Figure 2. The dust loss rates were computed adopting the albedo Ap($\alpha$) = 0.02 (Hanner and Newburn, 1989, $43° < \alpha < 51°$, phase angle $\alpha$ in Table 1). The slow increase of the dust number loss rate is mostly due to the decreasing size interval which was considered. The mass loss rate related to isotropic dust ejections shows a wide maximum at $t \approx -120$ (days related to perihelion), that is at $r \approx 2.4$ AU, whereas the mass loss rate related to strongly anisotropic ejections is about constant. Large uncertainties of the loss rates are due to the poorly known albedo of large grains. The loss rates shown in Figure 2 are inversely proportional to the assumed value of Ap($\alpha$). The uncertainties of the dust bulk density are much less important. In fact the mass loss rate computed by means of dust tail analysis is independent of the dust density (Fulle, 1989), whereas the number loss rate is directly proportional to the square of dust density. For plates exposed to the red pass-band, the contamination by plasma ($H_2O^+$) is a concern along the prolonged radius vector. This is reflected in the residual instability of the solutions for $t > -60$, which explains the large dispersion of the mass loss rates and of the power index of the size distribution. However, plasma contamination to the left-hand side of the tails is very improbable, so that for $t < -60$ the solutions should be free of significant errors.

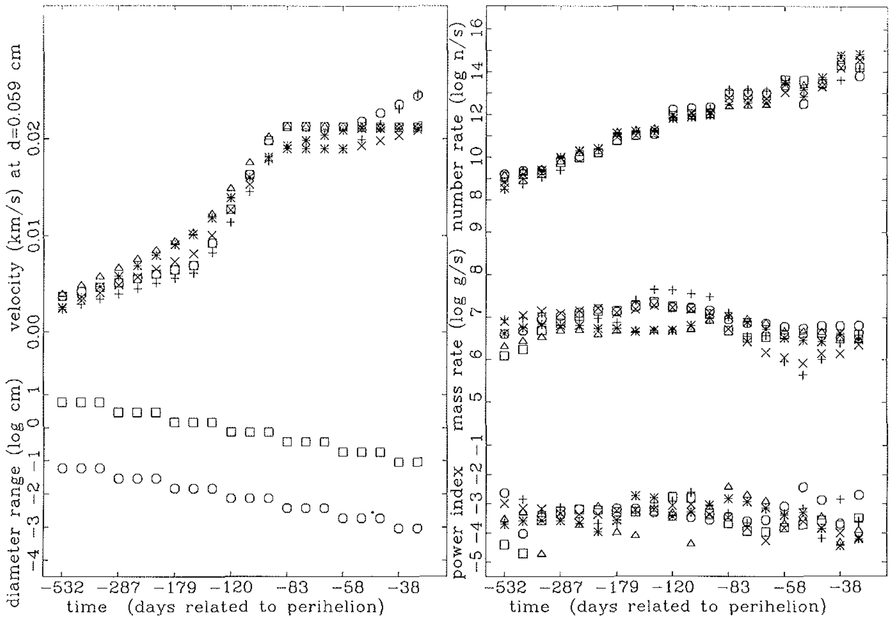


Figure 2: *Dust environment of Comet Wilson 1987 VII assuming the albedo Ap($\alpha$) = 0.02: the dust loss rates (depending inversely on Ap($\alpha$)), the dust ejection velocity, the power index of the time-dependent size distribution and the diameter interval to which all the solutions are related. The symbols are related to Table 2. The time sampling steps correspond to true anomaly steps of 5°.*

We find that C/1987 VII produced more than $10^6$ g $s^{-1}$ of dust during two years before perihelion, and this may be related to its high relative luminosity at the first observations. Our results suggest that the mass loss rate does not increase close to perihelion, in agreement with the results of Hanner and Newburn (1989). The power index of the size distribution shows small variations. We find that its value is higher than −4, and this implies the release of very large grains. This fact is confirmed by the time averaged size distribution, characterized by the very high power index of $-3.0 \pm 0.1$. These results show that the dust loss of Comet Wilson 1987 VII was already significant at $r \approx 7$ AU, a Sun-Comet distance even larger than that observed for Comet Kohoutek ($r \approx 5$ AU). At these distances the gas production should be dominated by $CO_2$, and we observe also a maximum of the dust mass loss rate and a fast increase of the dust ejection velocity when the sublimation of $H_2O$ becomes efficient.

## Acknowledgements


The plates were digitized by means of the PDS of the Padova Astronomical Observatory. The calculations were performed on the Apollo computers of Astronet Trieste centre. The diagrams were generated using Astronet AGL standard graphics. We thank P.D. Usher for useful discussions concerning the plate calibration. This work has been supported by a PSN/CNR grant to Prof. C. Barbieri.


### *References*


Fulle, M., 1989, *Astron. Astrophys.* **217,** 283.
Johnson, H.L., 1966, *Annual Review Astron. Astrophys.* **4,** 193.
Lasker, B.M., C.R. Sturch, C. Lopez, A.D. Mallama, S.F. McLaughlin, J.L. Russell, W.Z. Wisniewsky, B.A. Gillespie, H. Jenkner, E.D. Siciliano, D. Kenny, J.H. Baumert, A.M. Goldberg, G.W. Henry, E. Kemper and M.J. Siegel 1988, *Astrophys. J. Suppl. Ser.* **68,** 1.
Hanner, M.S., and R.L. Newburn, 1989, *Astron. J.* **97,** 254.


# Chiron's Blue Coma


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### The Most Distant Minor Planet Known

Among the nearly 4500 minor planets which have been numbered until now, (2060) Chiron is by far the most distant and certainly one of the most unusual. It moves in a rather eccentric orbit between the giant planets Saturn and Uranus and each revolution lasts just over 50 years.

Chiron was discovered in late 1977 by Charles Kowal of the Palomar Observatory. He found a slow-moving, 18-mag object on plates taken with the Palomar Schmidt telescope and within a few weeks, enough positions had been measured to compute a preliminary orbit. It was later identified on other photographic plates dating back to 1895, and soon the unique nature of Chiron was firmly established.

At the time of its discovery, Chiron was classified as a "minor planet", and it was obvious that it must be a very large one, in order to be so bright at this large distance. Depending on its ability to reflect sunlight (albedo), the diameter was estimated as somewhere between 100 and 250 kilometres. Kowal and other minor planet specialists felt that Chiron might be the first of a new family of minor planets, and it was inofficially de-

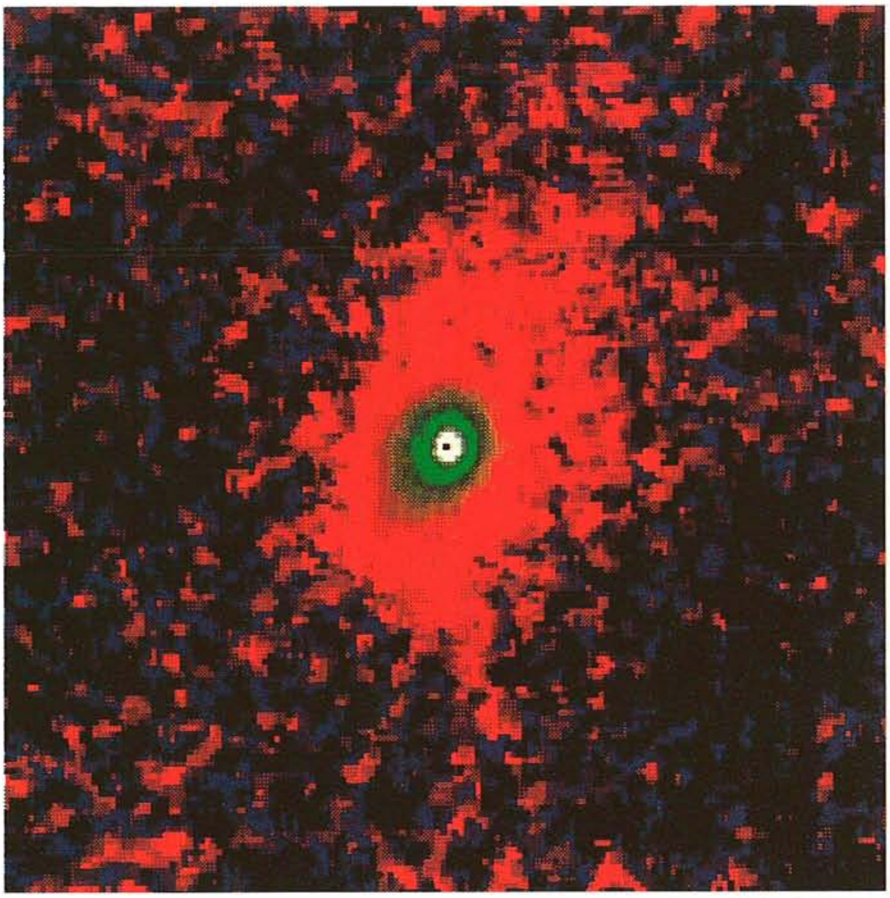

Figure 1: *False-colour reproduction of Chiron's coma in visual light. The field size is 70 × 70 arcsec; North is up and East is to the left. Galactic stars have been removed from this picture, which is a composite of 20 frames with a total integration time of 107 min. The outer isophote corresponds to a surface brightness of V ~27.5 mag/arcsec².*

cided that other members of this class would also be given the names of mythological Centaurs, half man and half animal like Chiron itself. However, despite various search programmes, notably by Kowal at Palomar, no other members of this class have been found until now, though some of the minor satellites of the outer planets may possibly be captured objects which are physically similar to Chiron.

## Minor Planet Or Comet?

The first years after its discovery, Chiron looked like a minor planet and behaved like one. Slowly moving towards its perihelion – which it will reach in early February 1996 at heliocentric distance 8.48 A.U. – its brightness rose gradually through the 1980's, exactly at the rate predicted for an inert body which shines by sunlight reflected from its surface.

However, in 1988 a strange phenomenon was observed. Comparing with observations from 1986, D.J. Tholen and his collaborators working at the NASA Infrared Telescope on Hawaii noticed that Chiron suddenly appeared to have brightened by several tenths of a magnitude more than predicted (IAU Circular 4554). This trend continued and by the end of 1988, Chiron was almost one magnitude brighter than it ought to be.

No other minor planet is known to have behaved this way and the idea was soon put forward that Chiron is actually a comet, i.e. a body consisting of ice and dust, rather than a minor planet of solid rock. Some astronomers also thought of a minor planet whose surface is partly covered by a layer of ices. A natural explanation of the brightness increase would then be the sublimation of ices from the surface, leading to the creation of a "coma", a surrounding cloud of icy particles and possibly also some dust, released in the same process. Such a coma would reflect the sunlight and thereby increase the observed brightness.

A coma was indeed seen around Chiron in early 1989 by Karen Mees and Michael Belton with the Kitt Peak 4-m telescope (IAU Circular 4770). It had the form of a 5-arcsecond, very weak extension towards southeast. Further observations with the Canada-France Hawaii Telescope by Karen Mees in early 1990 confirmed the presence of this coma (IAU Circular 4947).

## Observations at ESO

During four nights in late February this year, I had the opportunity to observe Chiron and its newly discovered coma with a CCD camera at the Danish 1.5-m telescope at La Silla. My main object of study, Comet Halley, was too low in the sky to be observed during the first hour of the night and I therefore took this opportunity to point the telescope towards Chiron. Both objects have a very faint coma around a point-like light source, but while the magnitude of Halley's nucleus was only 24–25, Chiron was much brighter, about 16.5 in the visual range. It was therefore necessary to restrict the integration time to a few minutes in order to avoid overexposing (saturating) the image of Chiron with the undesirable side-effects of photometric non-linearity and column "bleeding".

In all, about three hours of exposure was obtained in the two standard colours B (4000–4800 Å) and V (5000–5800 Å). The cleaning of the frames was quite laborious, in particular because of the rather large number of pixels with deviating sensitivity on this CCD chip (ESO No. 15). The sky background was also rather "dirty": there were comparatively strong interference fringes in the V-band, most likely due to the exceptional strength of the atmospheric oxygen line at 5577 Å, at this time near solar maximum activity.

Adding the frames in the V-band produced the false-colour image reproduced here (Fig. 1), for the first time showing the large extent of the Chiron coma and allowing a more detailed study of its morphology. We see first of all that it is elliptically shaped with the major axis in NW-SE direction. It can be followed to about 20 arcseconds from Chiron where the surface brightness is near 28 mag/arcsecond², i.e. ~7 mag, or over 600 times, fainter than the sky emission in the V-band (Fig. 2).

What may be even more interesting is that the colour of this coma is rather blue; at 5 arcseconds from the centre, (B–V) = 0.3 ± 0.1, and it looks as if the coma reddens slightly outwards to about (B–V) = 0.45 at 12 arcsecond distance. The colour of Chiron itself was measured in the early 1980's as (B–V) = 0.70 ± 0.02, i.e. near the solar value (0.65) and typical for a C-type minor planet (see also the article by di Martino et al. in this *Messenger* issue on page 50). Thus the coma is significantly bluer than the surface of Chiron. This is also confirmed, when the predicted light contribution from Chiron itself is subtracted from the central condensation of

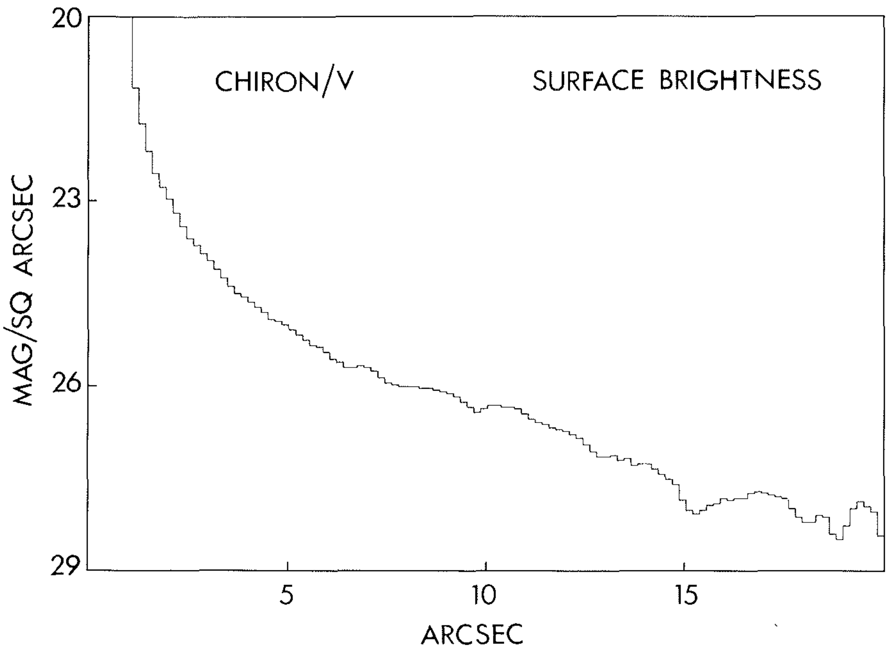


Figure 2: *Mean radial luminosity profile in V of Chiron's coma, after subtraction of the contribution from Chiron itself. The abscissa indicates the distance from the centre in arcseconds (1 arcsec = 7680 kilometres projected); the ordinate is the surface brightness in magnitudes per square arcsecond. The corresponding sky background emission is ~21 mag/arcsec$^2$.*

light; the remaining image, which is presumably that of the coma cloud immediately surrounding Chiron, is also blue, (B–V) = 0.4 ± 0.1.

The blue colour of the coma is most likely due to the scattering of the sunlight by small particles. The possible reddening outward can be explained by the destruction of the smallest particles as they drift away from Chiron, so that the relative content of larger particles increases outwards. This is therefore in general agreement with the idea that the coma is caused by the sublimation of ices on the surface, a process that apparently started when Chiron's inward-bound orbital motion brought it within ~12 A.U. of the Sun.

It will of course be necessary to study the coma in more wavebands before it is possible to be more specific about the nature of these particles, their size distribution, chemical composition and density.

## Chiron's Rotation

By careful measurement of the brightness of the central condensation, it was possible to confirm the light variation noted earlier by Bus et al. (*Icarus,* **77,** p. 223, 1989), on the basis of CCD measurements in 1986 and 1988. Thanks to the longer time interval, the period of this variation, i.e. the rotation period, can now be estimated with higher accuracy: P = 5.91783 ± 0.00005 hours.

The absence of any significant, night-to-night changes in the coma structure, and the lack of evidence of "jets" or "spirals" in the coma, leaves the impression that the evaporation occurs over a larger surface area, rather than from isolated vents, like those detected on the nucleus of Halley. It can be seen (Fig. 1) that the innermost part of the coma is somewhat asymmetrically placed with respect to the nucleus. The direction of this elongation does not coincide with the direction to the Sun or the direction of orbital motion, both vectors being near West (p.a. = 269° and 289°, respectively).

It is in principle possible that this asymmetry is connected to the direction of the rotation axis, the projection of which might be perpendicular to the direction of inner coma elongation. Since the evaporation from the surface is likely to be strongest during the "Chiron afternoon", just after the most intensive solar heating at "noon", the direction of rotation would appear to be from NW to SE, as seen projected onto the sky. However, it should not be forgotten that even the inner coma features are still at several arcseconds' distance from the centre of light, i.e. more than 20,000 km from Chiron's surface. They may therefore not be directly connected to phenomena on or just above the surface.

## Future Investigations

Details about these new observations of Chiron's coma will be reported in a forthcoming paper in *Astronomy & Astrophysics.* They pose a number of interesting questions which can only be answered by a more detailed investigation. For instance, it would be most desirable to perform photometry of the coma in other wavebands, also in the infrared region. Apparently, no gaseous emissions lines have been observed so far in the spectrum of Chiron, but it may well be that a gaseous component of the coma can be detected at a later time.

There is little doubt that Chiron will be a popular target for solar system astronomers during the coming years.

# New Communication Link Between Garching and La Silla

*A. WALLANDER, ESO*

## 1. Introduction

In the beginning of February a new permanent communication link between ESO Headquarters and observatory came into operation. This new 64 kbps digital link will, among other things, become the backbone for remote control of the New Technology Telescope (NTT). Although the physical distance between Garching and La Silla will always be the same, the new communication link will make the logical distance between people working in Europe and South America smaller. It will contribute to a higher level of integration of the organization increasing the productivity both in technological and scientific areas.

La Silla and Garching have already been linked on a permanent basis for several years via an analogue leased line. Astronomers and engineers have become accustomed to call up colleagues on the other side of the Atlantic