufficiently good for us to offset from a nearby star, but such accuracy is unusual. Hence our spectrophotometer has an x-y offset system which uses micrometer screws to shift the position of the guiding reticle and the eyepiece with respect to the diaphragm. This system was particularly useful at the ESO 1.5 m telescope. At the beginning of our observing run, we measured the relative positions of several stars and (by least-squares) derived the plate scale and a rotation parameter. We were then able to do offset pointing to better than a second of arc.

Photometric methods. So far we have described the basic properties of our instrument – as shown in Fig. 1 – except for the Fabry-Perot. Before proceeding further, it is useful to consider how we would use the photometer if we did not have the FP.

First, we must calibrate the photometer-telescope combination, using observations of standard stars through continuum filters for which the transmission curves have been accurately measured. This gives us an *effective collecting area,* which includes the effects of telescope size, reflectivities, photomultiplier quantum efficiency, etc. (but *not* the filter transmission). Now we can observe an H II region using a narrow-band (10 or 15 Å) filter centered on an emission line. Dividing the emission-line signal (in photons per second) by the transmission of this filter and by the effective collecting area gives us the line flux of the region. (Of course, we must correct for atmospheric extinction.)

The main problem is that, even with such filters, there is often a fair amount of continuum radiation which gets through

The article by D. Enard and G. Lund about "Multiple-Object Fiber Spectroscopy" will be published in the next issue of the *Messenger* (September 1983) and not in the present one as was announced in the *Messenger* No. 31.