5. *The motion of a condensation in Halley's Comet*

E. J. Öpik

(No abstract received)

6. *Some results of statistical investigations of Comets with plasma tails*

Rhea Lüst

Statistical investigations of comets with plasma tails, observed between 1892 and 1957, have been carried out by D. Antrack, L. Biermann and R. Lüst in order to study their interaction with the solar wind. The results are as follows:

(1) No dependence could be found between the number of comets with plasma tails and the general level of solar activity.

(2) Generally, plasma tails are not observed at solar distances of more than about 1·5 A.U. However, Comet Humason (1961*e*) has possessed a CO^+-tail already at distances of about 4–5 A.U. The comet has been in low heliocentric latitudes.

(3) No dependence could be found between the number of comets with plasma tails and their heliocentric latitude, as expressed by the latitude of their perihelia. The slight decrease towards the south pole of the ecliptic does not seem to be real. There are, however, indications for a small increase in a belt of about $\pm 15°$ latitude around the ecliptic plane.

(4) The average of the angle between the radius vector from the Sun and the axis of the plasma tail seems to be the same for comets with direct and retrograde orbits.

These results indicate that the quiet, steady component of the solar wind is already sufficient to create and maintain a plasma tail (1). The state of the interplanetary gas does not seem to change drastically in distances beyond the Earth's orbit, at least in regions close to the ecliptic plane (2). It also seems to be the same in larger distances from the ecliptic towards the poles out to solar distances of about 1·5 A.U. where most of the comets have been observed (3). There is no indication that the interplanetary gas co-rotates with the Sun in regions of more than 0·5 A.U. which is the lower limit of the solar distances of the comets investigated (4).

7. *Photo-electric observations of Comet Alcock* (1963*b*) *during the outburst*

V. Vanýsek

The brightness outburst of Comet Alcock (1963*b*) on 1963 May 29, was noted by several observers. A successful series of photo-electric observations of this phenomenon was obtained at Ondřejov Observatory (**1**). Scanning through the cometary head was applied in order to determine the intensity distribution in the coma and the density of the CN molecules. A combination of colour filters isolates the CN band at 3880 Å and the *U* spectral region of the *UBV* colour system. The values of energy emitted by CN molecules and continuum were determined from the known spectrophotometric data of the comparison star β Comae.

The available visual observations (**2**) located the maximum of outburst at May 29, but the photo-electric observations indicated the first increase in brightness—particularly the increase in band intensities—one day earlier, on May 28. During the outburst very interesting changes in intensity distribution were observed:

(1) The exponent κ representing the surface intensity distribution by a simple formula $I = I\rho^{-\kappa}$ (ρ = distance from the nucleus) increased on May 28 from 0·75 to 1·10 in an area around the nucleus of about 2×10^4 km diameter. At larger distances no significant change of exponent κ was observed. On May 31 the previous mean value of $\kappa \approx 2{\cdot}5$ at the periphery of the coma (about 6×10^4 km from the nucleus) decreased to $\approx 1{\cdot}0$. Then the same mean value held also to the very distant area of the head of the comet.

https://doi.org/10.1017/S0251107X00018915 Published online by Cambridge University Press

(2) The mean density distribution of CN molecules at a distance of 2×10^4 km increased on May 28 from 5 molecules per cm^3 to 17, but at a distance of about 6×10^4 km no increase of molecular concentration was observed. On May 31 molecular density at 2×10^4 km decreased to 9 molecules per cm^3, while, at the same time, at a distance of 6×10^4 km an increase to 5 molecules per cm^3 was observed.

The above-mentioned change in surface intensity and molecular concentration may be very important for the determination of the ejection velocity of gaseous particles. The time difference between the start of an increase in the production of parent molecules from the nucleus (May 28) and the maximum of the intensity of outburst (May 31) was at least 24 hours. The outflow of dissociated molecules from the coma required also more than 1 day, as can be concluded from the density distribution on May 31.

If we take into consideration the unusual activity in the cometary nucleus which lasted for about 48 hours, we obtain 1 km sec^{-1} for the velocity of extension of the gas in the coma. This conclusion agrees with the results mentioned by K. Wurm (3).

REFERENCES

1. Vanýsek, V., Tremko, J. *Bull. astr. Inst. Csl.*, **15**, 233, 1964.
2. Millard, J. J. *et al.* *Sky and Telescope*, **26**, 33, 1963.
3. Wurm, K. *Draft Report of IAU*, Hamburg, 1964.

8. *Recent observations of Comet Encke*

F. Dossin

During the 1964 return of Comet Encke the author was at Mt Stromlo Observatory, Australia, to study its spectrum. However, the brightness of the comet was much lower than predicted, and, in fact, the same decreased very rapidly within a few days.

July 6: the comet was seen visually through the 9-inch ($f/15$) refractor;
July 7: a direct photograph with a 5-inch ($f/5$) camera shows a diffuse image of about $m = 12$ (instead of $m = 9{\cdot}5$ as predicted);
July 9: guided exposure at the 5-inch camera showed a picture with a somewhat concentrated intensity of total magnitude 13·5; an attempt exposure for spectrum at the 74-inch reflector with a $f/1$ camera showed nothing after 24 minutes; an exposure with the Uppsala Schmidt ($f/3{\cdot}5$) objective-prism (400 Å/mm at $H\gamma$) revealed CN 3880 and $C_2$4737;
July 15: comet was seen at the Newton focus of the 74-inch telescope;
July 16: attempt with an 8-inch Schmidt camera ($f/1$) to photograph the comet was without success;
July 19: a 15 minutes exposure at the 74-inch Newtonian focus failed to show the comet; magnitude probably near $m = 20$.

After that day the Moon was too bright and no other long exposure was made.

The author has requested further observations during the dark of the Moon, in order to confirm (or infirm) the rapid decrease of brightness, which may be the disparition of Comet Encke.

9. *Interpretation of surface photometry of comets*

F. D. Miller

The distribution of surface brightness in the head of Comet Arend-Roland (1957 III) has been studied by Miller and Dennis, using five of a series of 17 exposures taken with the Curtis Schmidt on 103a–O emulsion without filter on the night of 1957 May 5. The primary purpose was to detect any alterations in the gross distribution of light which might have accompanied rapid changes in the type I tail and the rays. No such alterations were found.

This is the seventh detailed study of the surface brightness of this comet known to us; heretofore no attempt has been made to compare the isophote configurations with those predicted by head models.

Steady-state head models fall into two classes; those for neutral, decaying molecules experiencing negligible repulsive force; and those for dust particles which are repelled from the Sun in which, following a suggestion by Wallace and Miller, a dispersion in the velocity of ejection from the nucleus is incorporated. In both classes of models, a characteristic parameter has the dimensions of length; in the first class, the parameter is the mean distance travelled by a molecule prior to decay; in the second class, it is the most probable distance travelled by a dust particle ejected toward the Sun, before it is turned back by radiation pressure. It is noted that a number of published values of these parameters are of the order of 10^4 to 10^5 km, although the physical significance of the two parameters is quite different.

Neither model alone is suitable for comparison with our integrated-light isophotes of Comet 1957 III, but a judicious mixture of dust and gas yields isophotes which are a satisfactory first approximation to the observed forms, to a distance of 180 000 km toward the Sun, and 570 000 km into the tail.

Although photometry with suitable narrow-band filters is preferable to integrated-light observations, this preliminary analysis suggests that composite dust-gas models can usefully be compared with the numerous published observations of surface brightness made in integrated light.

10. *Na in tails of comets*

Yu. B. Levin

This communication appeared in the meantime in *Icarus*, **3**, 497, 1964.

11. *On a possible mechanism of comet outbursts*

O. V. Dobrovolskiy

This communication, which appeared in the Bulletin of the Commission on Comets and Meteors of the Astronomical Council of the U.S.S.R. Academy of Sciences, no. 9, 3, 1964, deals with enhancement of sublimation due to corpuscular bombardment (discussion of theoretical and experimental evidence with application to comets).

PART II. COMETS AND SPACE RESEARCH EXPERIMENTS

1. *Possibilities of cometary research by means of space experiments*

B. Donn

(Goddard Space Flight Center, Greenbelt, Maryland)

Serious gaps exist in our knowledge of comets which cannot be remedied by ground based observations. Laboratory experiments will provide certain data but some essential information will only be obtained by means of the techniques of space research.

Balloon observations with filters can search for intrinsically faint comets near the Sun or carry out standard observations as comets approach the Sun. Infra-red spectral scans using interference spectrometers and electronic Fourier transform computers are very suitable for comets because of the wide angle that can be used. The recent tentative identification of absorption bands of carbon polymers C_4 through C_{12} in the near infra-red makes such scans extremely exciting although the fluorescent excitation mechanism becomes weak in this region.

The availability of recoverable stabilized rockets with pointing controls will permit ultraviolet photographic and spectroscopic observations of bright comets to be made. A search for faint comets in the vicinity of the Sun can be combined with observations of bright comets.

A proposed artificial comet experiment runs into the problem of the rapid mechanism of formation of the observed radicals and ions. For an assumed instantaneous production, comparison with the luminosity of the coma of equivalent linear size for actual comets indicates about tenth magnitude for a $0{\cdot}5^\circ$ radius artificial coma from a 3 m diameter nucleus in a 24 hour orbit at a height of 36 600 km. With refined ground observing techniques and *in situ* detectors the experiment could be feasible.

The most significant space experiment and one which appears to be technically possible in the next decade is a comet probe. Present flight sensors indicate that densities of observed neutral and ionic particles in the coma would be possible at distances of about 10^5 km. Mass spectrometric measurements will be possible between 10^4 to 10^5 km. Measurements of magnetic fields to 10^{-6} gauss and solar proton fluxes of $10^6\ \mathrm{cm}^{-2}\ \mathrm{sec}^{-1}$ will permit determining the nature of the interplanetary plasma interacting with the coma.

The nucleus presents a major problem and its study should form a significant portion of the probe measurements. Photometric observations by a simple imaging device will yield sufficient resolution to determine the dimension and overall structure of the nucleus. The determination of mass and density may be possible with sensitive accelerometers.

2. *Brightness of natural and artificial comets*

E. J. Öpik

(No abstract received)

3. *Lifetimes of possible parent molecules of cometary radicals*

G. Herzberg

Recent observations of sudden brightness changes in comets suggest that the lifetimes of the parent molecules of C_2 and CN in the solar radiation field are only of the order of 1 to 3 hours. The question is whether there are parent molecules that fulfil this condition. Potter and Del Duca, in a recent paper, have investigated the ultra-violet absorption spectra of a number of possible parent molecules and derived their lifetimes by combination of the absorption cross section with the solar flux of photons. They have come to the conclusion that there is no parent molecule among those studied that would yield a sufficiently short lifetime. The main point of the present paper is to point out that discrete absorptions (not considered by Potter and Del Duca for the calculation of lifetimes) may in fact be subject to slight pre-dissociation undetectable by line broadening but still sufficient to give a high yield of dissociation. Examples of such apparently discrete spectra which under high resolution turn out to be diffuse, are the following: absorption bands of HCN in the region 1900–1300 Å, of ammonia in the region 2100–1400 Å, of ethylene in the region 1750–1550 Å, and of H_2O near 1250 Å. In some of these molecules inclusion of the diffuse bands may well bring down the lifetime of the respective molecules in the solar radiation field to the required level.

The question of successive photodissociation as in $NH_3 \rightarrow NH_2 \rightarrow NH \rightarrow N$ and $CH_4 \rightarrow CH_3 \rightarrow CH_2 \rightarrow CH \rightarrow C$ is briefly discussed and it is pointed out that the lifetimes of the intermediate free radicals are probably very short. Examples are also given of cases in which in the laboratory fairly complete photodissociations of complicated molecules have been observed.

4. *Artificial ion cloud experiments*

Reimar Lüst

Some years ago it has been proposed by L. Biermann and R. Lüst to create an artificial ion cloud in the interplanetary space for studying the state of the interplanetary medium. New data concerning excitation and ionization by sunlight are available for the alkali-earth metals Ca,

https://doi.org/10.1017/S0251107X00018915 Published online by Cambridge University Press

Sr, Ba and for the rare earth Eu which could be used for such an ion cloud. The expansion of the artificial cloud in the interplanetary space, the interaction of the ion cloud with the interplanetary medium and the minimum masses required have been estimated. The required minimum masses depend somewhat on the observational technique to be used. Estimates have been made for photographic and photo-electric methods and the results are given in the following table:

	Photographic methods	Photo-electric methods
Ca	33 kg	16·5 kg
Sr	38 kg	19 kg
Ba	4·8 kg	2·4 kg
Eu	4 kg	2 kg

Different chemical reactions have been used for the vaporization of the metals occurred. So far seven different experiments have been carried out with sounding rockets in the Sahara and in Sardinia. In these experiments metal vapour was released in the upper atmosphere.

Details can be found in paper 'Preliminary experiments for the study of the interplanetary medium by the release of metal vapour in the upper atmosphere' by H. Föppl, G. Haerendel, J. Loidl, R. Lüst, F. Melzner, B. Meyer, H. Neuss and E. Rieger, which will be published soon.

5. *NH_3-release experiments*

K. Wurm

Together with some colleagues of the Bergedorf Observatory (H. E. Schuster, I. Hiller, J. Rahe) and further supported by Dr Mannino, Bologna, and Dr Mammano, Asiago, the author took part in the observation of the ammonia release experiments which were carried through July 6 and July 8 on the Italian island Sardinia. The project leader of the NH_3-experiment was Dr Rosen, Liège. The payload was prepared by Dr Rosen and his collaborators. In the first launching a mass of 40 kg was released at a height of 200 km, in the second the same mass at 180 km.

In both experiments a rather bright cloud appeared which had instantly the shape of a symmetrical expanding ring. However, the bright phase of this expanding ring lasted only several seconds (3 to 4 seconds in the first launching, 6 to 7 seconds in the second one). The phenomenon was the same for other observers viewing the cloud from other directions, showing that we had to deal with an expanding shell. From the main observing station of the scientific groups (La Maddalena, north Sardinia) no trace of the cloud could be made out anymore after about 40 seconds. (After a letter of a person to the Bergedorf Observatory who viewed the cloud by chance from Tripoli, North Africa, from this place the bright expanding ring phase lasted several minutes, after which the ring had reached a diameter about 12 times that of the Moon.)

From the second launching, three well exposed spectra of the range λ 4000 to λ 6800 were obtained. The NH_3-experiments were intended to investigate whether the NH_3 molecules are dissociated to NH_2 when the same are exposed to the unweakened *UV* solar radiation. The NH_2 molecule has a resonance spectrum in the range λ 5000 to λ 7000 which appears generally well developed in cometary head spectra. On the spectra obtained there appears no trace of the bands of the NH_2 system, only an undisturbed scattered solar spectrum can be seen. The analysis of the physical conditions under which these spectra have been obtained (which is not yet finished) will probably allow to derive an upper limit of the product

$$\omega(NH_3 - NH_2 + H) \times p_e$$

wherein the factor ω designates the probability of dissociation by the *UV* solar radiation, and p_e the probability of a fluorescence excitation of a NH_2 molecule by the visible solar radiation.